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INFORMATION SOCIETY – IS 2008

Volume A

Inteligentni sistemi
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13.–17. oktober 2008 / October 13th–17th, 2008
Ljubljana, Slovenia

PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2008

V svojem enajstem letu ostaja multikonferenca Informacijska družba (http://is.ijs.si) ena vodilnih srednjeevropskih konferenc, ki združuje znanstvenike z različnih raziskovalnih področij, povezanih z informacijsko družbo. V letu 2008 smo v multikonferenco povezali osem neodvisnih konferenc. Informacijska družba postaja vedno bolj zapleten socialni, ekonomski in tehnološki sistem, ki je pritegnil pozornost vrste specializiranih konferenc v Sloveniji in Evropi. Naša multikonferenca izstopa po širini in obsegu tem, ki jih obravnava.

Rdeča nit multikonference ostaja sinergija interdisciplinarnih pristopov, ki obravnavajo različne vidike informacijske družbe ter poglabljajo razumevanje informacijskih in komunikacijskih storitev v najširšem pomenu besede. Na multikonferenci predstavljamo, analiziramo in preverjamo nova odkritja in pripravljamo teren za njihovo praktično uporabo, saj je njen osnovni namen promocija raziskovalnih dosežkov in spodbujanje njihovega prenosa v prakso na različnih področjih informacijske družbe tako v Sloveniji kot tujini.

Na multikonferenci bo na vzporednih konferencah predstavljenih 300 referatov, vključevala pa bo tudi okrogle mize in razprave. Referati so objavljeni v zbornikih multikonference, izbrani prispevki pa bodo izšli tudi v posebnih številkah dveh znanstvenih revij, od katerih je ena Informatica, ki se ponaša z 31-letno tradicijo odlične znanstvene revije.

Multikonferenco Informacijska družba 2008 sestavljajo naslednje samostojne konference:

- BIOMA 2008 – Optimizacijske metode po vzorih iz narave in njihova uporaba
- Inteligentni sistemi
- Jezikovne tehnologije
- Kognitivne znanosti
- Rudarjenje podatkov in podatkovna skladišča (SiKDD 2008)
- Slovenija pred demografskimi izzivi 21. stoletja
- Sodelovanje, programska oprema in storitve v informacijski družbi
- Vzgoja in izobraževanje v informacijski družbi

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi tudi ACM Slovenija. Zahvaljujemo se tudi Ministrstvu za visoko šolstvo, znanost in tehnologijo za njihovo sodelovanje in podporo. V imenu organizatorjev konference pa se želimo posebej zahvaliti udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

V letu 2008 sta se programski in organizacijski odbor odločila, da bosta podelila posebno priznanje Slovencu ali Slovenki za izjemen prispevek k razvoju in promociji informacijske družbe v našem okolju. Z večino glasov je letošnje priznanje pripadlo prof. dr. Ivanu Rozmanu. Čestitamo!

Franc Solina, predsednik programskega odbora
Matjaž Gams, predsednik organizacijskega odbora

FOREWORD - INFORMATION SOCIETY 2008

In its 11th year, the Information Society Multiconference (http://is.ijs.si) continues as one of the leading conferences in Central Europe gathering scientific community with a wide range of research interests in information society. In 2008, we organized eight independent conferences forming the Multiconference. Information society displays a complex interplay of social, economic, and technological issues that attract attention of many scientific events around Europe. The broad range of topics makes our event unique among similar conferences. The motto of the Multiconference is synergy of different interdisciplinary approaches dealing with the challenges of information society. The major driving forces of the Multiconference are search and demand for new knowledge related to information, communication, and computer services. We present, analyze, and verify new discoveries in order to prepare the ground for their enrichment and development in practice. The main objective of the Multiconference is presentation and promotion of research results, to encourage their practical application in new ICT products and information services in Slovenia and also broader region.

The Multiconference is running in parallel sessions with 300 presentations of scientific papers. The papers are published in the conference proceedings, and in special issues of two journals. One of them is Informatica with its 31 years of tradition in excellent research publications.

The Information Society 2008 Multiconference consists of the following conferences:

- BIOMA 2008 – Bioinspired Optimization Methods and their Applications
- Cognitive Sciences
- Collaboration, Software and Services in Information Society
- Data Mining and Data Warehouses (SiKDD 2008)
- Education in Information Society
- Intelligent Systems
- Language Technologies
- Slovenian Demographic Challenges in the 21st Century

The Multiconference is co-organized and supported by several major research institutions and societies, among them ACM Slovenia, i.e. the Slovenian chapter of the ACM. We would like to express our appreciation to the Slovenian Government for cooperation and support, in particular through the Ministry of Higher Education, Science and Technology.

In 2008, the Programme and Organizing Committees decided to award one Slovenian for his/her outstanding contribution to development and promotion of information society in our country. With the majority of votes, this honor went to Prof. Dr. Ivan Rozman. Congratulations!

On behalf of the conference organizers we would like to thank all participants for their valuable contribution and their interest in this event, and particularly the revieewers for their thorough reviews.

Franc Solina, Programme Committee Chair
Matjaž Gams, Organizing Committee Chair

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PREDGOVOR

Področje inteligentnih sistemov je stabilno in plodovito – že vrsto let tako v svetu kot Sloveniji in tudi na multikonferenci *Informacijska družba*. Stalnica je tudi trend, ko programi čedalje uspešneje opravljajo naloge inteligentnih pomočnikov in hkrati postajajo tudi bistveno bolj komunikativni v smislu govora in mimike. Inteligentni sistemi postajajo del naše vsakdanjosti.

Konferenca *Inteligentni sistemi* v letu 2008 ostaja mednarodna in vseslovenska hkrati. Prispevki so tako v slovenskem kot angleškem jeziku. Letos posebej izstopajo pristopi, ki temeljijo na izdelavi različnih modelov, analizi podatkov in uporabi različnih algoritmov preiskovanja.. Predstavljene so tudi konkretne aplikacije na področjih, kot so elektronsko komuniciranje, vodenje projektov, izobraževanje, medicina in računalniške igre. Ponovno so posebej razveseljivi prispevki mladih avtorjev, ki se srečujejo s kvalitetnim znanstvenim delom. Prispevki dokazujejo, da inteligentni sistemi nudijo pomembne prednosti pri reševanju zahtevnih praktičnih problemov.

Na letošnji konferenci Inteligentni sistemi 2008 je predstavljeno nadpovprečno število prispevkov kljub poostreni recenziji in posledično večjemu številu zavrnjenih prispevkov. Vsi prispevki so bili recenzirani s strani dveh anonimnih recenzentov. Oblikovne pripombe sva prispevala tudi predsednika konference.

Matjaž Gams in Marko Bohanec, predsednika konference

PREFACE

The area of intelligent systems is stable, providing useful results for several years – internationally and nationally and at the Multiconference *Information Society*. Not only that intelligent systems are becoming more and more advanced intelligent assistants, they are improving their communication skills in terms of speech and expression. Intelligent systems are becoming part of our everyday life.

The conference *Intelligent Systems 2008* remains a national and international event and presents papers written in both English and Slovenian languages. In this year, the focus is on approaches based on modeling, data analysis and utilisation of various search algorithms. Presented are applications in various problem domains, including elec2tornic communications, project management, education medicine and computer games. Particularly promising are contributions of young authors who present interesting practical applications of intelligent systems in different fields. The papers confirm that intelligent systems provide important advantages in the solving of difficult real-life problems.

The Proceedings of Intelligent Systems 2008 include over 20 papers. All submitted papers have been reviewed by two reviewers, this year resulting in more rejected papers due to higher criteria. Some additional suggestions for improvements were also provided by the chairmen of the conference.

Marko Bohanec and Matjaž Gams, Conference Chairs

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INTELIGENTNI VODNIKI PO TV PROGRAMIH

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POVZETEK

Članek podaja pregled stanja na področju razvoja inteligentnih vodnikov po TV vsebinah s predstavljenimi metodami za zajem, opis in filtriranje podatkov, profiliranje gledalcev in poosebljanje priporočil za ogled televizijskih oddaj.

1 UVOD

Nove televizijske tehnologije, kot so TV preko internetnega protokola (IPTV), video na zahtevo (VoD), osebni snemalniki (PVR), elektronski vodniki po TV programih (EPG), interaktivna digitalna TV (iDTV), P2PTV v omrežju enak z enakim in v zadnjem času poosebljeni sistemi za inteligentno priporočanje TV programov, počasi spreminjajo navade gledalcev, ki so bili še do desetletje nazaj, zgolj pasivni uporabniki, omejeni na klasično analogno TV, brez možnosti povratne komunikacije v TV mediju. Rešitve, kot je PVR, omogočajo ogled posnetih oddaj izven določenih urnikov in hitro preskakovanje reklam, kar spreminja uporabniške navade, kot tudi ponudbo vsebin in marketinških agencij. Predvajanje reklam za ciljno publiko, ki trenutno sedi pred TV zaslonom, je aktualna tema razvijalcev TV aplikacij. Prenos avdiovizualnih vsebin preko širokopasovnega dostopa skupaj z govorno telefonijo in internetom omogoča televiziji množico novih funkcionalnosti, kot so ocenjevanje oddaj, podajanje informacij o gledanosti, glasovanje, nakupovanje in nenazadnje integracijo TV v sistem inteligentnega doma, kar postavlja TV v popolnoma drugačen položaj v primerjavi s pasivnim zaslonom klasičnega TV sprejemnika v preteklosti.

V množici novih funkcionalnosti audio-video naprav in vedno večjih nepreglednih seznamih TV programov pa so elektronski programski vodniki nepogrešljiv del storitev ponudnikov TV vsebin. V zadnjem desetletju je zaznati množico inovativnih rešitev za priporočanje TV programov na osnovi uporabnikovih želja, navad, preteklega obnašanja, rangiranja in skupinske izmenjave informacij. V članku so predstavljene metode inteligentnih sistemov v inteligentnih programskih vodnikih po TV programih z nekaterimi naprednejšimi rešitvami v praksi.

2 OPIS PROBLEMA

Klasični elektronski programski vodniki pomagajo gledalcem pri iskanju željenih TV programov, podobno kot časopisni TV sporedi. Vendar klasični elektronski programski vodniki omogočajo predvsem omejen nabor funkcionalnosti, kot so podajanje osnovnih informacij o TV programu, kratki opisi oddaj in razporeditev TV programov v vnaprej pripravljene kategorije. Ročno razvrščanje TV programov po priljubljenosti je edina funkcija, s katero lahko uporabnik prilagaja uporabniški vmesnik, kar pa v vedno večji in nepregledni množici najrazličnejših TV programov ne omogoča uporabnikovim željam in navadam prilagojenega inteligentnega priporočanja TV oddaj. Inteligentni sistem, ki priporoča oddaje, se mora namreč zavedati, kakšne so želje in potrebe uporabnika, ki je trenutno pred TV zaslonom, kar pa zahteva množico podatkov, ki jih uporabnik praviloma ne želi ali ne zmore tekoče vnašati v sistem. V nadaljevanju se takoj srečamo s težavo, kako naj sistem sploh prepozna trenutne gledalce in nenazadnje, kakšna naj bodo priporočila, ko pred TV zaslonom hkrati sedi več članov družine. Potreba po podpori tovrstnih elektronskih programskih vodnikov z inteligentnimi metodami je takorekoč samoumevna. V literaturi so tovrstni pristopi opredeljeni predvsem kot poosebljena podpora pri izboru TV programov [6]. Sistem za priporočanje ogleda TV oddaj mora torej pokrivati naslednje zahteve [1]:

1. uporaba mora biti čim bolj enostavna, kar je mogoče zagotoviti preko intuitivnega, naravnega uporabniškega vmesnika;
2. sistem mora vzbujati zaupanje uporabnika; (3) podana priporočila morajo biti pregledno utemeljena, kar je še posebej pomembno v primeru priporočil za oddaje, ki jih uporabnik še ne pozna in
3. priporočila morajo biti čimbolj prilagojena trenutnim uporabnikovim željam in razpoloženju.

Lahko rečemo, da bodo gledalci dejansko uporabljali sistem le v primeru izpolnjevanja vseh treh zahtev, pri čemer je zadnja zahteva najbolj kompleksna, saj se želje po gledanju različnih oddaj ne spreminjajo samo glede na termin in pogostost gledanja oddaje, temveč tudi v odvisnosti od razpoloženja in navad uporabnika.

Navade uporabnikov pa je mogoče pridobivati tudi iz spremljanja uporabnikove interakcije z ostalimi medsebojno povezanimi napravami in sistemi v hišnem omrežju, iz katerih lahko sistem sklepa o navadah in željah uporabnika ter na ta način povečuje nabor znanja o uporabniku in tako izboljšuje točnost podanih priporočil (npr. v inteligentnem domu) [4].

Poznavanje gledalca ponudnikom vsebin in industriji oglaševanja omogoča povečevanje učinka prikazanih reklam. Usklajena TV reklama s trenutno vsebino gledane oddaje in prikazom v pravem trenutku, ko pred TV zaslonom sedi ključni gledalec, kot potencialni kupec izdelka, prinese boljše marketinške učinke. Ujemanje gledalčevega profila s kontekstom prikazane vsebine je torej ključno za učinkovito ciljanje reklam [12].

Pri razvoju inteligentnih vodnikov po TV programih imamo torej več tehnolološkik izzivov:

1. identifikacija vseh oseb, ki v danem trenutku sedijo pred TV zaslonom [2];
2. profiliranje uporabnikov oziroma grajenje uporabniškega profila na osnovi osebnih lastnosti (starost, spol, interesna področja), zajema podatkov iz senzorjev, uporabe TV aparata, priljubljenih oddaj ipd [6];
3. inteligentno sklepanje o trenutnih željah uporabnika in podajanje predlogov ali kompromisnih predlogov v primeru več uporabnikov (npr. starši in otroci, starši in stari starši, vsa družina ipd.) [3];
4. prijazen, uporabniku prilagojen in učinkovit uporabniški vmesnik, ki bo uporabnike spodbujal k uporabi sistema in vnosu informacij, ki jih ni mogoče zajemati samodejno.

3 PREGLED STANJA

Med slovenskimi ponudniki IPTV prevladujejo predvsem klasični vodniki po TV programih, brez vgrajenih metod za samodejno pridobivanje znanja o uporabniku. Ameriški priljubljeni osebni snemalnik TiVO [15] poleg številnih funkcij, kot so preskakovanje reklam, opomniki za priljubljene oddaje in povezave z internetnimi viri, omogoča iskanje programov po različnih kategorijah in podaja priporočila glede na uporabnikov profil, ki vsebuje informacije o priljubljenih žanrih, igralcih, režiserjih filmov, ključnih besedah, naslovih oddaj ipd. Poleg omejenega iskanja po vsebini in ključnih besedah pa spletna storitev TV Scout [9] uporabniku zagotavlja poosebljeni nabor TV programov glede na rangiranje oddaj s strani ostalih uporabnikov v podobnih interesnih skupinah. Ta metodologija je v literaturi opredeljena kot filtriranje na osnovi medsebojnega sodelovanja (colaborative filtering, CF), ki je poleg metode za filtriranje na osnovi vsebin (content-based filtering, CBF) najbolj razširjena v sistemih za priporočanje vsebin. Poleg metod za filtriranje pa je pomemben del vsakega sistema za priporočanje oddaj tudi opisovanje vsebin.

V Japonski TV Kingdom (http://tv.so-net.ne.jp/) je implementirana metoda za samodejno dopolnjevanje metapodatkov (automatic metadata expansion, AME), s katero se dopolnjujejo opisi TV programov iz klasičnih elektronskih programskih vodnikov (npr. žanri, igralci ipd.) z metapodatki, ki so pridobljeni iz dodatnih virov [5].

V nekoliko drugačni smeri so šli avtorji Googlovega patenta [8], ki so na osnovi izluščevanja ključnih besed iz zajetega zvoka na televizorju predvideli informiranje o gledanih vsebinah preko relevantnih internetnih strani.

Metode za filtriranje na osnovi sodelovanja pa ni mogoče uporabljati v P2P omrežjih, ker v tovrstnih omrežjih ni centralne baze podatkov, ampak so le ti široko porazdeljeni v omrežju in se stalno spreminjajo. V P2PTV Tribbler avtorji predlagajo decentralizirano filtriranje na osnovi sodelovanja, kjer se uporabniški profili samodejno izmenjujejo v sorodnih socialnih mrežah uporabnikov [13].

Na področju uporabniku prilagojenega prikazovanja TV reklam je Microsoft patentiral metodo [7], ki je osnovana na identifikaciji gledalca in uporabi podatkov iz osebnega koledarja, nakupovalne zgodovine, naslovov ipd.

4 METODE V INTELIGENTNIH TV VODNIKIH

4.1 Identifikacija gledalca

Za učinkovito in gledalcu prilagojeno poosebljeno priporočanje TV oddaj, mora sistem najprej vedeti, kdo sedi pred TV zaslonom. Različne tehnologije identifikacije oseb, od vnosa gesel, pin kode, različnih elektronskih ključev in kartic, do vedno bolj razširjenih biometričnih tehnologij za identifikacijo oseb, so prvenstveno namenjene varnostno zahtevnejšim aplikacijam, ki pa zaradi načina uporabe praviloma niso primerne za identifikacijo gledalcev pred TV zaslonom.

V zadnjem času se v literaturi pojavljajo rešitve za prepoznavanje oseb, ki sedijo pred TV zaslonom v realnem času na osnovi zajemanja podatkov z video kamero in prepoznavanje oseb v širšem kontekstu inteligentnega doma [2]. Prepoznavanje oseb na osnovi zajemanja podatkov z video kamero je primerno iz več razlogov: ni potrebna interakcija z uporabnikom oz. gre za takoimenovano neinvazivno identifikacijo. Uporabnik je samodejno prepoznan praktično takoj, ko sede pred TV zaslon. Pri določenem obsegu ljudi pa obstaja nelagodje pri vgrajevanju video kamer v domove, kar posledično omejuje širšo sprejemljivost in tržno uspešnost tovrstnih pristopov.

4. 2 Zajem podatkov

Zajem podatkov o navadah in željah uporabnikov oziroma gledalcev TV programov je lahko izveden implicitno oz. eksplicitno. Pri implicitnem zajemu podatkov gre za pasivno spremljanje obnašanja gledalcev npr. pri preklapljanju med TV programi z namenom izogibanja reklamam in običajnim preklapljanjem med kanali pri iskanju željene vsebine, podobno kot spremljanje navad uporabnika med brskanjem po spletu. Pri exsplicitnemu zajemu podatkov pa gre za nedvoumno aktivno podajanje informacij s strani gledalca o določeni vsebini glede na njegov okus oziroma gledalsko izkušnjo (npr. rangiranje filmov na lestvici od 1 do 5). Pri obeh metodah lahko opazimo prednosti in slabosti. Implicitne metode ne potrebujejo interakcije z gledalcem, saj gradijo uporabniški profil na osnovi zgodovine gledanja TV programov in torej za gledalca niso moteče. Na drugi strani, pa lahko z eksplicitnimi metodami zaradi aktivne vloge uporabnika, pridobimo bolj natančne informacije o interesih, lastnostih in okusu posameznika. Eksplicitne metode so v televiziji težje izvedljive, zaradi pasivnega principa gledanja TV in omejenih možnosti aplikacij in uporabniških vmesnikov v TV napravah. Po drugi strani pa pri implicitnih metodah takoj naletimo na težavo, kako izdelati profil za posameznika iz zgodovine uporabe TV aparata, ki ga uporablja celotna družina.

4.3 Metode za poosebljanje

Najbolj razširjeni metodi za poosebljanje sta metoda za filtriranje na osnovi medsebojnega sodelovanja (CF) in metoda za filtriranje na osnovi vsebin (CBF) [6].

Metoda CF je osnovana na izhodišču, da se bodo mnenja o primernosti za ogled ali nakup vsebine (naj gre za izdelek, TV oddajo, knjigo, glasbo ipd.) določene skupine uporabnikov iz preteklosti (npr. zgodovina nakupov in rangiranje) ujemale z mnenji uporabnikov, ki so podobno ocenili oziroma uporabljali izdelek ali vsebino, tudi v prihodnosti. Metoda ne podaja analize vsebine oziroma rangiranega predmeta in je kot taka neodvisna od domene v kateri je uporabljena oziroma posebnosti posameznih vsebin oziroma izdelkov. Zato je metoda CF primerna za široko uporabo, na primer za priporočanje TV oddaj, izdelkov, storitev ipd. Slabost metode je v odvisnosti ocenjevanja od predhodnih uporabnikov, ki so že ocenili predmet, pri čemer mora biti za podajanje ocene predhodno podano vsaj eno mnenje. Relativno majhna pokritost domene z mnenji s strani enega uporabnika pa onemogoča zadostno ujemanje med posameznimi sorodnimi skupinami ocenjevalcev znotraj ene domene. V praksi so metode CF uporabljene v spletnih trgovinah (npr. Amazon, Barns and Noble itd.), prodajalnah glasbe (iTunes), TV snemalniku TiVO in drugih.

Metoda CBF uporabniku priporoča izdelke oziroma ponujene vsebine, v kolikor imajo izdelki podobno vsebino oziroma lastnosti, kot izdelki, ki jih je uporabnik pozitivno ocenil v preteklosti. Metoda CBF podaja napovedi o ustreznosti izdelka na predpostavki, da so uporabnikova mnenja o primernosti za ogled ali nakup vsebine iz preteklosti primerno izhodišče za sklepanje o njegovem obnašanju tudi v prihodnosti. Med pomembnejše slabosti metode sodi omejenost glede na tip izdelka oziroma domene. Na primer v netekstualnih domenah, kot so filmi in glasba, algoritmi težko pokažejo dovolj zanesljivo analizo vsebine. Prav tako je subjektivne lastnosti izdelka težko analizirati (npr. stil ali kakovost knjige). Slabost metode CBF je tudi omejena zmožnost analize vsebine, saj metoda priporoča izdelke, ki so po vsebini podobni izdelkom v preteklosti, vendar ne more priporočati izdelkov, ki imajo sicer drugačno vendar sorodno vsebino.

Metoda DF uporablja demografske podatke oseb za iskanje povezav med posameznimi izdelki in osebami, ki so jim izdelki všeč. Osnovi slabosti te metode sta posploševanje interesov uporabnika glede na demografske podatke in nezmožnost prilagoditve uporabniških profilov pri spremembah interesov posameznika, kar se običajno dogaja skozi daljše časovno obdobje.

Nekateri avtorji predlagajo odpravljanje slabosti metod CBF in CF s kombiniranjem algoritmov obeh metod. Eden od takih hibridnih pristopov je metoda AIMED [9], ki ne podaja predlogov za oglede TV oddaj le na osnovi eksplicitno podanih demografskih in osebnostnih informacij in kriterijev v gledalčevem profilu, temveč upošteva širši kontekst gledanja TV programa, posameznikove aktivnosti, interese, trenutno razpoloženje in izkušnje. Med gledanjem TV oddaj uporabniki vnašajo svoje razpoloženje preko daljinskega upravljalca, ki ima v ta namen vgrajene posebne tipke. Sistem stalno zajema metapodatke o TV programu, uporabnik pa lahko sproti rangira tekoče oddaje. Ponudnik storitve pošilja te uporabniške ocene v skupinski model, ki na tej osnovi izvaja priporočila za konkretnega uporabnika. Vsak uporabniški model se formira na osnovi ujemanja uporabniškega profila in skupinskega modela. Sistem AIMED na ta način priporoča ustrezno oddajo glede na trenutno razpoloženje uporabnika.

4.4 Ontologije in semantika

Pri veliki količini podatkov, ki opisujejo in klasificirajo vsebine, naletimo na težavo, da običajne tehnologije iskanja in filtriranja, ki so osnovane na sintaktičnem pristopu ne zadoščajo. Korak naprej pri snovanju sistemov za inteligentno priporočanje TV programov je uporaba ontologij, ki v so v tovrstnih pristopih tipično uporabljene za procesiranje poizvedb na osnovi semantičnega znanja o domeni. Ontologije so opisani pomeni besed, ki se uporabljajo za predstavitev znanja na določenem področju. Po definiciji [11] pa je ontologija formalna specifikacija splošno priznane konceptualizacije določene problemske domene.

Avtorji sistema SenSee [4] so razvili semantični model znanja, ki omogoča razumevanje informacij o vsebinah v TV programih. Z uporabo jezika OWL (Web Ontology Language) so izdelali semantično obogateni model za opisovanje vsebin, ki ima dve osnovni funkciji, razumevanje in posledično kakovostnejše iskanje TV vsebin ter vnašanje semantičnega znanja o določeni domeni. Po vnosu ključne besede v uporabniški vmesnik se poizvedba izboljša s semantičnim znanjem iz podsistema ontologij in z dodanimi vrednostmi semantične bližine do ključnih besed in povezavami na opise pojmov. Naknadno se ključne besede v poizvedbi primerjajo z metapodatki v podatkovni bazi, kar generira zbirko rezultatov. Naslednji korak je filtriranje in prikaz rezultatov, urejenih po stopnji ujemanja z metapodatki. Filtriranje je izvedeno s kombinacijo različnih metod, kot so filtriranje po ključnih besedah, kontekstu, filtriranje po metodi CBF in CF. Modeliranje uporabnika je izvedeno z uporabniškim modelom, ki vsebuje različne pojme, kot so starost, kraj bivanja, osebne lastnosti, interesi, navade, okus. Uporabniški modeli se sčasoma dopolnjuje z gledalčevimi ocenami oddaj. Pomemben del modela je kontekst uporabe, ki vsebuje trenutni status uporabnika oziroma vpetost uporabnika v okolje z opisom časa, lokacije, rabe hišnih naprav, ostalih uporabnikov in celo razpoloženja uporabnika. Na ta način je doseženo dinamično prilagajanje sistema na trenutno stanje uporabnika. Vsa zgodovina uporabnikove interakcije vsebuje podatke o preteklem obnašanju uporabnika, kar omogoča iskanje vzorcev obnašanja. Pomembna funkcija modula za hranjenje zgodovine je filtriranje redundančnih podatkov, katerih količina se lahko sčasoma močno poveča.

5 ZAKLJUČEK

V povečevanju obsega TV programov in drugih vsebin, klasični vodniki po TV programih več ne zadoščajo potrebam po enostavnemu, intuitivnemu in uporabniku prilagojenemu ponujanju avdiovizualnih vsebin. Tradicionalno enosmerna komunikacija in pasivnost gledalca TV programa zahteva nove pristope z uporabo metod za filtriranje podatkov, izgradnjo uporabniških profilov, inteligentnih uporabniških vmesnikov. Izmenjava uporabniških izkušenj med posamezniki v širših socialnih skupinah omogoča bolj kakovostna in uporabniku prilagojena priporočila o TV programih. Tehnologije inteligentnih sistemov, kot so ontologije, omogočajo semantično razumevanje opisanih vsebin in konteksta uporabe multimedialnih naprav ter na ta način še izboljšujejo kakovost priporočil v sistemih za inteligentno priporočanje TV oddaj. Odpirajo se popolnoma nove možnosti izrabe TV medija, kot je ciljanje reklamnih sporočil na točno določeno skupino gledalcev, ki v danem trenutku sedijo pred TV zaslonom. Dvosmerna interakcija z multimedialnimi napravami pa omogoča tudi nakupovanje in nove storitve z dodano vrednostjo za ponudnike vsebin.

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PREPOZNAVANJE NENAVADNIH VSTOPOV V OBJEKT

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Povzetek

V današnjem svetu je vedno več terorističnih napadov na objekte, zato narašča zahteva po večji varnosti. Za preprečevanje takih vrst nezaželjenih dogodkov je kontrola dostopa bistvenega pomena. Za prepoznavo teroristov ter ostalih nenavadnih dogodkov se danes uporabljajo senzorji v povezavi z inteligentnimi metodami, ki se učijo na preteklih dogodkih [1]. Inteligentni sistem, ki smo ga razvili, sestavljajo štiri neodvisni moduli: ekspertna pravila, mikro učenje, makro učenje in kamera. Rezultat, ki ga vrne vsak izmed modulov, je klasifikacija dogodka kot alarm ali kot normalen dogodek, poleg tega pa vrne tudi razlago o klasifikaciji. Testno okolje sistema je vsebovalo štiri senzorje: sensor odpiranja vrat, čitalec kartic, čitalec prstnih odtisov in kamero.

1 UVOD

Teroristični napadi na civilne in vladne objekte so naraščajoča nevarnost posebno v državah zveze Nato. Pri tem je bistvenega pomena, da se zazna vstop teroristov v stavbo in s tem prepreči teroristični napad.
Pri večjih stavbah imamo veliko množico vstopnih točk. Učinkovit fizični nadzor je praktično nemogoč. Določene vrste nezaželjenih dogodkov so prepoznane s pomočjo biometričnih metod, a to včasih ni dovolj [2]. Nov pristop pri varovanju stavbe je uporaba inteligentnih metodih. Te predstavljajo velik napredek na področju varovanja objektov [3], saj pomagajo varnostnikom tako, da jim sporočijo, kdaj se je zgodil nenavaden dogodek [4].
Za varovanje objekta je potrebno imeti popoln nadzor nad vstopi v stavbo, kar je izvedeno s senzorji, ki se nahajajo na vsaki vstopni točki, poleg tega pa je potrebno imeti tudi inteligentni sistem, ki obdela vsak dogodek in ga klasificira kot alarm oziroma teroristični napad ali kot normalen dogodek [5]. Sistem mora prepoznati tudi nenavadno obnašanje zaposlenih, kot je na primer kraja.
Človeško gibanje je klasificirano na dveh nivojih s pomočjo inteligentnih metod. Gibanje na mikro nivoju je določeno s hitrostjo vstopanja v stavbo, ki je odvisna od navad osebe in njene spretnosti pri gibanju. Makro nivo pa je določen z dnevnimi navadami osebe. Pri tem se na primer opazuje, ob kateri uri na določen dan v tednu vstopa oseba v stavbo. Navade oseb se običajno ne spreminjajo prav dosti. Zato lahko inteligentni sistem klasificira dogodek glede na mikro in makro navade oseb [6].

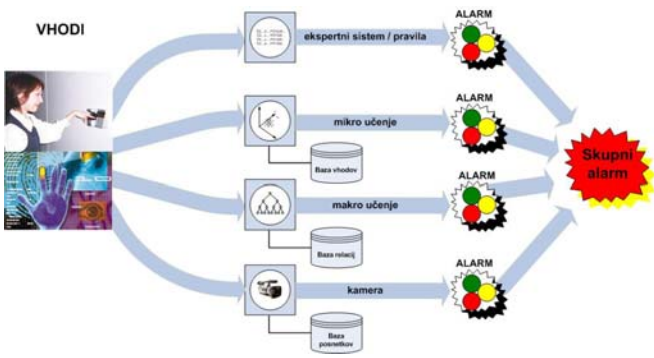
2 OPIS SISTEMA

2.1 Inteligentni sistem

Testno okolje, ki smo ga vzpostavili za izvedbo testiranja, vsebuje:

- vrata s senzorjem, ki zaznava, kdaj se vrata odprejo in kdaj se zaprejo,
- čitalec kartic,
- čitalec prstnih odtisov
- kamero.

Vsak normalen dogodek je sestavljen iz uspešne identifikacije s kartico in uspešne verifikacije s prstnim odtisom [7]. Ob uspešni identifikaciji in verifikaciji se vrata odklenejo. Za vsak regularen dogodek se v bazo podatkov zapišejo čas identifikacije s kartico, čas verifikacije s prstnim odtisom, čas odpiranja vrat in čas zapiranja vrat.
Ko senzorji sporočijo sistemu, da se je zgodil dogodek, začnejo vsi moduli sistema obdelovati dogodek. Na koncu obdelovanja vsak modul vrne klasifikacijo dogodka [8]. Na podlagi klasifikacij posameznih modulov se tvori skupna klasifikacija, ki je odvisna od vseh štirih modulov, kot je prikazano na sliki 1. Pri tem je dogodek klasificiran kot OK (dogodek je regularen) ali opozorilo (dogodek je malo drugačen od ostalih dogodkov) ali alarm (dogodek je neregularen).



Slika 1: Sistem je sestavljen iz štirih modulov. Vsak modul klasificira dogodek kot ok ali opozorilo ali alarm. Nato so vsi štiri rezultati združeni v skupen rezultat.
Zaporedje prikazovanja rezultatov modulov je nedoločeno, saj moduli izvajajo klasifikacijo vzporedno, pri čem hitrejši

moduli vrnejo rezultat in razlago pred počasnejšimi moduli, kar se takoj prikaže na ekranu.

2.2 Moduli inteligentnega sistema

Moduli inteligentnega sistema so:

- ekspertna pravila,
- mikro učenje,
- makro učenje,
- kamera.

Ekspertna pravila definirajo, kakšen je legalen dogodek.
Mikro učenje klasificira dogodke glede na pretekle dogodke osebe, pri čem pregleduje dogodke na mikro nivoju.
Makro učenje klasificira dogodke glede na pretekle dogodke osebe, pri čem pregleduje dogodke na makro nivoju [9].
Kamera preučuje navade osebe iz preteklih posnetkov in klasificira dogodek glede na podobnost med gibanjem osebe na preteklih posnetkih in gibanjem osebe na posnetku novega dogodka [10].

3 PODROBNEJŠI OPIS MODULOV

3.1 Klasični sistem nadzora dostopa

Pri testiranju smo uporabili štiri senzorje. Opisan pristop je v splošnem neodvisen od števila senzorjev. Za nadzor delovanja senzorjev smo uporabili DOX – večkanalni kontroler, razvit v podjetju Špica International, ki sprejema signale iz čitalca kartic, čitalca prstnih odtisov in senzorja vrat.
Vsi podatki o dogodkih se shranjujejo v Time&Space bazo podatkov. O vsakem dogodku na senzorju se pošlje sporočilo Event Collectorju, ki je program, razvit v podjetju Špica International. Ta program obdela podatke dogodka in jih shrani v bazo podatkov. Podatki dogodka so:

- če je dogodek identifikacija osebe, potem se v bazo zapišejo dan in čas dogodka ter tip dogodka, ki je lahko vhod ali izhod,
- če je dogodek verifikacija osebe, potem se v bazo zapišejo dan in čas dogodka ter stopnja ujemanja prstnega odtisa,
- če je dogodek odpiranje ali zapiranje vrat, pa se v bazo zapišeta dan in čas dogodka.

Med vsako sekvenco dogodkov Event Collector pošilja dva tipa signalov. Signal prvega tipa je poslan inteligentnemu sistemu preko TCP/IP komunikacijskega kanala. Inteligentni sistem dobi te vrste sporočilo vsakič, ko se zgodi regularno zaporedje dogodkov vstopa. Nato prebere vse podatke o dogodku iz centralizirane baze podatkov. Regularni dogodki sprožajo »clocking« dogodke.
Signal drugega tipa, katerega tudi pošilja Event Collector, je poslan Video Collectorju preko vrste sporočil. Video Collector je Time&Space program, ki nadzira kamero. Ko dobi sporočilo, shrani posnetek iz spomina kamere na disk in začne snemati nov posnetek, katerega čas snemanja je nekaj sekund in ki se na koncu združi s predhodno shranjenim posnetkom v skupen posnetek.
Event Collector pošlje TCP/IP signal tudi, ko se zgodi neregularen dogodek. Primer takega dogodka je vdor skozi vrata oziroma odpiranje vrat brez predhodne identifikacije in verifikacije. V tem primeru Collector pošlje signal, ko se vrata odprejo oziroma ko so uničena, na primer po bombnem napadu. Ta tip signalov se imenuje »alarm« dogodek.

3.2 Opis ekspertnih pravil

Ekspertna pravila so množica generičnih pravil, katera lahko preverjajo dogodke le po predhodnem definiranju vrednosti parametrov. Generična pravila, katerih parametri so podčrtane besede, so:

a) dogodek je klasificiran kot <u>opozorilo/alarm,</u> če <u>oseba</u> sproži dogodek med časoma <u>čas1</u> in <u>čas2</u> na <u>dan</u>,
b) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če <u>oseba</u> sproži več kot <u>število</u> dogodkov v <u>času</u>,
c) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če uporabnik ne zapusti stavbe v <u>ure</u> urah,
d) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če vsi <u>uporabniki</u> zapustijo stavbo med <u>čas1</u> in <u>čas2</u>,
e) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če je čas med <u>dogodek1</u> in <u>dogodek2</u> večji od <u>čas</u>,
f) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če oseba ne zapusti stavbe do <u>čas</u>,
g) dogodek je klasificiran kot <u>opozorilo/alarm</u>, če oseba sproži zaporedna vhoda ali izhoda.

Ob novem dogodku se izvede preverjanje vseh pravil, ki imajo določene vrednosti parametrov. Izjema je le pravilo f, ki se preverja vsakih deset sekund.
Vsako pravilo vrne klasifikacijo in razlago, ki sta prikazani takoj, ko sta vrnjeni. Končni rezultat pravil združi rezultate vseh testiranih pravil. Če je eno izmed pravil klasificiralo dogodek kot alarm, potem je končni rezultat alarm. Če nobeno izmed pravil ni klasificiralo dogodka kot alarm, a je vsaj eno pravilo klasificiralo dogodek kot opozorilo, potem je končni rezultat opozorilo. Če ni nobeno izmed pravil klasificiralo dogodek kot alarm oziroma opozorilo, potem je končni rezultat ok.

3.3 Povezovanje modulov v inteligentni sistem

Ko se zgodi nov dogodek, inteligentni sistem dobi sporočilo preko TCP/IP komunikacijskega kanala. Če se niso zgodili dogodki identifikacija s kartico, verifikacija s prstnim odtisom, odpiranje vrat in zapiranje vrat v točno tem vrstnem redu, potem dogodek ni regularen.
Če je zaporedje pravilno, a se ni še zaključilo, ko je prišlo obvestilo o novem dogodku do inteligentnega sistema, potem sistem čaka, da se zaporedje zaključi. Čakanje se zgodi le ob »clocking« dogodkih. Ob »alarm« dogodkih se ob prejemu sporočila preverjanje takoj zaključi in dogodek se klasificira kot alarm.

Če je prišlo do »clocking« dogodka, inteligentni sistem prebere podatke dogodka iz podatkovne baze ter pokliče štiri niti, saj je vsak modul implementiran kot nit, ter jim poda podatke dogodka. Nato čaka, dokler vse niti ne vrnejo rezultatov.
Administrator lahko izključi vsakega izmed modulov. Ob dogodku izključen modul ne vrne rezultata.
Modul ekspertnih pravil je notranji modul, ki je implementiran kot nit. Natančneje je opisan v razdelku 3.2.
Modul mikro učenja je zunanji modul. Ekspertni sistem zapiše njegove vhodne podatke v vhodno datoteko modula. Ob klicu modula mikro učenja se poleg njegove vhodne datoteke poda tudi mikro parametre: meji za opozorilo in alarm ter število sosedov, katerih vrednosti so določene v ekspertnem sistemu. Ekspertni sistem čaka, dokler mikro modul ne vrne rezultata v obliki izhodne datoteke. Ti rezultati so nato prikazani na ekranu.
Modul makro učenja je zunanji modul in je sestavljen iz treh podmodulov: drevo makro učenja, drevo mikro učenja in LOF mikro makro učenja. Ekspertni sistem zapiše vhodne podatke makro učenja v tri vhodne datoteke, eno za vsak podmodul. Ob klicu modula makro učenja se poleg vhodnih datotek poda tudi meji za LOF opozorilo in LOF alarm, število sosedov za LOF ter utežitev podmodulov pri računanju skupnega rezultata [11]. Ekspertni sistem čaka, dokler makro modul ne vrne rezultata v obliki izhodne datoteke, v kateri so zapisani rezultati vseh podmodulov, skupni rezultat in razlage. Nato so rezultati in razlage prikazani na ekranu.
Modul kamere je zunanji modul, kateremu ekspertni sistem pošilja zahteve preko TCP/IP komunikacijskega kanala. Implementiran je kot strežnik, na katerega se poveže ekspertni sistem in ko se zgodi nov dogodek, mu pošlje zahtevo po njegovi klasifikaciji. Nato ekspertni sistem čaka na rezultat ter ko ga modul kamere pošlje, ga ekspertni sistem prikaže na ekranu.
Ko vsi štiri moduli vrnejo rezultate, jih ekspertni sistem združi v skupni rezultat, ki je ok ali opozorilo ali alarm. Pri tem lahko administrator definira prag opozorila ali alarma, ki je med 1 in 4. Če je prag tri in če vsaj tri moduli vrnejo ok, potem je skupni rezultat ok. Če vsaj tri moduli ne vrnejo ok ter če vsaj tri moduli vrnejo ok ali opozorilo, potem je skupni rezultat opozorilo. V nasprotnem primeru pa je skupni rezultat alarm.
Le en dogodek je lahko obravnavan naenkrat. Če se med obravnavo dogodka zgodi nov dogodek, potem mora ta čakati na obdelavo.

4 TESTIRANJE SISTEMA

Testiranje ekspertnega sistema je vključevalo vhode petih oseb. Vsaka oseba je izvedla približno 40 učnih in 10 testnih vhodov. Nato smo simulirali test lažne identitete, pri katerem se osebi dodeli identifikacijska kartica druge osebe. Tako so testni podatki ene osebe tudi testni podatki testa lažne identitete druge osebe.

Testirali smo le ekspertna pravila, mikro in makro učenje, saj je bilo testiranje simulirano, posnetkov, ki jih potrebuje kamera, pa ne moremo simulirati.
Rezultati so prikazani v tabeli 1. Rezultati, prikazani v stolpcu »kartica prave osebe«, so dobljeni s testiranjem oseb, ki vstopajo s svojimi identifikacijskimi karticami. Rezultati, ki so prikazani v stolpcu »lažna identiteta«, pa so dobljeni s testiranjem oseb, ki vstopajo z identifikacijskimi karticami drugih oseb.
V tabelah 2 in 3 lahko opazimo, da inteligentni sistem klasificira kot OK 88% regularnih vhodov in kot alarm 69% neregularnih vhodov oziroma vhodov z lažno identiteto.
Pri tem moramo poudariti, da je bilo testiranje izvedeno tako, da čitalec prstnih odtisov ni preverjal ujemanje prebranih prstnih odtisov s tistimi, ki so shranjeni v podatkovni bazi. V realnem svetu predstavlja biometrično preverjanje oseb osnovo varnosti, inteligentne metode pa dodajajo višjo stopnjo varnosti.

		kartica prave osebe			lažna identiteta		
Oseba		A	O	OK	A	O	OK
#1	pravila	0	0	10	0	0	40
	mikro	0	0	10	23	6	11
	makro	0	3	7	32	7	1
	skupno	**0**	**3**	**7**	**36**	**3**	**1**
#2	pravila	0	0	10	0	0	40
	mikro	0	0	10	17	4	19
	makro	0	1	9	21	13	6
	skupno	**0**	**1**	**9**	**24**	**10**	**6**
#3	pravila	0	0	10	0	0	40
	mikro	0	0	10	25	5	10
	makro	0	0	10	21	9	10
	skupno	**0**	**0**	**10**	**25**	**5**	**10**
#4	pravila	0	0	10	0	0	40
	mikro	0	1	9	14	6	20
	makro	0	0	10	21	19	0
	skupno	**0**	**1**	**9**	**23**	**17**	**0**
#5	pravila	0	0	10	0	0	40
	mikro	0	0	10	20	9	11
	makro	0	1	9	29	1	10
	skupno	**0**	**1**	**9**	**30**	**1**	**9**
all	pravila	0	0	50	0	0	200
	mikro	0	1	49	99	30	71
	makro	0	5	45	124	49	27
	skupno	**0**	**6**	**44**	**138**	**36**	**26**

Tabela 1: Testiranje ekspertnih pravil, mikro in makro učenja s 5 osebami.

	A	O	OK
pravila	0%	0%	100%
mikro	0%	2%	98%
makro	0%	10%	90%
skupno	**0%**	**12%**	**88%**

Tabela 2: Statistika regularnih vhodov.

	A	O	OK
pravila	0%	0%	100%
mikro	50%	15%	36%
makro	62%	25%	14%
skupno	**69%**	**18%**	**13%**

Tabela 3: Statistika neregularnih vhodov.

5 ZAKLJUČEK

Opisani sistem prepoznava nenavadne dogodke, kot so na primer teroristični napadi, kraje, vstop oseb pod vplivom alkohola itd. Sestavljen je iz štirih neodvisnih modulov, katerih število je v splošnem poljubno. Kompleksnost sistema se lahko spreminja z dodajanjem in odstranjevanjem ter z vključevanjem in izključevanjem modulov. Izvedene meritve so pokazale, da sistem občutno poveča varnost objektov. Zato lahko zaključimo, da je strojno učenje, ki se uči na preteklih dogodkih, pomembni varnostni mehanizem za varovanje objektov.

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ANALIZA OPTIMALNOSTI UKREPOV ZA IZRAVNAVO KONIC PRI INDUSTRIJSKEM ODJEMALCU ELEKTRIČNE ENERGIJE

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ABSTRACT

Energy market liberalization and environmentally sustainable growth increase the need for efficiency and flexibility of power generation, distribution and consumption. New services are sougt to ensure reliable supply, protect the environment and balance the costs and benefits between the involved parties, the suppliers and the consumers. Our goal is to design and implement a system for optimization of power flows in the distribution network through adaptable power generation and consumption. This paper outlines the proposed functionality of the system and then focuses on the issue of peak demand management on the consumer's side. A case study from an industrial plant is considered where peak demand is leveled by scheduling of production processes. The effects of generated schedules are analyzed in view of conflicting objectives faced in energy consumption optimization.

1. UVOD

Proizvajalci električne energije ter njeni dobavitelji in odjemalci se srečujejo z novimi izzivi, kot so obvladovanje naraščajoče porabe, zagotavljanje zanesljivosti elektroenergetskih sistemov, varovanje okolja, liberalizacija elektroenergetskih trgov in nastajanje enotnega elektroenergetskega trga v Evropi. Med tehnološkimi izzivi velja izpostaviti potrebo po povečanju učinkovitosti prenosnih omrežij, na kar so opozorile analize številnih izpadov severnoameriških in evropskih elektroenergetskih sistemov v preteklih letih. Prav tako bodo zaradi znatnega deleža energetike v onesnaževanju okolja s toplogrednimi plini potrebni razvoj novih energetskih tehnologij in ukrepi za njihovo uveljavitev v praksi. Narašča pomen razpršene proizvodnje električne energije iz obnovljivih virov ter prilagajanja odjema električne energije kot ukrepa za povečevanje zanesljivosti elektroenergetskih sistemov.

Trajnostni razvoj energetike v teh pogojih zahteva nove rešitve za usklajevanje zmožnosti dobaviteljev in potreb odjemalcev. Te rešitve so na različnih stopnjah razvoja: mnoge šele v fazi raziskav, nekatere v prototipnih izvedbah, redke že dostopne na trgu. K napredku tega področja želimo prispevati z inovativno e-storitvijo za optimiranje pretokov električne energije v distribucijskem omrežju s prilaganjem odjema in razpršene proizvodnje [9]. Projekt njenega razvoja sofinancirata Ministrstvo za visoko šolstvo, znanost in tehnologijo Republike Slovenijo in Evropski sklad za regionalni razvoj na osnovi javnega razpisa za spodbujanje raziskovalno-razvojnih projektov razvoja e-vsebin in e-storitev.

V nadaljevanju predstavljamo zasnovo predlagane e-storitve in se nato osredotočimo na izravnavanje konic pri odjemu električne energije kot enem od ukrepov za prilagajanje na strani odjemalcev. Opišemo primer izravnavanja konic na osnovi optimiranja urnikov procesov v industrijskem obratu in povzamemo dosežene rezultate. Rezultate optimizacije dodatno ovrednotimo z vidika nasprotujočih si kriterijev, ki jih moramo upoštevati pri optimiranju energetske porabe. Analiza služi kot študija primera v razvoju predlagane e-storitve.

2. OPTIMIRANJE PRETOKOV ELEKTRIČNE ENERGIJE V DISTRIBUCIJSKEM OMREŽJU KOT E-STORITEV

Namen e-storitve optimiranja pretokov električne energije v distribucijskem omrežju s prilaganjem odjema in razpršene proizvodnje je podjetjem omogočiti doseganje pozitivnih finančnih učinkov na osnovi optimiranja nakupa oziroma prodaje električne energije. Storitev bodo podjetjem nudila distribucijska podjetja, ki bodo z njeno uvedbo v prakso povečala varnost in zanesljivost delovanja distribucijskega omrežja, znižala stroške odstopanj oddaje in odjema električne energije od napovedi, omogočila učinkovito rabo energije pri odjemalcu in omogočila množično integracijo razpršene proizvodnje električne energije, kar bo pozitivno vplivalo tudi na podnebne razmere.

Tehnično osnovo za izvajanje storitve bo omogočal računalniški sistem, ki bo vključeval naslednje komponente, povezane preko interneta:

- osrednji nadzorni sistem, nameščen v centru za vodenje distribucijskega omrežja,
- nadzorni računalniki, nameščeni na lokacijah odjema oziroma razpršene proizvodnje električne energije,
- industrijski krmilniki z merilno in ostalo pripadajočo opremo, nameščeno na lokacijah odjema oziroma razpršene proizvodnje električne energije.

Osrednji nadzorni sistem bo omogočal centralizirano zbiranje in obdelavo podatkov, izvajanje optimizacijskih postopkov in pripravo obračunov. Strojna in programska oprema nadzornega sistema bosta omogočali zbiranje in analizo velikih količin podatkov za daljše časovno obdobje z veliko kompresijo podatkov, grafične prikaze, alarmiranje, daljinsko vodenje naprav, izračunavanje optimalnih ukrepov prilagajanja odjema in usklajevanje o njih z odjemalci.

Osrednji nadzorni sistem bo z lokalnimi odjemalci oziroma proizvajalci električne energije, kot so proizvodna podjetja, male hidroelektrarne ipd., povezan preko navideznih zasebnih omrežij (angl. virtual private network, VPN), kar bo zagotavljalo ustrezno varnost povezav. Nadzorni računalniki in krmilniki na lokacijah lokalnih odjemalcev oziroma proizvajalcev bodo skrbeli za vodenje bremen in sistemov proizvodnje energije.

Jedro raziskovalno-razvojnih aktivnosti pri razvoju nove e-storitve je v snovanju in implementaciji optimizacijskih algoritmov za potrebe računalniškega vodenja. Cilj optimizacije je zagotavljati optimalnost pretokov električne energije v distribucijskem omrežju preko potrebnih ukrepov računalniškega vodenja. Distributer električne energije mora v ta namen po eni strani upoštevati stanje, možnosti in omejitve omrežja, po drugi pa zahteve in omejitve odjemalcev. Zagotavljanje cilja in upoštevanje teh dejstev je zajeto v formalni opredelitvi optimizacijskega problema, ki vključuje nabor možnih rešitev, med katerimi želimo poiskati optimalno, omejitve in stroškovno funkcijo. Rešitve iščemo v obliki ukrepov za izklapljanje oz. časovno prerazporejanje obremenitev. Omejitve, ki jih je potrebno upoštevati pri tvorjenju rešitev, se nanašajo na pogostost, prioritete in druge pogodbeno določene značilnosti ukrepov vodenja. S stroškovno funkcijo vrednotimo možne rešitve v postopku iskanja optimalne med njimi. V njej so kot primarni kriterij zajeti stroški odstopanj oddaje in odjema električne energije od napovedi. Dodatna zahteva za optimizacijski postopek je njegovo izvajanje v realnem času. Podatki, ki opisujejo elemente problema se osvežujejo v določenih časovnih intervalih (tipično na 15 minut) in optimizacijski izračuni morajo slediti tej dinamiki. Ukrepi, ki bodo rezultati teh izračunov, se bodo izvajali avtomatsko ali ob potrditvi operaterja.

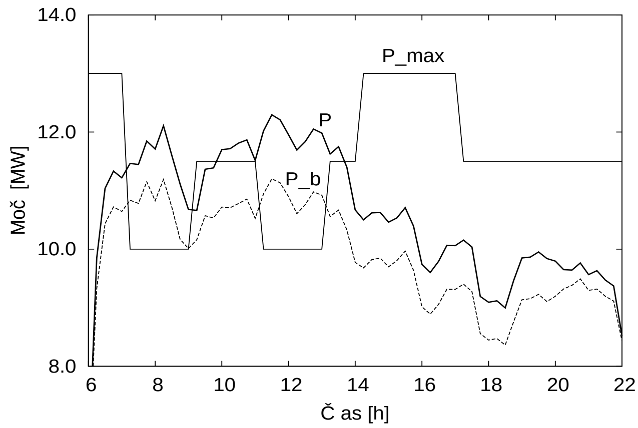
3. PRILAGAJANJE ODJEMA ELEKTRIČNE ENERGIJE Z IZRAVNAVANJEM KONIC

Izravnavanje konic pri odjemu električne energije je eden od ukrepov za prilagajanje odjema na strani odjemalcev. S porastom cen električne energije postaja ta pristop za podjetja ponovno zanimiv in bo tudi vključen v izvajanje e-storitve. Pri izravnavanju konic za prilagajanje odjema skrbijo optimizacijski algoritmi, ki izklapljajo oziroma razbremenjujeo bremena ter časovno razporejajo proizvodne procese oziroma porabo električne energije. V nadaljevanju predstavljamo študijo primera iz industrijske prakse [7].

3.1. Izravnavanje konic kot optimizacijski problem

V enem od obratov podjetja deluje šest proizvodnih linij, ki jih obravnavamo kot enovite delovne procese in po posameznih procesih tudi spremljamo porabo električne energije. Procese želimo časovno razporejati tako, da bo skupni odjem moči v podjetju čim manj presegal predpisano omejitev, kar bo tudi znižalo proizvodnne stroške.

Proizvodnja v obratu poteka po dnevnem načrtu, ki določa časovni razpored delovanja linij. Poraba energije v obratu je enaka vsoti porab delujočih linij. V podjetju so tudi drugi porabniki, katerih poraba z vidika obravnavanega obrata predstavlja t.i. porabo ozadja. Skupna poraba energije v podjetju je enaka vsoti porabe v obratu in porabe ozadja. Omejena je z največjim dovoljenim odjemom, ki ga predpiše dobavitelj električne energije. Slika 1 prikazuje značilen dnevni potek odjema moči in omejitve odjema.



Slika 1: Dnevnih potek odjema moči: poraba ozadja P_b, skupna poraba P in omejitev odjema $P_{\max}$

Prekoračitve največjega dovoljenega odjema mora podjetje plačevati po višji tarifi in predstavljajo dodatni proizvodni strošek, zato jih želi v največji možni meri zmanjšati. V ta namen skuša znižati tudi prispevek obrata k presežnemu odjemu. Eden od načinov za dosego tega cilja je prekinjanje procesov v obratu v času konic. V času prekinitev potekajo vzdrževalni posegi na linijah, menjave izmen in odmori za delavce. Da bi bil dnevni proizvodni načrt izpolnjen, prekinitev ne sme biti preveč, zato so omejene z:

- dolžino trajanja prekinitev, T_0,
- najkrajšim časom med dvema prekinitvama vsakega procesa, T,
- največjim številom sočasno prekinjenih procesov, n.

Naloga je torej ob upoštevanju teh omejitev časovno razporediti prekinitve procesov v obratu tako, da bo presežna poraba energije čim manjša.

Da definiramo stroškovno funkcijo za ocenjevanje urnikov prekinitev, privzemimo, da so $P_{\max}(t)$ največji dovoljeni odjem moči ob času t, $P_b(t)$ trenutna moč ozadja, n število delujočih linij in $P_i(t),\ i = 1, \ldots, n$, trenutne moči proizvodnih procesov na linijah. Potem je skupna moč procesov

$$P_{\mathrm{proc}}(t) = \sum_{i=1}^{n} P_i(t), \tag{1}$$

skupni odjem moči v podjetju pa

$$P(t) = P_{\mathrm{proc}}(t) + P_b(t). \tag{2}$$

Prispevek procesov k presežnemu odjemu ob času t znaša

$$P_{\mathrm{pres}}(t) = \begin{cases} P_{\mathrm{proc}}(t), & P_b(t) \geq P_{\max}(t) \\ P(t) - P_{\max}(t), & P_b(t) < P_{\max}(t) < P(t) \\ 0, & \text{sicer,} \end{cases} \tag{3}$$

tako porabljena energija pa

$$E_{\mathrm{pres}} = \int_{t_1}^{t_2} P_{\mathrm{pres}}(t)\, dt, \tag{4}$$

kjer sta t_1 in t_2 začetni in končni čas obratovanja linij na obravnavani dan. Optimizacijski problem je minimizirati E_{pres} preko možnih dnevnih urnikov prekinitev procesov.

3.2. Optimizacijski algoritem in njegovi rezultati

Za razporejanje prekinitev procesov smo razvili hibridni optimizacijski algoritem, ki hevristično preiskuje prostor možnih rešitev in išče urnik z najmanjšo presežno porabo energije [7, 8]. Osnovna preiskovalna hevristika temelji na evolucijskem računanju [5], rešitve pa med preiskovanjem spreminjamo z lokalnimi transformacijami, kot so vstavljanje prekinitve v urnik, brisanje prekinitve iz urnika in premik prekinitve v urniku. Algoritem je parametriziran, tako da uporabnik lahko nastavlja čas trajanja prekinitev, T_0, najkrajši čas med dvema prekinitvama vsakega procesa, T, in največje število sočasno prekinjenih procesov, n. Kot primer rezultata navajamo urnik prekinitev za šest delujočih linij ter porabo ozadja in omejitev odjema s slike 1. Urnik je bil dobljen pri nastavitvah $T_0 = 30$ min, $T = 300$ min in $n = 2$ ter zmanjšuje dnevno presežno porabo energije za 20,6%.

Algoritem je bil implementiran kot programski modul v sistemu za spremljanje in upravljanje porabe energije v obratu. Testiranje na realnih vhodnih podatkih za enomesečno obdobje je pokazalo, da je moč ob primernih nastavitvah vrednosti T_0, T in n, ki omejujejo prekinjanje procesov, ob delovnikih v povprečju zmanjšati presežno porabo električne energije za okrog 30%. Analiza ponovljivosti rezultatov je pokazala, da optimizacijski algoritem kljub svoji stohastični naravi pri enakih vhodnih podatkih daje urnike z zanemarljivim raztrosom vrednosti stroškovne funkcije, saj

Tabela 1: Primer urnika prekinitev proizvodnih procesov za dnevni odjem moči, prikazan na sliki 1

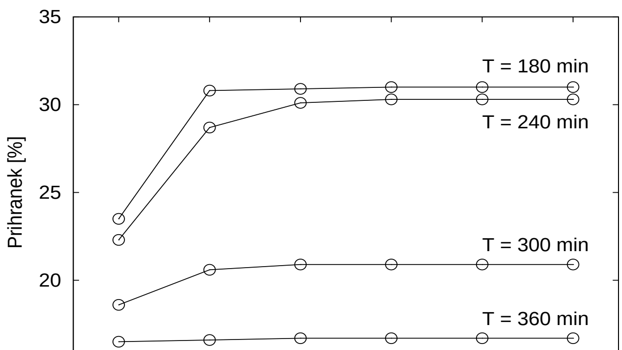
Proizv. linija	Število prekinitev	Časi prekinitev	
1	1	07:30–08:00	
2	2	07:15–07:45	12:45–13:15
3	1	12:15–12:45	
4	2	07:30–08:00	12:30–13:00
5	1	11:45–12:15	
6	1	12:00–12:30	

se najboljša in najslabša vrednost v večini primerov razlikujeta za manj kot 1%, v redkih primerih pa do 3% [7].

Posebna študija je bila namenjena tudi primerjavi rezultatov z optimalnimi. Uporabljeni optimizacijski postopek je namreč računsko učinkovit, a ne zagotavlja optimalnosti rezultatov. Za izbrani delovni dan smo izračunali optimalne rešitve pri različnih omejitvah za prekinjanje procesov z metodologijo logičnega programiranja z omejitvami (angl. constraint logic programming, CLP) [2]. Rezultati v nadzornem sistemu vgrajenega postopka so bili od optimalnih pri praktično smiselnih omejitvah slabši za vsega 0,2% [6, 8].

3.3. Večkriterijska analiza rezultatov

Na zmanjšanje presežne porabe energije bistveno vplivajo omejitve za prekinjanje procesov, podane z vrednostmi T_0, T in n. Z njimi je treba iskati ravnotežje med zahtevo po izpolnitvi dnevnega proizvodnega načrta in čim boljšo izravnavo konic pri odjemu energije. Za rezultat optimizacije pri danih vrednostih velja, da bi bil pri blažjih omejitvah prihranek še večji, pri strožjih pa manjši. Postavlja se torej vprašanje, kako najustrezneje nastaviti omejitve. Odgovor nanj pokažejo rezultati empirične analize, strnjeni v sliki 2.



Slika 2: Zmanjšanje presežne porabe električne energije (prihranek) v odvisnosti od dovoljenega števila sočasnih prekinitev proizvodnih procesov in predpisanega časa med dvema prekinitvama procesa T

Analizo smo opravili za običajno dolžino prekinitev procesov $T_0 = 30$ min ter različne vrednosti T in n. Posamezna točka na sliki 2 ustreza prihranku, ki ga dobimo kot povprečen rezultat 30 zagonov optimizacijskega algoritma za šest delujočih linij ter porabo ozadja in omejitev odjema s slike 1. Opazimo, da k večjemu prihranku pomembno pripomore ponovno prekinjanje procesov po štirih urah ($T = 240$ min), dodatno krajšanje časa med prekinitvami pa ne več bistveno. Podobno ugotovimo, da je dovoljeno število sočasnih prekinitev procesov z vidika prihrankov smiselno omejiti na $n = 3$.

Tovrstni rezultati omogočajo celovitejši pregled učinkov razporejanja procesov pri različnih nastavitvah omejitev na izravnavanje konic. Metodološko gledano pa imamo opraviti z večkriterijskim optimizacijskim problemom, saj želimo pri čim manjšem številu sočasno prekinjenih delovnih procesov in čim daljšem neprekinjenem obratovanju linij doseči čim večje zmanjšanje presežnega odjema energije. Tradicionalni pristop k reševanju takšnih problemov, vgrajen tudi v opisani sistem za izravnavanje konic, je reševanje prirejenega enokriterijskega problema, kjer optimiramo po izbranem najpomembnejšem kriteriju, ostale pa obravnavamo kot omejitve in zanje predpišemo mejne vrednosti. Sodobne metode optimiranja z evolucijskimi algoritmi pa omogočajo sočasno iskanje množic optimalnih rešitev po več kriterijih [4]. Analiza rezultatov izravnavanja konic je začetni korak k večkriterijskem optimiranju v predlagani e-storitvi. Pri razvoju optimizacijskih algoritmov zanjo sledimo prvim zgledom večriterijskega načrtovanja in optimiranja delovanja elektroenergetskih sistemov [1, 3].

4. ZAKLJUČEK

Zahteve po obvladovanju naraščajoče energetske porabe, varovanju okolja in trajnostnem razvoju energetike ter mednarodno povezovanje in liberalizacija elektroenergetskih trgov spreminjajo tudi odnose med dobavitelji in odjemalci električne energije. Pri iskanju za obe strani sprejemljivih pristopov bodo potrebne nove tehnologije in storitve kot tudi ukrepi za njihovo uveljavitev v praksi. Za te potrebe razvijamo inovativno e-storitev optimiranja pretokov električne energije v distribucijskem omrežju s prilaganjem odjema in razpršene proizvodnje.

V prispevku smo opisali zasnovo načrtovane storitve in se osredotočili na optimizacijske postopke, ki bodo vanjo vključeni tako na strani dobavitelja pri iskanju kompromisnega nabora ukrepov za zmanjšanje razlike med napovedanim odjemom in dejansko porabo električne energije, kot pri odjemalcih za ustrezno odzivanje na zahteve po izravnavanju odjema. Na primeru analize optimalnosti ukrepov za izravnavanje konic pri odjemu električne energije v industrijskem obratu smo pokazali potrebo po večkriterijskem optimiranju v e-storitvi. Njen razvoj bomo nadaljevali s formalno opredelitvijo kriterijev in implementacijo optimizacijskega postopka. Sledilo bo preizkušanje pilotne izvedbe storitve v laboratorijskem okolju, nato pa v realni navezi dobavitelja električne energije z izbranimi industrijskimi odjemalci.

ZAHVALA

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PATOLOGIJA KONČNO RAZLOŽENA?

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Povzetek

Pred 26 leti smo se ukvarjali s prvimi raziskavami patologije. V zadnjih nekaj letih smo sestavili celovit model patologije tako za igre kot za reševanje nalog enega samega akterja. Modeli kažejo podobne lastnosti, kot izmerjene na raznih realnih domenah kot npr. šah ali 8-ploščic. Nekaj ugotovitev je novih.

1 UVOD

Glede na večje število objav s področja preiskovalne patologije ni smotrno še enkrat navajati osnovne definicije. Prav tako ne bomo debatirali o smotrnosti boljšega iskanja ali boljše inteligence (Gams 2001). Namesto tega bomo pripravili samo osnovno besedilo, podobno kot ga pripravljamo za objavo v pomembni reviji.

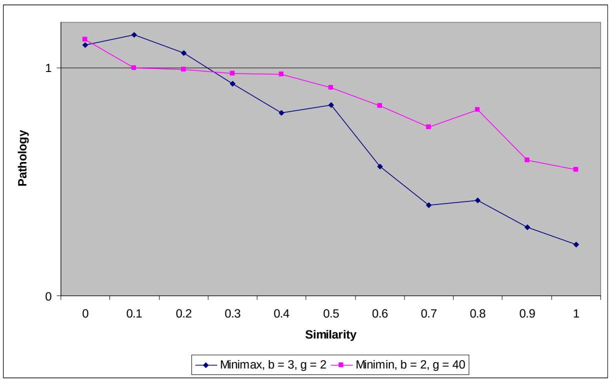
Osnovna ideja za celoten prispevek je uvesti prikaz najprej osnovne Pearlove igre (Nau 82, 83), nato model igranj dveh nasprotnikov (algoritem minimaks) in model igranja enega samega akterja, ter pojasniti podobnosti med obema modeloma. Sledi prikaz realnih domen, predvsem šaha in 8-ploščic.

2 PEARLOVA IGRA

Formalna Pearlova igra temelji na razdeljevanju plošče, na kateri se originalno nahajajo ničle in enice. Prvi igralec razdeli ploščo navpično in izbere bolj perspektivno polovico, nato pa drugi igralec izbrano polovico prereže na pol vodoravno na dve novi polovici, torej četrtinki. Igralca nadaljujeta, dokler se igra ne konča s samo enim poljem. Prvi igralec zmaga, če je v tem polju enica, drugače pa nasprotnik.
Nau je odkril, da je igra v dokaj smiselnih pogojih (porazdelitev ničel in enic v razmerju 0,39:0,61, hevristična ocenjevalna funkcija je vsota vseh enic) patološka, torej da se z večjo globino kvaliteta izbiranja optimalne poteze tik pod korenom drevesa poslabša. To pomeni, da je bolje izbrati na osnovi ocene na nivoju prve poteze iz korena.

Podobno igro si lahko zamislimo tudi takole: V dveh vrečicah imamo zlata zrnca različnih težin. Prvi igralec potehta obe vrečici in izbere težjo. Ta vrečica se pretrese na dve vrečici in drugi igralec izbere lažjo. Nadaljujeta, dokler prvemu igralcu ne ostane samo eno zrnce.

Še tretjo igro si lahko predstavljamo takole: na plošči imamo enako porazdelitev kot v osnovni Pearlovi igri. Igra samo en igralec, ki izbira polovico z več enicami.



Slika 1: Patologija v osnovni Pearlovi igri pri spreminjanju podobnosti med sosednjimi podpodročji.

V vseh treh igrah se lahko zgodi patologija v primernih pogojih. V nadaljevanju bomo predstavili splošna modela za oba tipa iger.

3 MODELI IGER

Naredili smo vrsto modelov z namenom preiskovanja relacij predvsem med tremi osnovnimi parametri (Kaluža idr. 2007, Luštrek idr. 2005, 2006, 2007):

- B - vejitev (branching)
  Gradimo vedno uniformna drevesa, kjer imajo očetje vedno enako število sinov.
- G - zrnatost (granularity)
  Število vrednosti pozicije oz. število vrednosti hevristične ocenjevalne funkcije. V naših modelih sta ti vrednosti enaki.
- S - odvisnost (similarity)
  Drevesa z odvisnostjo 0 imajo povsem naključno generirane liste, medtem ko imajo

drevesa z odvisnostjo 1 povsem urejene liste po nekem postopku.

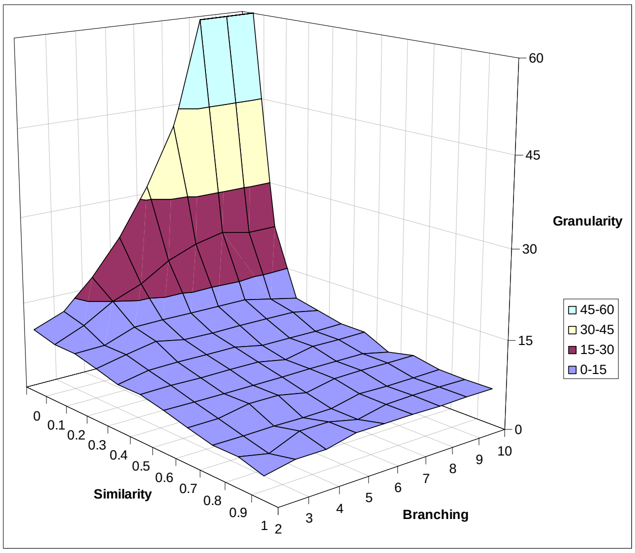
Naredili smo vrsto modelov tako, da smo generirali vrsto dreves in na njih merili uspešnost odločanja prve poteze iz korena, ko imamo enkrat na voljo hevristične poteze samo iz prvega nivoja, drugič pa iz globine 5.

Nato smo spreminjali tri parametre: s, g in b.

Spreminjanje s – podobnosti. Modele iger z dvema igralcema smo običajno gradili na dva načina: od spodaj navzgor in od zgoraj navzdol. Pri prvem načinu smo čedalje bolj sortirali vrednosti po določenem algoritmu in na koncu končali s povsem sortiranimi vozlišči. Pri drugem načinu smo »sortirali« z dodajanjem popolnoma urejenega drevesa v prvo drevo. Pri modelih iger z enim igralcem smo podobnost uvajali samo od spodaj navzgor.

Spreminjanje b – vejitve ni problematično, vprašljiva je samo zmožnost preračunati modele za velike b.

Spreminjanje g – število pravih vrednosti pozicij in število vrednosti hevristične funkcije. Pri modelu z enim igralcem smo dodatno spreminjali še število maksimalnih vrednosti in do neke mere tudi velikost hevristične napake.



Slika 2: Model iger v patoloških pogojih kaže odvisnost od b, s, g.

Število dreves se je pri izračunavanju obnašanja modela sukalo okoli 10.000.

Podobne rezultate je prikazal tudi model iger z enim igralcem, le da je bilo potrebno za iskanje patoloških obnašanj nastaviti še en parameter več.

Zaključki nekaj tovrstnih modelov so:

- Podobnost močno vpliva na zmanjšanje patološkosti
- Tudi zrnatost hevristične ocenjevalne funkcije močno vpliva na zmanjševanje patološkosti
- Večja vejitev rahlo povečuje patološkost, teoretsko pa je znano, da obstaja razred iger z neskončno pripadnicami, v katerem dovolj velika vejitev pomeni patološkost v vsakem primeru (Nau 79). Vejitev pa tudi povečuje učinek patološkosti v obe smeri – rahla patološkost se ob podobnih pogojih poslabša ob večji vejitvi in rahlo nepatološkost spremeni v večja izboljšanja.

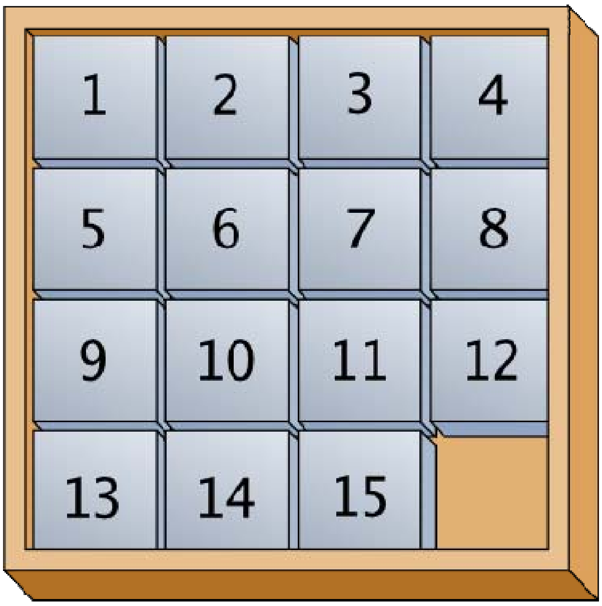
Originalni modeli imajo določene slabosti:

- Izračun b je običajno le do 10, saj je za večje b računsko postopek zelo zahteven.
- Vpeljava podobnosti ni enotna oz. v literaturi definirana na enoten način.
- Kvaliteta hevristične funkcije je v vseh modelih neodvisna od globine, kar verjetno ni običajno v mnogih realnih nalogah, kjer bližina cilja izboljša oceno.
- Modeli vsebujejo mehanizme, ki preprečujejo, da bi se v korenu preiskovalnega drevesa z veliko verjetnostjo pojavila zgolj ena vrednost. Tem mehanizmom v prid govori, da si želimo preučevati zanimive položaje, ki niso z veliko verjetnostjo dobljeni za enega od igralcev, a kako točno je s tem pojavom v igrah, ne vemo.
- Model enega igralca je manj preizkušen kot model z dvema igralcema in za primerno patološkost potrebuje en parameter več.
- Modeli dajejo vtis, da je patološkost nekaj pogostega v igrah z enim ali dvema igralcema, kar v praksi ni tako.

4 PRAKTIČNI PRIMERI PATOLOGIJ

Z mukotrpnim iskanjem smo našli nekaj patologij v realnih igrah – v dveh šahovskih končnicah jih je našel Aleksander Sadikov. Ko je bila prava vrednost pozicije število potez do konca in kvaliteta hevristične ocenjevalne funkcije neodvisna od globine, sta dve končnici pokazali patološko oz. praktično patološko obnašanje pri majhnih g, nato pa z večjimi g čedalje večje izboljšanje s preiskovanjem v večjo globino.

Podobno lastnost je pokazal Rok Piltaver pri preiskovanju lastnosti problema 8-ploščic (Piltaver 07). Poleg tega je ugotovil, da so podobne odvisnosti glede g in s tudi pri funkciji Manhattanske razdalje, ki se z globino izboljšuje. Ta ocena pa je bila načeloma pri vseh g z globino bolj uspešna kot od globine neodvisna ocena.



Slika 3: Problem 8-ploščic je tudi patološki in kaže, da je tudi v igrah enega igralca prisotna patološkost ob določenih pogojih.

Rok Piltaver je pokazal tudi, da je število pozicij, kjer je iskanje v globino bolj uspešno, skoraj primerljivo s številom pozicij, kjer je bolj uspešno preiskovanje na prvem nivoju, in da je pri precejšnjem deležu vseh pozicij vseeno, ali iščemo globlje ali ne.

Matej Guid je pokazal, da je v preko 1000 šahovskih partijah za naslov svetovnega prvaka približno 6-8 odstotkov vseh pozicij patoloških.

Patologija oz. »skoraj patologija« torej ni tako izredno redka, kot bi lahko domnevali iz praktičnih izkušenj, kjer programi z večjo globino pregledovanja praktično vedno igrajo bolje.

5 DISKUSIJA

Predlagani modeli patologij gotovo ne zajemajo vsem možnih iger in vseh možnih načinov patologij – daleč od tega. Podajajo pa nek splošen model iger. Izvirnost je v naslednjem:

- Celovit prikaz treh najpomembnejših parametrov na patološkost
- Prikaz odvisnosti med številom vrednosti hevristične funkcije in patološkostjo
- Nova relacija med vejitvijo in stopnjo patološkosti
- V modelu iger z enim igralcem
- V podrobnem prikazu patološkosti v nekaj igrah realnega sveta
- V prikazu, da je patološkost oz. »skoraj patološkost« pogostejša, kot se je to do sedaj domnevalo.

Zahvala:
Zahvaljujemo se ARRS za financiranje raziskovalne programske skupine Umetna inteligenca in inteligentni sistemi. Zahvaljujemo se naslednjim sodelavcem za sodelovanje pri raziskavah: Rok Piltaver, Aleš Tavčar, Aleksander Sadikov, Matej Guid.

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FALL DETECTION AND ACTIVITY RECOGNITION METHODS FOR THE CONFIDENCE PROJECT: A SURVEY

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ABSTRACT

The Confidence project is designed to support independent living of the elderly. The main goal of the project is reconstructing the user's posture to detect falls in real time and to detect other abnormalities in behavior. This paper presents a survey of methods for fall detection and activity recognition and discusses how suitable they are for the Confidence project. The presented methods use accelerometers, velocity profiles and visual markers.

1 INTRODUCTION

While the expected lifetime in Europe is increasing, the population growth is negative. The over-65 population is anticipated to rise from 17.9 % in 2007 to 53.5 % by 2060 [5] as shown in Figure 1. Thus an effort needs to be made to ensure that elderly people could live longer independently with minimal support of working-age population.

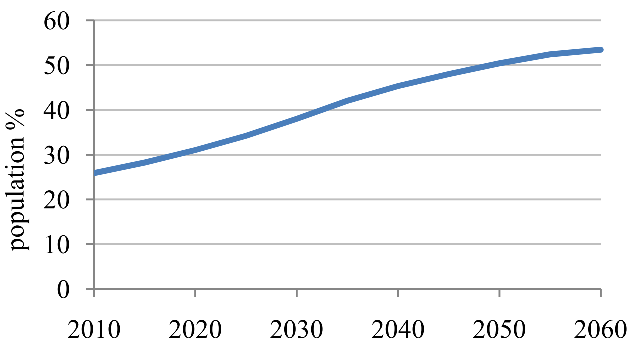

Figure 1: *Projected dependency ratio of persons aged 65 and over in EU (27 countries).*

The Confidence project will develop a ubiquitous care system to support independent living of the elderly. The system will be able to reconstruct the user's posture and detect abnormal situations, such as falls, loss of consciousness or behaviors indicating a disease.

This paper surveys fall detection and activity recognition methods that could be used in the project. They are mostly based on the data from accelerometers, gyroscopes or cameras, which will not be employed in Confidence, so they cannot be used directly. Nevertheless, some may be adapted to the system to be developed in the project.

Section 2 presents the hardware architecture of the Confidence system and the basic ideas of the project. Section 3 is dedicated to fall detection using acceleration-based methods, velocity profiles and computer vision. In Section 4 are presented some systems and methods for activity and posture recognition. Section 5 summarizes the survey.

2 CONFIDENCE SYSTEM DESCRIPTION

The user will wear small low-cost wireless tags placed on the significant places on the body such as wrists, elbows, shoulders, ankles, knees and hips. The precise number and placement of tags will be defined during development. The tags may be sewn into the clothes. The location of the tags will be detected by a base station located in the apartment or a portable device carried outside. This will make it possible to reconstruct the user's posture as shown in Figure 2.

Some tags will be placed in the user's environment at specific positions, such as bed, chair, sofa, table, etc. These tags will enable the recognition of situations such as the user lying in the bed or sitting in a chair.

Intelligent modules in the Confidence system will process and analyze the data and raise the alarm if the user's behavior indicates a hazardous situation such as a fall, stroke, epileptic attack etc. First, the system will make a phone call to the user and verify the user's state by requiring the user to press a sequence of buttons or say a certain word. If the user does not pick up the phone, the system will make a phone call to relatives, friends and even the emergency services if nobody answers.

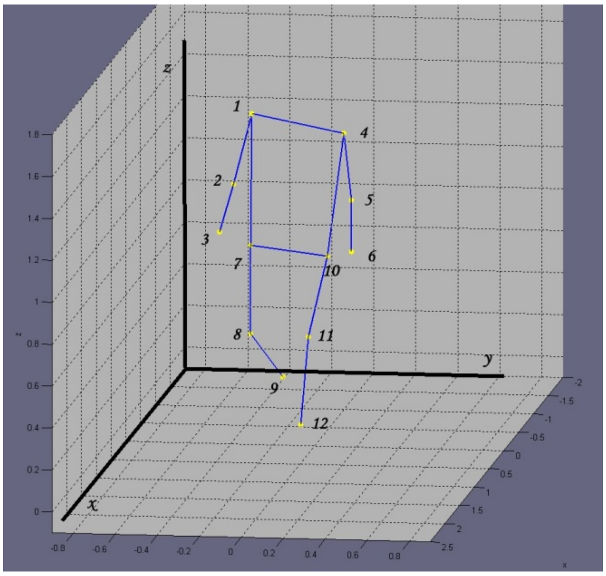

Figure 2: *3D locations of body tags obtained by motion capture system.*

3 FALL DETECTION

Falls among the elderly are the leading cause of injury, even death, and the loss of independent living. Detection and prevention of falls is consequently an important issue in the Confidence project. Figure 3 shows simulation of a fall during the capturing of training data in the laboratory.

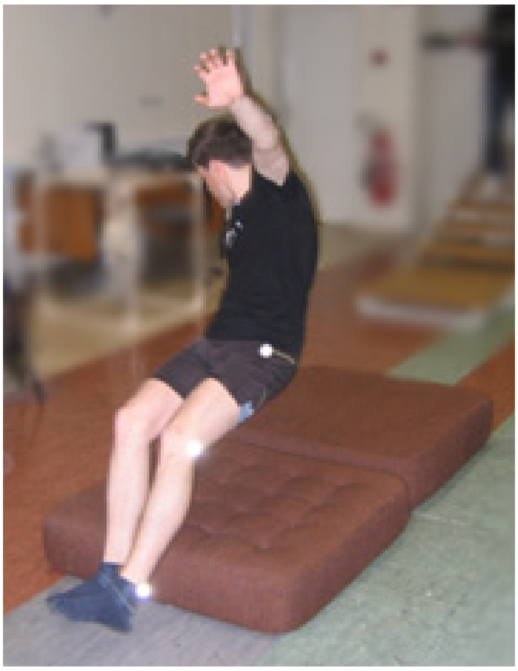

Figure 3: *A simulation of a fall.*

3.1 Accelerometer-based methods

The most common and simple methodology for fall detection is using a tri-axial accelerometer with quite simple threshold-based algorithms [3, 7]. Such algorithms simply raise the alarm when the threshold value of acceleration is reached. There are several sensors with hardware built-in fall detection [1, 4, 9].

D. J. Willis [12] developed a more complex fall detection system based on dynamic belief network models, which can be used to model and produce conclusions about the state of complex temporal environments. He used pressure transducers besides accelerometers.

T. Zhang et al. [15] designed fall detector based on support vector machine algorithm. Their method detected falls with 96.7 % success rate. Researches embedded an accelerometer in a cell phone [14] and detected falls with the proposed method. The cell phone was put in the pocket of clothes or hanged around the neck. The system correctly raised the alarm in 93.3 % of the cases.

Researchers using accelerometers give a lot of attention to the optimal sensor placement on the body [3, 7]. A head-worn accelerometer provides excellent impact detection sensitivity, but its limitations are usability and user acceptance. A better option is a waist-worn accelerometer. The wrist did not appear to be an optimal site for fall detection. Some researchers made a step further and used accelerometers for trying to recognize the impact and the posture after the fall [8].

In Confidence we will be able to derive accelerations from the movement of the tags and use one of the threshold algorithms if the localization precision is sufficient. Using more complex algorithms such are dynamic belief networks and support vector machine may be considered if threshold algorithms do not achieve the desired accuracy. Posture after the fall can be obtained from the locations of the body tags rather than from accelerations. Studies of the sensor placement may be valuable for deciding where to place tags in Confidence.

3.2 Velocity profile

A. K. Bourke and G. M. Lyons [2] introduced a threshold algorithm to distinguish between normal activities and falls. The ability to discriminate was achieved using a bi-axial gyroscope sensor mounted on the trunk, measuring pitch and roll angular velocities. They constructed a threshold algorithm based on the investigation of peaks in the angular velocity signal, angular acceleration and trunk angle change. System proved 100 % successful in fall detection.

In Confidence we may use the proposed method. Having sufficiently precise tag localization would enable us to compute the required signals. Decreased precision may cause problems when defining the threshold values.

G. Wu [13] studied unique features of the velocity profile during normal and abnormal (i.e. fall) activities so as to make the automatic detection of falls during the descending phase of a fall possible. Normal activities included walking, rising from a chair and sitting down, descending stairs, picking up an object from the floor, transferring in and out of a tub and lying down on a bed.

The study provides exhaustive velocity parameters for fall detection, which could be very useful in Confidence.

Supposing that we have sufficiently precise tag localization, we could simply extract those velocities and detect falls extremely quickly.

3.3 Computer vision

Z. Fu et al. [6] described a vision system designed to detect accidental falls in elderly home care applications. The system raised the alarm when a fall hazard was detected. They used an asynchronous temporal contrast vision sensor, which extracts changing pixels from the background and reports temporal contrast. A lightweight algorithm computed an instantaneous motion vector and reported fall events. They were able to distinguish fall events from normal human behavior, such as walking, crouching down and sitting down.
Temporal contrast vision sensor gives a similar human body contour as the Confidence human body model derived from tag locations. Z. Fu et al. defined a centroid event as the average of the motion events, which was used for fall detection. This method could be potentially useful when localization precision is reduced.

4 ACTIVITY AND POSTURE RECOGNITION

E. M. Tapia et al. [11] presented a real-time algorithm for automatic recognition of not only physical activities, but also, in some cases, their intensities, using five wireless accelerometers and a wireless heart rate monitor. Features were extracted from time and frequency domains using a predefined window size on the signal. The classification of activity was done with C4.5 and Naïve Bayes classifiers.
The algorithm was evaluated using datasets consisting of 30 physical gymnasium activities collected from a total of 21 people. On these activities, they obtained a recognition accuracy of 94.6 % using subject-dependent training and 56.3 % using subject-independent training.
Although the researchers were using a different monitoring system, the presented system successfully dealt with real-time activity recognition, which could be useful in Confidence.
G. Qian et al. [10] introduced a gesture-driven interactive dance system capable of real-time feedback for performing arts. They used 41 markers on the body measured by 8 cameras with the frame rate of 120 Hz. They developed data cleaning algorithm to tackle missing markers and constructed a human body model. The model was used to extract features such as torso orientation, joint angles between adjacent body parts etc., which was used to represent different gestures. Each gesture was statistically modeled with a Gaussian random vector. Gesture matching was performed to determine whether a new pose is inside the gesture space and if it is, the likelihoods of the feature vector given different gestures were computed.
Experimental results with two dancers performing 21 different gestures achieved gesture recognition rate of 99.3 %.

The markers in the proposed system have the same role as tags in the Confidence system. The presented methods could be directly used for posture recognition. The Confidence system will avoid data cleaning due to wireless transmission of 3D coordinates instead of detecting them with a camera.
A lot of researches investigated fall detection and posture recognition using video surveillance. They extracted features from image signal and used one of the abovementioned methods. Such feature extraction is not applicable to Confidence and consecutively not discussed.

5 CONCLUSION

The presented systems and methods are successful in detecting falls and activities. Falls are mainly detected with accelerometers and gyroscopes. In the Confidence system, the derivation of accelerations is questionable due to tag sampling rate. Methods using velocity profiles are more appropriate. In combination with furniture tags to detect the location of the fall, they may give very reliable results.
Activity recognition is mainly based on processing video images. System based on markers detected with a camera give promising results.

Acknowledgement

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RAČUNALNIŠKI SISTEMI ZA AVTOMATSKI DIALOG

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Povzetek

V svetu neštetih informacij postaja vse težje najti pravi odgovor na zastavljeno vprašanje. V ta namen se razvijajo sistemi za avtomatsko odgovarjanje na vprašanja (AVO). V prispevku predstavljamo pregled obstoječih AVO sistemov, virtualnega informatorja, ki smo ga razvili, mehanizme delovanja, ki so v ozadju in ideje za razvoj sistemov v prihodnosti.

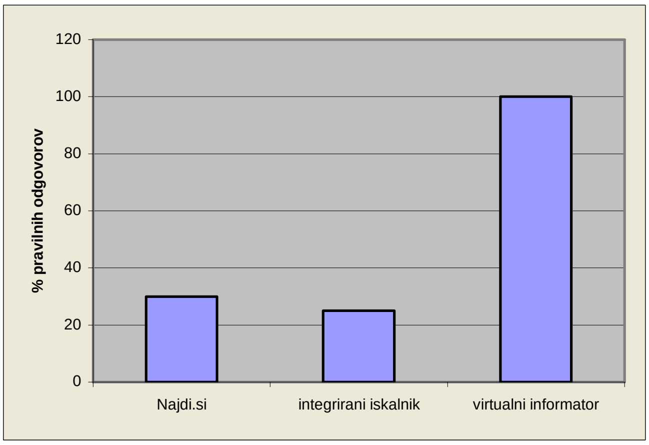
1 UVOD

V sodobnem informacijskem svetu postaja velika količina informacij precejšen problem. Obstoječi integrirani iskalniki posameznih spletnih strani ali splošno uporabni iskalniki sicer nudijo določeno možnost iskanja informacij, vendar delujejo zgolj kot klasični internetni iskalniki, na podlagi ključnih besed. Mnogokrat ne znajo poiskati konkretne informacije, ki zanima uporabnika s specifičnim vprašanjem, postavljenim v naravnem jeziku.

Vprašanja, postavljena v stavkih, prinesejo na najbolj popularnih iskalnikih kot je npr. Google ali Yahoo bistveno slabše zadetke kot nekaj dobro premišljenih ključnih besed.
Popularen način odgovarjanja na vprašanja so FAQ (ang. »frequently asked questions«), oziroma pogosto zastavljena vprašanja in odgovori nanj. Problem FAQ pa je, ali da je zbirka premajhna in ne pokrije vsega, kar zanima stranke, ali da je prevelika, zaradi česar je stranke ne preberejo. Podjetja imajo velikokrat tudi skupino strokovnjakov, ki je zaposlena, da odgovarja na vprašanja strank (npr. Google Answer), kar pa je drago.

V zadnjem času postaja vse bolj popularno t.i. avtomatsko odgovarjanje na vprašanja. V prispevku predstavljamo »virtualnega informatorja« oz. svetovalca, ki zna odgovoriti tudi na konkretno zastavljena vprašanja o določeni tematiki. Na Sliki 1 je predstavljena naša statistika ustreznosti odgovorov na enostavna vprašanja, izpeljana iz spletne strani uporabnika, ki smo jih dobili s pomočjo splošnega spletnega iskalnika [14], integriranega iskalnika na uporabnikovi spletni strani in našega virtualnega informatorja. Ugotovimo lahko, da je uporaba virtualnega informatorja v mnogih primerih zelo koristna. Glavna prednost je v tem, da se lahko vprašanja virtualnemu informatorju postavljajo v naravnem, človeškem, jeziku, v katerem dobijo tudi odgovore. Gre za neke vrste dialoga.

Ocenjujemo, da lahko svetovalec bistveno izboljša informiranost uporabnikov in predvsem poenostavi iskanje informacij o množici rešitev konkretnejših vprašanj in problemov. Svetovalec bi lahko zamenjal obstoječe človeške informatorje in svetovalce na različnih področjih kot na primer v potniškem prometu, za posedovanje informacij ob prvi pomoči, integracijo v inteligentni dom ipd. [1].



Slika 1. Statistika ustreznosti povratne informacije na zastavljeno vprašanje z uporabo različnih spletnih iskalnikov in virtualnega informatorja.

2 PREGLED PODROČJA

Avtomatsko odgovarjanje na vprašanja (AOV) ima že dolgo zgodovino. Alain Turing je že davnega leta 1950 [4] dejal, da je glavni cilj umetne inteligence izdelat program, ki bo prestal Turingov test, to je, da človek ne bo mogel ugotoviti, ali ima opravka (se pogovarja) s človekom ali z računalnikom. To bi pomenilo, da je program (človeško) inteligenten. Današnji različno kompleksni govoreči roboti skušajo simulirati pogovor na čim bolj inteligenten način.

Več desetletij se znanstveniki z različnimi pristopi trudijo izboljšati človeku podobne jezikovne sposobnosti računalnikov. Na stotine je različnih sistemov avtomatskega dialoga, razvitih z različnimi razlogi; izključno za zabavo ali kot del interaktivnih iger, t.i. internetni oz. virtualni informatorji, ki uporabnikom posredujejo informacije, ki ji zanimajo, virtualni asistent, ki uporabnike opominjajo na stvari in dogodke, agenti etrgovine in podobno. Večina teh vsebuje specifične informacije in usmerja dialog na specifične teme [8].

Prvi splošno znan program za avtomatski dialog je bila ELIZA [9], ki jo je leta 1966 razvil računalničar Joseph Weizenbaum. ELIZA simulira psihološkega terapevta. Vgrajeni algoritem temelji na prepoznavanju ključnih besed in transformaciji uporabnikovega komentarja v odgovor. Tako na primer na besedo "mama" ELIZA odgovori "povej mi več o tvoji družini". Če takšno pravilo ni obstajalo, pa je za odgovor preprosto uporabil katerega od preteklih uporabnikovih komentarjev. Še danes je ta program konkurenčen ostalim in predstavlja nekakšen standard kakovosti ostalim programom AOV.

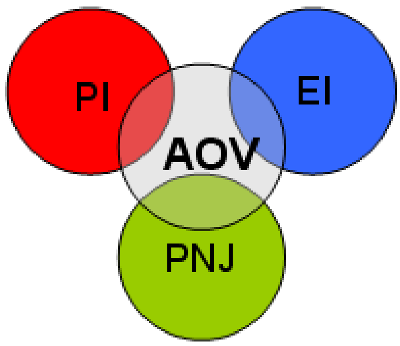
Po ELIZI je prišel Parry (Kenneth Colby), ki naj bi simuliral paranoidnega bolnika. V naslednjih letih je nastalo še veliko podobnih sistemov[1] npr. Alice, kjer je bil dialog prav tako krmiljen na podlagi ključnih besed. Temeljna prednost tega sistema pa je bila v tem, da se je učil iz preteklih izkušenj. Pri nas sta trenutno najbolj znana sistema dialoga oz. virtualna agenta v slovenščini Vida [11], ki poseduje informacije o davku in bolj zabavno-konverzacijski Klepec [13].

Kljub temu, da je ELIZA še vedno zabaven partner za pogovor, se sposobnosti modernih AOV programov od nje bistveno ne razlikujejo in delujejo bolj ali manj na osnovi podobnih pristopov. Kljub temu, da lahko programi izvedejo razumljiv pogovor, s precejšnjo lahkoto razkrinkamo mehanizem v ozadju in jih posledično tudi preslepimo. Morda so postali malenkost pametnejši, nekoliko težje izgubljeni v pogovoru, vendar se je do sedaj kakršnakoli drastičnejša vpeljava »inteligence« izkazala za nekoristno, če ne celo škodljivo in so še daleč od tega, da bi bili pripravljeni prestati pravi Turingov test.

Glavna izboljšava na tem področju se nanaša predvsem na skriptne jezike AOV programov kot je Dr. Richard Wallaceov razvoj AIML (Artificial Intelligence Markup Language) [15] in razvoj CHAT (Conversational Hypertext Access Technology) Dr. Thomas Whalena [5]. Večina ostalih programov pa je še vedno napisana v LISPU, enemu izmed osnovnih računalniških jezikov profesorja Johna McCarthyja [12].

Kaj predstavlja računalniških sistemom tako velik problem pri razumevanju in procesiranju naravnega jezika? Vzroke za to lahko iščemo v osnovni kompleksnosti, nejasnosti in pretkani preciznosti in semantiki človeškega jezika.

Naša sposobnost grajenja neštetih svetov in omejenega števila besed izhaja iz dejstva, da je v jeziku več pomenov kot obstoječih besed. Ta nejasnost se začne pri osnovnem gradniku jezika - besedi. Večina besed je dvoumnih. Beseda bolnica lahko denimo pomeni osebo, ki je v bolnici, ali stavbo samo. Ljudje se pri razumevanju pomena besed zanašamo na kontekst, v katerem besedo slišimo ali preberemo (t.j. ostale besede, ki našo besedo v tem trenutku obkrožajo). Ali lahko podobno storijo tudi računalniški programi? Zaenkrat pravila, ki bi določalo, na kakšni osnovi naj razberejo pomen stavka dvoumnega pomena, še nismo razvili. Za računalnike so med težjimi vprašanji tudi vprašanja oblike »Kako« in »Zakaj«. Da bi odgovoril na ta dva tipa vprašanj, je potrebno imeti znanje o določenem področju. Za odgovor na vprašanje »Zakaj je AOV težko?« je potrebno poznati praktično vse, kar je možno izvedeti na področju AOV. Problem AOV je, da je to področje presek različnih področij (Slika 2): procesiranja naravnega jezika (PNJ), ekastakcije informacij (EI) in pridobivanja informacij (PI).



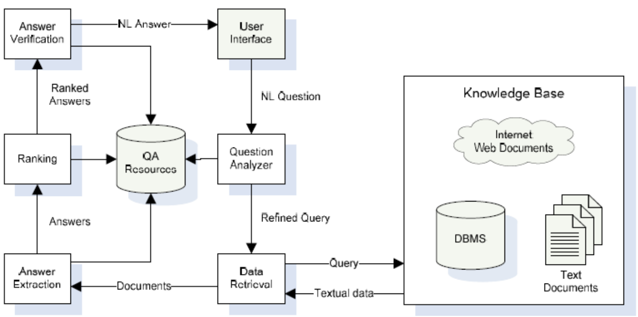
Slika 2. Presek področij, ki se pojavljajo v AOV raziskovanju [3].

Eksperimenti procesiranja naravnega jezika (ang. »natural language processing« NLP) so vključevali na stotine različnih raziskovalnih tehnik od Markovih verig [2], ki pri napovedi, kaj sledi v stavku, uporabljajo teorijo statistične verjetnosti, do povezane slovnice, ki razdeli stavke na stavčne člene, a vse z ne ravno idealnimi uspehi. A določanje slovnice ni vedno enako razumevanju. Nekateri avtorji so v ta namen ustvarili ogromne »baze znanja«, ki naj bi računalniškim programom omogočile razločevati sopomenke in druge jezikovne pojave. Takšna najpomembnejša baza znanja se razvija v okviru projekta CYC [6], ki namerava zgraditi bazo 100 milijonov med seboj prepletenih in povezanih izjav. Po 15 letih dela ima ta baza trenutno vkodiranih 1.5 milijona takšnih stavkov in predstavlja produkt, s katerim si ne moremo pomagati dosti več od tega, da analiziramo računalniško varnost.

[1] Obstoječi tuji sistemi dialoga: *Jupiter* (vremenska napoved; goups.csail.mit.edu/sls/research/jupiter/shtml), *Trains* (načrtovanje železniških potovanj; www.cs.rochester.edu/research/trains), C*onquest* (info.o spremljajočih dogodkih konference; www.conquest-dialog.org/), in še bi lahko naštevali

Teoretiki na tem področju, kot so Noam Chomsky, Steven Pinker [7] in mnogi drugi, so razvili natančen sistem kompleksnih, vgrajenih slovničnih struktur, ki pa nas ne vodijo v smeri »prave« umetne inteligence, ko jih poskušamo transformirati v računalniško kodo in jih uporabiti za interpretacijo jezika.

3 DELOVANJE SEDANJIH SISTEMOV DIALOGA



Slika 3. Splošna shema AOV sistemov.

Shema AOV sistemov je v splošnem sestavljena iz uporabniškega vmesnika, sistema za vodenje dialoga, baze znanja in sistema za tvorjenje govora (Slika 3) [3].

3.1 Uporabniški vmesnik

Večina AOV sistemov vključno z našim ima vmesnik za uporabnika (user interface) na internetni strani, kjer lahko vtipkamo vprašanje. Sistem interpretira vprašanje in poišče odgovor, ki je podoben odgovoru, ki bi ga dal človek, če bi odgovarjal na vprašanje. Trenutno je še uporabniški vmesnik vnosno polje, vendar pa bo ta v pridnosti najbrž postal neviden del drugih naprav, kot npr.: mobilnih telefonov, gospodinjskih strojev, navigacijskih sistemov.

3.2 Vodenje dialoga

Vodenje dialoga je osnova sistema dialoga in upravlja celoten postopek interakcije z uporabnikom in reakcije sistema, vzdržuje zgodovino dialoga, določa strategijo vodenja dialoga, ima povezavo s podatkovnimi bazami v ozadju, iz katerih črpa informacije in vsebine.

Večinoma sta v uporabi dva načina, kako povezati vprašanje z odgovorom. To sta boolean model in vektorski model [10]. Boolean model je preprost binarni sistem, uporabljen tudi v našem primeru, ki izbira, katere ključne besede morajo biti v vprašanju, da odgovori s določenim odgovorom. Za primer imejmo izraz $q = t_1 + (t_2|t_3) – t_4$. To pomeni, da bomo dali izbran odgovor, če bo v vprašanju ključna beseda t_1 in ena izmed besed t_2 in t_3, ne bo pa besede t_4. Ta model je preprost in deluje precej dobro. Glavni problem je, da mora biti boolean izraz dobro premišljen. Če je v njem veliko omejitev, potem je verjetno, da določeni odgovor nikoli ne bo izbran. Če pa je omejitev premalo, se lahko zgodi, da je izbran prepogosto in v napačnih primerih. Obstajajo tudi sistemi, ki namesto ključnih besed prepoznavajo fraze ali celo cele stavke.

Drug način je vektorski model, kjer ima vsaka ključna beseda za nek odgovor določeno utež. To metodo je težje implementirati, vendar pa deluje bolje za težja vprašanja.

Najbolj sofisticirani programi uporabljajo tudi algoritme učenja, tako da si sistem zapomni informacije celotnega pogovora in jih uporabi v prihodnje. To naj bi omogočalo sistemu, da avtomatsko širi svojo bazo znanja iz informacij ki jih dobi od uporabnikov. Žal pa ti sistemi zaenkrat še ne delujejo dovolj dobro.

3.3 Baza znanja

Baza znanja predstavlja v našem primeru ključne besede ali kombinacijo le teh, povezanih z ustreznim odgovorom. Ključne besede sestavljajo le koreni ustreznih besed, s čimer se razširi svoboda oblikovanja vprašanj.

Pri grajenju baze znanja moramo biti previdni pri sestavljanju ključnih besed. Njihovo število mora biti ravno pravšnje, same besede pa primerne. Če jih je premalo, obstaja večja verjetnost, da bo na neko drugo vprašanje, ki ima sicer omenjeno ključno besedo, odgovoril z odgovorom, ki bo napačen. Če jih je preveč, potem obstaja večja verjetnost, da bo odgovor manjkrat prišel v poštev, saj bodo lahko uporabniki isto vprašanje zastavili nekoliko drugače (z katero drugo ključno besedo). Z »ali« zanko je potrebno zajeti čim več sopomenk, ki jih lahko ljudje uporabljajo, ko na različne načine zastavljajo vprašanje, na katerega nameravamo podati enak odgovor.

Poleg tega je pri grajenju baze znanja pomemben tudi vrstni red ključnih besed in z njimi povezanih stavkov. Navadno je tako, da sistem nekatere kombinacije prej pregleda kot druge. Zato je pomembno, da denimo zagotovimo, da v primeru, ko se v vprašanju pojavi več »znanih« ključnih besed, računalnik poda odgovor, ki ustreza bolj pomembnim ključnim besedam. Načeloma so na prvih mestih kombinacije, ki imajo v odgovoru bolj specifične informacije.
Bazo nam pomagajo graditi tudi sami uporabniki, saj imajo možnost, da ob nezadovoljivem odgovoru vpišejo ključne besede iz svojega vprašanja in podajo odgovor, ki se jim zdi primeren. Administrator sistema le-te pregleda in jih vgradi v bazo.

3.4 Tvorjenje odgovora

Poznamo dva tipa generiranja odgovorov. Odgovore lahko pridobivamo iz celotnega interneta. Na ta način se bo AOV spoznal na vsa področja, vendar pa je pridobivanje odgovora dolgotrajno ali pa zahteva veliko bazo podatkov. Odgovori so ponavadi splošni, saj ne moremo natančno pregledati vseh dokumentov na internetu. Če znanje omejimo na določeno področje, sistem postane točnejši in hitrejši. Lahko dobimo odgovore na bolj specifična vprašanja. Pri omejenem področju veliko vlogo igrajo tehnični izrazi, ki v splošnem nimajo pomena ali pa imajo drugačen pomen (npr.: kratice E9, IJS,…) Seveda je pri tem težava, da so vprašanja bolj specifična, kompleksna in kompleksna vprašanja zahtevajo kompleksne odgovore.

4 IZZIVI ZA PRIHODNOST

Kot smo omenili in lahko iz opisa delovanja sistemov ugotovimo, da je v ozadju AOV programov dokaj enostavna logika, potrebna je le precejšna mera natančnosti in razumevanja področja. Seveda pa si v prihodnje želimo, da bi stvari izboljšali, dodatno avtomatizirali in dodali bolj sofisticirane inteligentne module. Ideje, ki se jih nameravamo mi lotiti, so naslednje:

Kombinacije ključnih besed in odgovorov v bazi znanja bomo označili s širšimi tematskimi sklopi. V sklopu »osebno« bi denimo bile vse »osebne informacije o AVO«, v sklopu »administracija« bi bili podatki o administraciji inštitucije, za katero je sistem namenjen…ipd. Ko bo sistem enkrat vstopil v določeno tematiko, bo najprej iskal ključne besede v njej in šele če ne bo našel primernega odgovora, se bo preselil na iskanje po celotni bazi. To bi pripomoglo k hitrejšemu in natančnejšemu (manj napak) odgovarjanju.

Odgovore, ki jih bo sistem podal, bodo lahko uporabniki ocenjevali kot zadovoljive ali ne. Iz ocen bomo izračunali statistiko, ki bo predstavljala neke vrste obteženost odgovora. Bolj obteženi odgovori naj bi bili boljši, zato bodo ob ključnih besedah, ki bi teoretično lahko sprožili dva odgovora, prej priklicani kot manj obteženi=slabši.

Razviti nameravamo program, ki bo iz ustreznih spletnih strani sam znal izluščiti ključne besede in odgovore, ki so z njimi povezane, kar bi avtomatiziralo dopolnjevanje baze znanja.

Avtomatsko prepoznavanje stavčne strukture bi lahko hkrati pomenilo avtomatsko prepoznavanje ključnih besed oz. smisla stavka, kar bi bil korak na poti k reševanju Turingovega testa. Vendar tudi če bo znal prepoznati stavčno strukturo, še vedno ostajajo problemi pri mehanizmih za prepoznavanje smisla stavkov, ki se nanašajo predvsem na jezikovne dvoumnosti, kot so sinonimi, antonimi, preimenovanji, leposlovjem ipd. Če na primer rečemo, da je »Janez priletel okrog ovinka, ko je guma počila« mislimo, da se je pripeljal hitro okrog ovinka, ne pa, da je dejansko priletel.

Za vprašanja, ki ne vključujejo nejasnosti in dvoumnosti in bi jih sistem pravilno prepoznal, bi lahko sistem sam (na internetu?) poiskal tudi primeren odgovor.

Kadar sistemu pomen vprašanja ni jasen, si lahko pomaga z uporabo drugih modalnosti (t.j. drugih kanalov, poleg govora zlasti še slika). Pri tem govorimo o sistemih multimodalnega dialoga, ki postajajo vedno bolj popularno področje robotike.

5 ZAKLJUČEK

V mnogih pogledih so sistemi dialoga preprosto utelešenje Turingove vizije umetne inteligence. Nimajo »možganov« v človeškem pomenu, le sposobnost reakcije na dražljaje, v tem primeru tipkane besede in stavke. Njihov cilj ni posnemati človekova notranja kognitivna stanja, ampak simulacija človeške inteligentnosti preko uporabe jezika.

Kljub precejšnji popularnosti sistemov dialoga pa, predvsem zahvaljujoč kompleksnosti in nejasnosti človeškega govora, ostaja leta 1990 razpisana nagrada za sistem, ki bi prestal Turingov test, vredna 100.000 USD, do danes še nepodeljena. Rojevajo pa se nove ideje, ki bodo lahko prihodnje rodove AVO sistemov dvignile na višjo inteligenčno stopnjo.

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PREPOZNAVA POLOŽAJA TELESA S STROJNIM UČENJEM

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POVZETEK

Iz koordinat 12 značk, pritrjenih na sklepe, smo s strojnim učenjem prepoznavali položaj telesa. V ta namen smo uporabili tri nabore atributov: (1) koordinate značk in iz njih izpeljane atribute v referenčnem koordinatnem sistemu, (2) koordinate in izpeljane atribute v telesnem koordinatnem sistemu in (3) kote med deli telesa. Za prepoznavanje položaja telesa smo uporabili osem algoritmov za strojno učenje. Ugotovili smo, da so najboljši atributi v referenčnem koordinatnem sistemu, med algoritmi za strojno učenje pa se najbolje obnese metoda podpornih vektorjev.

1 UVOD

Metode za prepoznavanje položaja telesa, ki jih opisujemo v prispevku, so namenjene uporabi v projektu Confidence [1]. Cilj projekta je starejše osebe opremiti z radijskimi značkami, s pomočjo katerih bo moč zaznavati položaj telesa in na podlagi tega ugotavljati zdravstvene težave, posebej padce.

Ker značke in senzorje, ki bodo uporabljene v projektu, partnerji še razvijajo, smo namesto njih uporabili infrardeči sistem Smart [2]. Osebam smo na telo pričvrstili 12 značk, ki odsevajo v infrardeči svetlobi. S šestimi infrardečimi kamerami smo ugotavljali koordinate teh značk v prostoru in jih klasificirali v šest dejavnosti ali stanj. Ker je infrardeča tehnologija bistveno natančnejša od radijske (~1 mm proti ~15 cm), smo vhodne podatke zašumili.

Položaj telesa smo prepoznavali s strojnim učenjem. Uporabili smo različne nabore atributov: koordinate značk in iz njih izpeljane atribute v koordinatnem sistemu, vezanem na prostor, koordinate in izpeljane atribute v različnih koordinatnih sistemih, vezanih na telo, in kote med deli telesa. Preizkusili smo osem algoritmov za strojno učenje iz programskega paketa Weka [5].

2 VHODNI PODATKI

Uporabili smo po 45 posnetkov gibanja treh oseb. Posnetke smo razbili na več dejavnosti (ali stanj), ki smo jih nato skušali prepoznati.

- 3 × 15 posnetkov padanja na različne načine (glavni cilj projekta), sestavljenih iz hoje, padanja in ležanja.
- 3 × 10 posnetkov uleganja (podobno padanju), sestavljenih iz hoje, uleganja in ležanja.
- 3 × 10 posnetkov usedanja (tudi nekoliko podobno padanju), sestavljenih iz hoje, usedanja in ležanja.
- 3 × 10 posnetkov hoje.

Posnetki vsebujejo koordinate 12 značk, pritrjenih na rami, komolca, zapestji, kolka, koleni in gležnja. Koordinate so bile zajete s frekvenco 60 Hz, kar smo zmanjšali na 10 Hz, ker je tolikšna frekvenca pričakovana pri radijski opremi, ki se bo uporabila v projektu. Posnetke, ki so se končali z ležanje ali sedenjem, smo podaljšali z 2 s mirovanja: 20-krat smo kopirali zadnji posnetek in vsakič dodali Gaussov šum s σ = 0,2 cm, da mirovanje ni bilo popolno. Da bi bili podatki bolj podobni zajetim z radijsko opremo, smo jih zašumili z Gaussovim šumom s σ = 4,36 cm v smereh x in y ter σ = 5,44 cm v smeri z. Tolikšen je namreč standardni odklon šuma sistema za določanje položaja Ubisense [4], ki je podoben onemu, ki se bo uporabil v projektu. Zašumljene podatke smo zgladili z enosmernim Kalmanovim filtrom (za glajenje uporablja zgolj pretekle koordinate) [3].

3 ATRIBUTI ZA STROJNO UČENJE

Želeli smo dognati, kolikšno uspešnost je mogoče doseči z enostavnimi in splošnimi atributi. Splošnost je pomembna, ker ni težko izbrati atributov, ki bi bili prilagojeni našim posnetkom in zato na njih zelo uspešni. A ker je s posnetki nemogoče zajeti ves razpon človeškega obnašanja, se taki atributi na splošnem obnašanju verjetno ne bi obnesli.

Atributni vektor smo sestavili iz N = 10 zaporednih posnetkov položaja telesa (kar pomeni eno sekundo), razred pa je bila ena od šestih dejavnosti (hoja, padanje, ležanje, uleganje, usedanje, sedenje). Preizkusili smo tudi N = 20, a rezultati niso bili bistveno različni, zato smo zaradi kratkosti nekaterih posnetkov uporabili krajši interval. Pri atributnih vektorjih, ki so vsebovali več dejavnosti, smo za razred izbrali najdaljšo. Za vsak posnetek smo izračunali več naborov atributov.

3.1 Atributi v referenčnem koordinatnem sistemu

Referenčni koordinatni sistem je koordinatni sistem prostora, v katerem se opazovana oseba giblje, in je nepremičen. Koordinat x in y nismo upoštevali, ker ni pomembno, kje v prostoru oseba je.

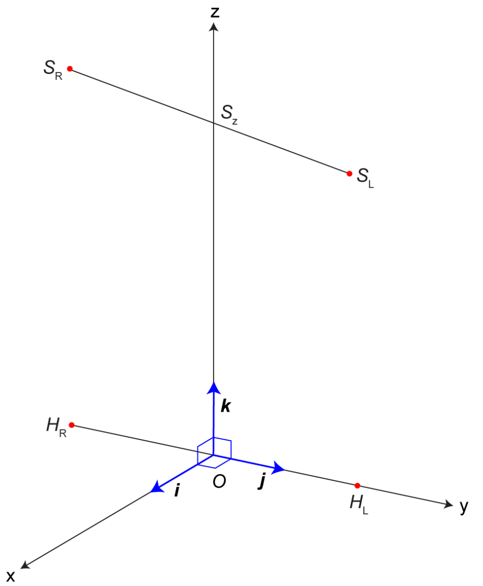
Gornji indeks t pomeni čas znotraj intervala: $t = 1 \ldots N$. Spodnji indeks i pomeni značko: $i = 1 \ldots 12$. Spodnji indeks R pomeni referenčni koordinatni sistem.

- $z^t_{i\mathrm{R}}$ … koordinata z značke i v času t
- $v^t_{i\mathrm{R}}$ … absolutna hitrost značke
- $v^t_{zi\mathrm{R}}$ … hitrost značke v smeri z
- $d^t_{ij\mathrm{R}}$ ... absolutna razdalja med značkama i in j; $j = i + 1 \ldots 12$
- $d^t_{zij\mathrm{R}}$ ... razdalja med značkama i in j v smeri z

3.2 Atributi v telesnem koordinatnem sistemu

Telesni koordinatni je pripet na opazovano osebo in omogoča opazovanje koordinat x in y. V njem ti dve koordinati namreč nista odvisni od položaja osebe v prostoru, temveč le opisujeta medsebojna razmerja položajev značk.

Telesni koordinatni sistem je prikazan na sliki 1. Njegovo izhodišče O je na sredini med levo in desno kolčno značko (H_R in H_L). Premica skozi H_R in H_L določa os y, ki je usmerjena proti levemu kolku. Os z je pravokotna na y, se dotika premice, ki povezuje ramenski znački (S_R in S_L) v točki S_z, in je usmerjena navzgor. Os x je pravokotna na y in z ter je usmerjena naprej.



Slika 1. *Telesni koordinatni sistem.*

Za pretvorbo koordinat iz referenčnega v telesni koordinatni sistem moramo izraziti izhodišče O ter bazne vektorje $\boldsymbol{i}$, $\boldsymbol{j}$ in $\boldsymbol{k}$ telesnega koordinatnega sistema v referenčnem. Krepka pisava označuje vektorje in $\boldsymbol{x}$ pomeni vektor iz izhodišče do točke X. Enačba (1) da izhodišče koordinatnega sistema.

$$\boldsymbol{o} = \frac{\boldsymbol{h}_\mathrm{L} + \boldsymbol{h}_\mathrm{R}}{2} \tag{1}$$

Bazni vektor $\boldsymbol{j}$ se izračuna z enačbo (2).

$$\boldsymbol{j} = \frac{\boldsymbol{h}_\mathrm{L} - \boldsymbol{o}}{|\boldsymbol{h}_\mathrm{L} - \boldsymbol{o}|} \tag{2}$$

Da dobimo $\boldsymbol{k}$, najprej izračunamo $\boldsymbol{s}_\mathrm{z}$ z enačbo (3).

$$\begin{aligned} &\boldsymbol{s}_\mathrm{z} = \boldsymbol{s}_\mathrm{R} + a(\boldsymbol{s}_\mathrm{L} - \boldsymbol{s}_\mathrm{R}) \\ &(\boldsymbol{s}_\mathrm{z} - \boldsymbol{o})(\boldsymbol{h}_\mathrm{L} - \boldsymbol{h}_\mathrm{R}) = 0 \\ &a = \frac{(\boldsymbol{s}_\mathrm{R} - \boldsymbol{o})(\boldsymbol{h}_\mathrm{L} - \boldsymbol{h}_\mathrm{R})}{(\boldsymbol{s}_\mathrm{L} - \boldsymbol{s}_\mathrm{R})(\boldsymbol{h}_\mathrm{L} - \boldsymbol{h}_\mathrm{R})} \end{aligned} \tag{3}$$

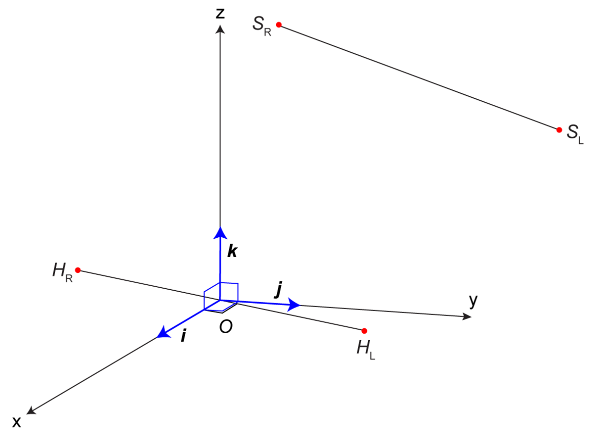
Ko poznamo $\boldsymbol{s}_\mathrm{z}$, izračunamo $\boldsymbol{k}$ z enačbo (4).

$$\boldsymbol{k} = \frac{\boldsymbol{s}_\mathrm{z} - \boldsymbol{o}}{|\boldsymbol{s}_\mathrm{z} - \boldsymbol{o}|} \tag{4}$$

Končno z enačbo (5) izračunamo $\boldsymbol{i}$.

$$\boldsymbol{i} = \boldsymbol{j} \times \boldsymbol{k} \tag{5}$$

Preizkusili smo še **telesni koordinatni sistem z referenčno osjo z**. Prikazan je na sliki 2. Izhodišče ima enako kot prvi telesni koordinatni sistem, za os z pa uporablja kar os z referenčnega koordinatnega sistema. Os y je pravokotna na z, leži v ravnini, ki jo določajo H_R, H_L in os z, ter je usmerjena proti levemu kolku. Os x je pravokotna na y in z ter je usmerjena naprej (pri pokončnem položaju telesa).



Slika 2. *Telesni koordinatni sistem z referenčno osjo z.*

Tudi pri tem koordinatnem sistemu se izhodišče izračuna z enačbo (1). Bazni vektor $\boldsymbol{k}$ je enak baznemu vektorju $\boldsymbol{k}$ v referenčnem koordinatnem sistemu: $\boldsymbol{k} = (0, 0, 1)$. Bazni vektor $\boldsymbol{i}$ je pravokoten na $\boldsymbol{k}$ in na vektor od O do H_L, kar izraža enačba (6).

$$\boldsymbol{i} = \frac{\boldsymbol{k} \times (\boldsymbol{h}_\mathrm{L} - \boldsymbol{o})}{|\boldsymbol{k} \times (\boldsymbol{h}_\mathrm{L} - \boldsymbol{o})|} \tag{6}$$

Bazni vektor $\boldsymbol{j}$ pa izračunamo z enačbo (7).

$$\boldsymbol{j} = \boldsymbol{k} \times \boldsymbol{i} \tag{7}$$

Za pretvorbo koordinat iz referenčnega v telesni koordinatni sistem uporabimo enačbo (8). Vektor $\boldsymbol{p}_\mathrm{R} = (x_\mathrm{R}, y_\mathrm{R}, z_\mathrm{R}, 1)$ ustreza točki $(x_\mathrm{R}, y_\mathrm{R}, z_\mathrm{R})$ v referenčnem koordinatnem sistemu, vektor $\boldsymbol{p}_\mathrm{B} = (x_\mathrm{B}, y_\mathrm{B}, z_\mathrm{B}, 1)$ pa točki $(x_\mathrm{B}, y_\mathrm{B}, z_\mathrm{B})$ v telesnem. $\boldsymbol{T}_{\mathrm{R}\to\mathrm{B}}$ je transformacijske matrika iz referenčnega v telesni koordinatni sistem. Oznaka $\boldsymbol{i}_{(\mathrm{B})\mathrm{R}}$

pomeni bazni vektor $\boldsymbol{i}$ telesnega koordinatnega sistema, izražen v referenčnem koordinatnem sistemu.

$$\boldsymbol{p}_{\mathrm{B}} = \boldsymbol{T}_{\mathrm{R}\to\mathrm{B}}\boldsymbol{p}_{\mathrm{R}}^{\mathrm{T}}$$

$$\boldsymbol{T}_{\mathrm{R}\to\mathrm{B}} = \begin{bmatrix} x_{\boldsymbol{i}(\mathrm{B})\mathrm{R}} & y_{\boldsymbol{i}(\mathrm{B})\mathrm{R}} & z_{\boldsymbol{i}(\mathrm{B})\mathrm{R}} & -\boldsymbol{o}_{(\mathrm{B})\mathrm{R}}\boldsymbol{i}_{(\mathrm{B})\mathrm{R}} \\ x_{\boldsymbol{j}(\mathrm{B})\mathrm{R}} & y_{\boldsymbol{j}(\mathrm{B})\mathrm{R}} & z_{\boldsymbol{j}(\mathrm{B})\mathrm{R}} & -\boldsymbol{o}_{(\mathrm{B})\mathrm{R}}\boldsymbol{j}_{(\mathrm{B})\mathrm{R}} \\ x_{\boldsymbol{k}(\mathrm{B})\mathrm{R}} & y_{\boldsymbol{k}(\mathrm{B})\mathrm{R}} & z_{\boldsymbol{k}(\mathrm{B})\mathrm{R}} & -\boldsymbol{o}_{(\mathrm{B})\mathrm{R}}\boldsymbol{k}_{(\mathrm{B})\mathrm{R}} \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (8)$$

Atributi v telesnem koordinatnem sistemu (povsem telesnem ali z referenčno osjo z), ki ga označuje spodnji indeks B:

- ($x^t_{i\mathrm{B}}$, $y^t_{i\mathrm{B}}$, $z^t_{i\mathrm{B}}$) ... koordinate značke i v času t
- $v^t_{i\mathrm{B}}$ … absolutna hitrost značke
- ($\varphi^t_{i\mathrm{B}}$, $\theta^t_{i\mathrm{B}}$) … kota gibanja značke glede na os z in ravnino xz

K gornjim atributom spadajo še atributi, izraženi v referenčnem koordinatnem sistemu, ki opisujejo izhodišče telesnega koordinatnega sistema:

- z^t_{OR} ... koordinata z izhodišča telesnega koordinatnega sistema
- (Φ^t_{OR}, Θ^t_{OR}) ... usmeritev osi x telesnega koordinatnega sistema glede na os z in ravnino xz
- v^t_{OR} … absolutna hitrost izhodišča telesnega koordinatnega sistema
- (φ^t_{OR}, θ^t_{OR}) ... kota gibanja izhodišča telesnega koordinatnega sistema glede na os z in ravnino xz

Koordinate in izpeljane atribute je v telesnem koordinatnem sistemu mogoče izraziti za vsak položaj telesa posebej, lahko pa vseh N položajev znotraj intervala, ki ga opisuje atributni vektor, izrazimo v telesnem koordinatnem sistemu, ki pripada prvemu položaju v intervalu. Tako lahko zajamemo spremembe koordinat x in y znotraj opazovanega intervala. **Atributi v telesnem koordinatnem sistemu prvega položaja** so enaki atributom v telesnem koordinatnem sistemu, le da jih namesto z indeksom B označujemo z Bf. Nekoliko drugačni pa so pripadajoči atributi v referenčnem koordinatnem sistemu:

- z_{OfR} … koordinata z izhodišča telesnega koordinatnega sistema prvega položaja
- (Φ_{OfR}, Θ_{OfR}) … usmeritev osi x telesnega koordinatnega sistema prvega položaja glede na os z in ravnino xz

3.3 Koti med deli telesa

Podrobnostim izračuna atributov kotov med deli telesa se v prispevku ne bomo posvečali. Koti med deli telesa, ki se ne pregibajo zgolj v eni osi, so izraženi s kvaternioni.

- α^t_{EL}, α^t_{ER}, α^t_{KL} in α^t_{KR} ... koti levega in desnega komolca ter levega in desnega kolena v času t
- q^t_{SL} in q^t_{SR} ... kota leve in desne rame glede na zgornji del trupa
- q^t_{HL} in q^t_{HR} ... kota levega in desnega kolka glede na spodnji del trupa
- q^t_{T} ... kot med spodnjim in zgornjim delom trupa

4 POIZKUSI S STROJNIM UČENJEM

Iz posnetkov, opisanih v razdelku 2, smo dobili 5.760 atributnih vektorjev, ki so jih sestavljali atributi, opisani v razdelku 3 (v različnih kombinacijah, tako da jih je bilo med 240 in 2.700). Izbrali smo osem algoritmov za strojno učenje iz paketa Weka. Vse algoritme razen Adaboosta M1 smo pognali s privzetimi nastavitvami. Pri Adaboostu M1 smo za osnovni algoritem vzeli odločitvena drevesa Fast Decision Tree Learner, saj je s privzetimi odločitvenimi štori dajal izredno slabe rezultate. Klasifikacijsko točnost smo izmerili z desetkratnim prečnim preverjanjem, ki smo ga ponovili desetkrat, da smo lahko izračunali statistično pomembnost. Tabela 1 kaže točnosti za vse algoritme in posamične nabore atributov, obravnavane v razdelku 3, za nezašumljene in zašumljene vhodne podatke. Točnost pri najboljših atributih za vsak algoritem je krepka, pri najboljšem algoritmu za vsake atribute pa na sivi podlagi.

Algoritem \ Atributi	referenčni	telesni	telesni z ref. z	telesni1. položaja	telesni1. položaja z ref. z	koti
	Nezašumljeni podatki					
odločitvena drevesa C4.5	**94,1**	92,8	93,7	92,9	93,2	91,8
odločitvena pravila RIPPER	**93,1**	91,4	92,8	92,0	93,0	90,9
naivni Bayes	89,5	88,7	**90,6**	86,8	88,2	76,7
3-najbližji sosedi	**97,1**	92,0	82,8	88,1	85,1	96,9
podporni vektorji	**97,7**	94,4	95,0	94,1	94,3	90,5
naključni gozd	**97,0**	96,5	96,8	96,0	96,0	96,8
“bagging”	**95,9**	95,3	95,7	95,4	94,9	94,5
“boosting” Adaboost M1	**97,7**	94,9	95,3	94,7	94,7	94,4
	Zašumljeni podatki					
odločitvena drevesa C4.5	**90,1**	88,4	89,9	88,9	90,0	80,8
odločitvena pravila RIPPER	87,5	84,7	88,1	86,2	**88,6**	80,0
naivni Bayes	83,9	79,1	**84,0**	81,0	82,2	78,2
3-najbližji sosedi	**95,3**	74,6	79,7	73,4	74,7	93,3
podporni vektorji	**96,3**	87,2	91,6	89,9	91,1	87,2
naključni gozd	**93,9**	90,5	93,4	91,9	93,2	90,5
“bagging”	**93,6**	91,8	93,3	92,3	93,5	89,1
“boosting” Adaboost M1	**93,2**	92,0	93,1	92,1	92,9	88,4

Tabela 1. *Klasifikacijska točnost za vse algoritme in vse posamične nabore atributov.*

Tabela 2 za vsak algoritem kaže število primerjav z drugimi algoritmi, v katerih ima statistično pomembno ($p < 0,05$) večjo klasifikacijsko točnost, zmanjšano za število primerjav, kjer je slabši. Tabela 3 isto kaže za posamične nabore atributov. Rezultati najboljšega algoritma in nabora so krepki, rezultati algoritmov in naborov, s katerimi se bomo ukvarjali v naslednjem koraku, pa na sivi podlagi. Za potrebe kombiniranja naborov atributov smo ohranili atribute v telesnem koordinatnem sistemu brez referenčne osi z. Atributi z referenčno osjo z imajo sicer večjo točnost, a referenčne koordinate z so že vključene v nabor atributov v referenčnih koordinatah. Primerjava med atributi v telesnem koordinatnem sistemu vsakega položaja in prvega položaja je rahlo v prid slednjim, a smo se vseeno odločili za prve, ker so hitreje izračunljivi.

Algoritem	Zmage – porazi	
	Nezašumljeni	Zašumljeni
odločitvena drevesa C4.5	–12	–10
odločitvena pravila RIPPER	–18	–21
naivni Bayes	–38	–34
3-najbližji sosedi	–13	–16
podporni vektorji	13	11
naključni gozd	**38**	23
"bagging"	17	**25**
"boosting" Adaboost M1	13	22

Tabela 2. *Število zmag – število porazov vsakega algoritma proti drugim.*

Atributi	Zmage – porazi	
	Nezašumljeni	Zašumljeni
referenčni	**25**	**28**
telesni	–2	–21
telesni z ref. z	9	20
telesni 1. položaja	–11	–9
telesni 1. položaja z ref. z	–2	12
koti	–19	–30

Tabela 3. *Število zmag – število porazov vsakega posamičnega nabora atributov proti drugim.*

V naslednjem koraku smo preizkusili kombinacije naborov atributov. Tabela 4 kaže klasifikacijske točnosti za štiri algoritme, izbrane v prejšnjem koraku, in kombinacije izbranih naborov atributov za nezašumljene in zašumljene vhodne podatke. Točnost pri najboljših atributih za vsak algoritem je krepka, pri najboljšem algoritmu za vsake atribute pa na sivi podlagi.

5 ZAKLJUČKI IN NADALJNJE DELO

Ugotovili smo, da se med preizkušenimi algoritmi za strojno učenje najbolje obnesejo podporni vektorji, naključni gozd, "bagging" in "boosting" Adaboost M1 (tabela 2). Nekoliko prednjači metoda podpornih vektorjev, ki v kombinaciji z najboljšimi atributi v vseh primerih doseže največjo klasifikacijsko točnost (tabeli 1 in 4). Zaradi rezultatov z atributi v referenčnem koordinatnem sistemu in koti med deli telesa je zanimiva tudi metoda najbližjih sosedov (tabela 1). Te algoritme bi veljalo preizkusiti še z uglašenimi parametri in večjim šumom (kakšen bo šum sistema za določanje položaja v projektu Confidence, ne vemo zanesljivo).

Od atributov se najbolje obnesejo atributi v referenčnem koordinatnem sistemu (tabela 3). Kombinacije naborov atributov so si med seboj podobne (tabela 4) in komaj presežejo posamične nabore atributov. Morda je razlog preveliko število atributov (tudi do 2.700), tako da bi veljalo preizkusiti kako metodo za izbiro atributov.

Atributi / Algoritem	referenčni + telesni	referenčni + telesni z ref. z	referenčni + koti	telesni + koti	telesni z ref. z + koti	vsi	vsi (ref. z)
	Nezašumljeni podatki						
podporni vektorji	96,6	96,9	**97,7**	95,3	95,5	96,7	96,9
naključni gozd	97,0	97,0	**97,2**	96,7	96,9	97,1	97,0
"bagging"	96,1	96,0	96,1	95,6	95,7	**96,3**	96,0
"boosting" Adaboost M1	**95,7**	95,6	95,5	95,3	95,3	95,6	95,5
	Zašumljeni podatki						
podporni vektorji	95,5	95,4	**96,5**	91,9	92,5	95,6	95,5
naključni gozd	93,8	**94,2**	94,1	91,8	93,5	93,9	94,0
"bagging"	93,8	**94,1**	93,7	92,4	93,4	93,8	**94,1**
"boosting" Adaboost M1	93,6	**93,7**	93,2	93,2	93,3	93,6	**93,7**

Tabela 4. *Klasifikacijska točnost za izbrane algoritme in kombinacije naborov atributov.*

Zahvala

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KLASIFIKACIJA IN VIZUALIZACIJA PROCESOV Z METODAMI STROJNEGA UČENJA

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POVZETEK

Razvili smo novo metodo za klasifikacijo procesnih podatkov. Metoda temelji na pridobivanju klasifikacijskih pravil iz odločitvenih dreves in je še posebej primerna za procese z veliko atributi in malo učnimi primeri, kjer je potrebno rezultat razložiti. V ta namen smo razvili tudi program za vizualizacijo in modeliranje procesa. Metodo smo uporabili na podatkih iz farmacevtske industrije.

1 UVOD

Metode za rudarjenje podatkov delujejo najbolje na podatkih, ki imajo malo atributov in veliko primerov. Kadar pa imamo na voljo malo primerov in veliko atributov, so standardne metode precej manj uspešne. Če poleg tega podatke dobimo pri procesu, kjer je določen atribut odvisen od vseh prejšnjih, potem je jasno, da je potrebno uporabiti nov pristop. Naročnik dela je farmacevtska družba, v kateri želijo poleg klasifikacije izdelka že med proizvodnim procesom dobiti tudi razlago, zakaj je bil določen polizdelek klasificiran za slabega.

1.1 Implementacija PAT

Administracija Združenih držav za hrano in zdravila (United states Food and Drug Administration, FDA) je leta 2004 uvedla mehanizem Procesno analitskih tehnologij (PAT) [1], ki je danes sprejet širom sveta. PAT je definirala kot ogrodje za razvoj novih pristopov k ohranjanju visoke kvalitete farmacevtskih proizvodov.

To je spodbudilo farmacevtske družbe, da se povežejo z raziskovalnimi ustanovami. Farmacevtske družbe se soočajo s problemom, kako PAT vpeljati v svoje že utečene produkcijske postopke. Težave so z nezanesljivimi meritvami podatkov, ter z velikimi stroški, povezanimi z izvajanjem eksperimentov. Zato se soočajo z velikim šumom v maloštevilnih podatkih.

Cilj projekta je razvoj programa, ki bi znal napovedovati kvaliteto izdelka že med postopkom izdelave. Pri tem je treba napovedi utemeljiti, vse znanje pa mora biti prikazano pregledno in razumljivo tudi nestrokovnjakom.

2 OPIS POSTOPKA

2.1 Gradnja dreves

Glede na to, da potrebujemo klasifikacijsko metodo, ki nudi tudi razlago, smo izbrali odločitvena drevesa kot preizkušeno in uspešno klasifikacijsko metodo. Uporabljali smo algoritem C4.5 [4].

Pri klasičnem načinu gradnje dreves, bi poskušali zgraditi le eno, čim boljše drevo. Zaradi specifičnosti problema želimo v drevesa vključiti čim več atributov, saj verjamemo, da prav vsi atributi prispevajo h kvaliteti izdelka. Zato ne zgradimo le eno, najboljše odločitveno drevo, ampak zgradimo množico dreves. Množica dreves je tudi manj občutljiva na napačno klasifikacijo nekaterih dreves, ki so nastala zaradi nezanesljivih podatkov. Tak pristop je skladen s principom mnogoterega znanja [5] in je podoben mnogim modernim ansambelskim metodam.

Pri gradnji odločitvenih dreves smo morali upoštevati, da podatke med proizvodnim procesom dobivamo postopoma. Zdravila se izdelujejo v šestih stopnjah, zato tudi drevesa gradimo po stopnjah. Najprej gradimo drevesa le z atributi iz prve stopnje. Nato le z atributi prve in druge stopnje, itn. vse dokler ne zgradimo drevesa z atributi vseh šestih stopenj procesa. Na ta način so atributi začetnih stopenj privilegirani, saj nastopajo v vseh drevesih. To se ujema z mnenjem farmacevtskih strokovnjakov, ki pravijo, da se o kvaliteti izdelka odloča že v začetnih stopnjah. Obstaja tudi praktični vidik privilegiranja začetnih stopenj procesa. Če model predvidi slabo kvaliteto končnega izdelka že na začetku, lahko poskušamo v naslednjih stopnjah izdelku zvišati kvaliteto. Če pa ugotovimo slabo kvaliteto šele proti koncu, nam odločitvena drevesa ne koristijo več mnogo.

2.2 Gradnja pravil

Postopek gradnje dreves končamo z množico dreves, od katerih so mnoga, zaradi izjemno majhnega števila primerov in mnogih atributov, preveč podrobna. Natančnost klasifikacije popravimo tako, da izberemo le najboljše veje v drevesih in jih napišemo v obliki klasifikacijskih pravil. Najboljše veje so tiste, ki so kratke, vsebujejo čim več primerov in nobenega primera ne klasificirajo narobe. Tako iz manj natančnih dreves dobimo natančna pravila. Pri gradnji pravil se ravnamo po načelu Ockhamove britve, ki pravi, da je v primeru dveh ekvivalentnih pravil boljše tisto, ki je enostavnejše.

Izdelava drevesa samo zato, da ga večino zavržemo, ni tako vprašljiva, kot se zdi na prvi pogled. Na ta način se izognemo slabostim, ki jih imajo algoritmi za generiranje pravil. Ti so večinoma nagnjeni k prevelikem krnjenju [2].
Pravila niso enakovredna. Vsako pravilo utežimo glede na število primerov učne množice, ki jih pravilo pokrije. Vsa pravila morajo pregledati farmacevtski strokovnjaki in izločiti tista, ki so po njihovem mnenju nesmiselna. Tako dobimo prečiščeno množico uteženih pravil, ki se dobro obnesejo na šumnih podatkih.

2.3 Klasifikacija

Za klasifikacijo primerov v razrede obstaja več metod. Mi smo se zaradi narave problema odločili za kombinacijo več metod. Ker lahko že ena slaba sestavina pokvari končni izdelek, vsako pravilo, ki polizdelek klasificira kot slab, sproži alarm. Po drugi strani pa lahko s pravilno izbiro atributov izboljšamo kvaliteto izdelka. Zato je končna kvaliteta utežena aritmetična sredina rezultatov pravil.

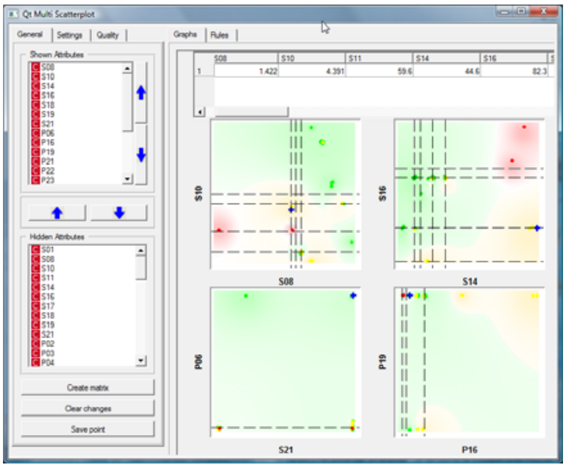
3 VIZUALIZACIJA

Glavna prednost dreves in iz njih narejenih pravil je enostavna razlaga rezultatov. Še posebej je razlaga pomembna med procesom izdelave, ko bi želeli vedeti, katere atribute bi bilo potrebno popraviti v nadaljevanju, da bi dobili boljšo kvaliteto izdelka.

Zato smo izdelali program za vizualizacijo in klasifikacijo, ki temelji na programu Orange [3]. Kljub temu, da so odločitvena drevesa pregledna in enostavna za razlago, je težko pregledovati več dreves hkrati. Zato je potrebno prikazati rezultate pravil na pregleden način. Zato se najprej uporablja utežena aritmetična sredina klasifikacij, ki nam da okvirno oceno kvalitete izdelka. Posebno pozornost je potrebno nameniti pravilom, ki napovejo, da bo izdelek neuporaben.

Ko bi radi med procesom spreminjali vrednost atributov, je vprašanje, kako spremeniti atribute, da bo izdelek kvalitetnejši. Popolno informacijo bi dobili, če bi znali prikazati meje varnega področja (načrtovalskega prostora) v visokodimenzionalnem prostoru, kjer bi vsak atribut tvoril novo dimenzijo. Če bi imeli dovolj učnih primerov, bi lahko aproksimirali načrtovalski prostor. Tega bi predstavljal hiperkvader, v notranjosti katerega bi bilo področje visoke kvalitete, zunaj pa področje slabše kvalitete.

Ker je zaslon računalnika dvodimenzionalen (2D), mora biti vsak graf, ki je tri ali večdimenzionalen, projekcija na dve dimenziji. Pri tem se del informacij izgubi. Zato program na zaslonu prikaže nabor 2D grafov, ki imajo za koordinatni osi dva izbrana atributa (primer na sliki 1). Program sam predlaga atribute, ki so v določeni točki procesa najbolj kritični. Na takšnem grafu so meje med enim in drugim razredom, ki jih določajo pravila, navpične ali vodoravne premice. Območja visoke kvalitete so omejeni ali neomejeni pravokotniki.



Slika 1: Prikaz načrtovalskega prostora z množico 2D grafov.

Prednost množice 2D grafov pred 1D nomogrami je v prikazu interakcije dveh atributov na kvaliteto izdelka, saj za noben atribut ne velja, da bi bil linearno povezan s kvaliteto izdelka.
Program dopušča enostavno modeliranje procesa. Tako lahko z uporabo miške spreminjamo atribute, program pa nam v realnem času izračunava predvideno kvaliteto izdelka in opozarja na kritične atribute.
Na sliki 1 je prikazan prikaz na zaslonu. Skušali smo hkrati prikazati vse podatke, ki so trenutno zanimivi za uporabnika.

4 IMPLEMENTACIJA METODE NA FARMACEVTSKIH PODATKIH

Uporabljali smo podatke, pridobljene iz procesa izdelave tablet. Podatke so beležili ročno med postopkom izdelave, zato so ti pomanjkljivi in večkrat netočni.

Posamezen proces izdelave tablet imenujemo serija. Za učenje modela smo imeli na voljo 30 serij in 70 atributov. Atribute razdelimo na parametre surovin in na parametre procesa izdelave. Slednje razdelimo na 5 faz. Tako smo atribute razdelili na 6 skupin.

Podatke je bilo potrebno pred procesom učenja še precej obdelati. Tako smo izločili nepomembne atribute, izračunali nove atribute ter popravili netočne podatke. Podrobneje je proces opisan v nadaljevanju.

4.1 Parametri surovin

Priprava atributov surovin je zahtevala dodatno obdelavo podatkov, saj se lahko v eni seriji uporabljajo surovine različnih lastnosti. V takšnih primerih smo atribute surovin za neko serijo izračunali kot uteženo vsoto parametrov surovin, ki so bile uporabljene v tej seriji, kjer je bila utež sorazmerna s količino uporabljene surovine. Skupaj smo imeli okoli 30 parametrov, ki so bili dobljeni z analitskimi izvidi vhodnih surovin. Vsi parametri so numerični.

4.2 Parametri procesa izdelave

Proces izdelave je opisovalo okoli 40 t. i. »procesnih parametrov«, ki jih lahko podrobneje združimo v 5 faz: granulacijo, sušenje, hlajenje, mletje in tabletiranje. Pri tem je bilo v celotnem procesu le nekaj nad 10 takšnih parametrov, ki so direktno nastavljivi, medtem ko večina parametrov predstavlja le rezultat procesa. Nas so najbolj zanimali nastavljivi parametri v fazi granulacije, saj je to faza, kjer je manevrski prostor še najbolj odprt in kjer se oblikujejo osnove za rezultat končne kakovosti. Od vseh parametrov so bili 4 nominalni (dvojiški), vsi ostali pa numerični. Atributi strojnega učenja so večinoma enaki podanim parametrom proizvodnega procesa. Dva nova atributa, ki smo jih izračunali iz obstoječih parametrov procesa, smo dodali le pri postopku granulacije. Tri atribute procesa smo normirali glede na jakost tablete.

4.3 Kakovost izdelka

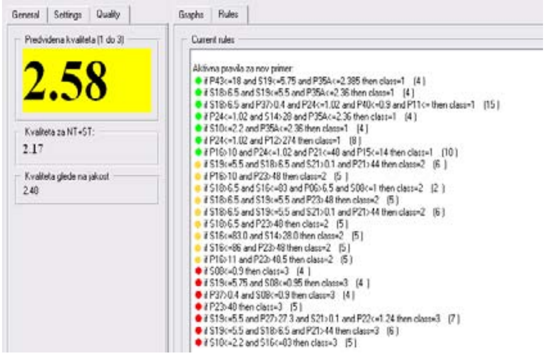
Vsaka serija tablet je na koncu podvržena analizi kakovosti, kar predstavlja razred, ki smo ga s strojnim učenjem želeli napovedati. Kakovost je bila v osnovi izražena numerično, za potrebe našega projekta pa smo jo s pomočjo mnenj strokovnjakov razdelili v 3 razrede: zelo dobra kvaliteta - 1, srednje dobra kvaliteta - 2 in slaba kvaliteta - 3.

4.4 Izgradnja modelov

Pri gradnji modelov smo si pomagali z dvema zbirkama orodij strojnega učenja: Orange in Weka [2].
Z algoritmom C4.5 in različnimi podmnožicami atributov smo na več načinov zgradili množico odločitvenih dreves oz. pravil, ki na čim bolj smotrn način opozorijo, kadarkoli bi se približali nevarnemu območju. Delali smo po postopku, ki je opisan v poglavju 2.

5 UPORABA RAČUNALNIŠKEGA PROGRAMA

Želimo si, da bi uporabnik čim bolj izkoristil kvalitete modela in množico informacij, ki jih računalnik izračuna. Uporabnika ni smiselno obremenjevati s tehničnimi podrobnostmi. Zanj je najpomembnejši del vizualizacija procesa in pregledan predstavitev podatkov in izračunov.
Ko ekspert dobi nove surovine za tablete, mora najprej ugotoviti, ali so te primerne za kvaliteten končni izdelek in nato še ustrezno nastaviti procesne parametre. Zato smo v pomoč temu v okvirju orodja Orange izdelali orodje Multiscatter za vizualizacijo podatkov, razumljiv prikaz pravil in napoved kvalitete novega izdelka, ki je prikazan na sliki 2. *MultiScatter* omogoča tako prikaz načrtovalskega prostora kot tudi napovedovanje kakovosti novih serij s pomočjo izbranega modela, ki je v ozadju programa.



Slika 2: Primer uporabe MultiScatter. Prikazana so pravila in ocena kakovosti izdelka.

Uporabnik v računalnik vnese podatke o atributih surovin in procesa. Računalnik sproti izpisuje pravila, ki so pomembna za trenutne podatke (slika 2). Pravila so ustrezno obarvana glede na razred, ki ga določajo (zeleno za dobro kvaliteto, rumeno za srednje dobro kvaliteto in rdeče za slabo kvaliteto) in različno utežena. Uteženost pravila se izračuna iz kombinacije števila parametrov v pravilu in števila primerov, ki ga pravilo pokrije.
Poleg tega se za pomembne atribute izriše še nabor grafov, ki še dodatno pripomorejo k lažji odločitvi, katere atribute je potrebno spremeniti, da dosežemo visoko kakovosten izdelek.

6 ZAKLJUČEK

Razvili in preizkusili smo nov pristop za klasifikacijo in vizualizacijo podatkov, dobljenih pri procesu. Pristop se odlikuje z visoko klasifikacijsko točnostjo kljub majhnemu številu podatkov.

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STROJNO UČENJE PRI NAČRTOVANJU ALGORITMOV ZA RAZPOZNAVANJE TIPOV GIBANJA

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POVZETEK

Komercialni sistemi za lociranje v realnem času postajajo vse bolj dostopni, s tem pa se odpirajo nove možnosti za njihovo uporabo. Ker so dostopnejše različice takih sistemov razmeroma nenatančne, jih je nujno potrebno podpreti z robustno programsko opremo. Mnogo dilem, ki se pojavijo med načrtovanjem take programske opreme, je mogoče sistematično rešiti z uporabo strojnega učenja. V pričujočem delu bomo predstavili primer uporabe strojnega učenja za razvoj algoritma, ki z > 96 % zanesljivostjo loči med gibanjem in mirovanjem značke za sledenje v realnem času z natančnostjo ± 15 cm in frekvenco zajema položaja 9 Hz.

1 UVOD

Sistemi za lociranje v realnem času [7] (angl. RTLS – real time location system) omogočajo lociranje objektov, ki so običajno opremljeni z RTLS značkami (angl. tag), v 2D ali 3D prostoru v realnem času. Razlikujejo se po [5]:

- tehnologiji (Ultra-wideband, Wi-Fi, optična, infrardeča, ultrazvočna, z žiroskopi in pospeškomeri, idr.);
- natančnosti (od ± 1 mm do ± 10 m);
- frekvenci osveževanja (od 0,1 Hz do 60 Hz);
- ceni (od 2.000 € do 100.000 €);
- področju delovanja (od nekaj m^2 do nekaj sto m^2)
- zanesljivosti, velikosti značk in senzorjev, raznih omejitev za delovanje in drugih dejavnikih.

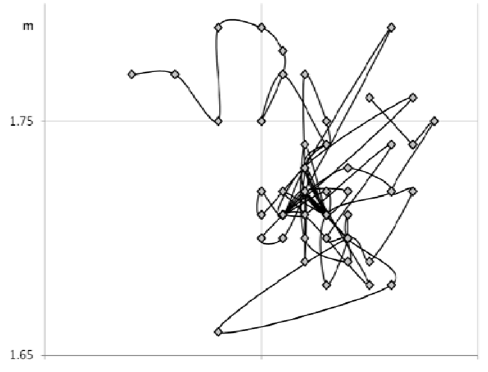
Meritve, ki jih bomo predstavili v nadaljevanju, smo opravili z RTLS Ubisense [6], ki omogoča določanje položaja z natančnostjo ± 15 cm in frekvenco osveževanja 9Hz. Za mnoge praktične aplikacije je ta natančnost premajhna, vendar lahko s primerno obdelavo zaporednih položajev izluščimo tip gibanja. V pričujočem delu bomo predstavili razvoj algoritma za ločevanje med gibanjem in mirovanjem značke, ki jo nosi npr. človek. Taki algoritmi so uporabni v dolgi vrsti aplikacij – od zdravstvenih do varnostnih [2] in vojaških [3].

V razdelku 2 bomo predstavili delovanje in natančnost RTLS Ubisense, v razdelku 3 bomo opisali možne postopke za ločevanje med gibanjem in mirovanjem. V razdelku 4 bomo opisali, kako smo s pomočjo strojnega učenja izbrali najprimernejše lastnosti, po katerih je mogoče ločiti med gibanjem in mirovanjem. V razdelku 5 bomo predstavili končne rezultate, v razdelku 6 pa bomo podali zaključke opravljenega dela.

2 RAZLIKA MED GIBANJEM IN MIROVANJEM

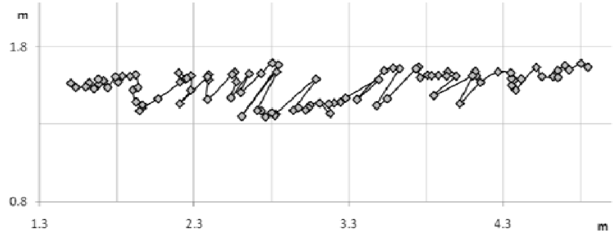
RTLS Ubisense je sestavljen iz 4 do 6 *senzorjev*, ki se namestijo in umerijo v prostoru velikosti od 5 × 5 do 30 × 30 m, *značk* velikosti 40 × 40 × 16 mm s težo 25 g, ki oddajajo UWB radijski signal [8], *mrežnega usmerjevalnika* (anlg. router) in *osebnega računalnika*, na katerem teče posebna *programska oprema* za obdelavo UWB signalov, ki jih izmerijo senzorji.

Med mirovanjem značke izmerjen položaj niha do 10 cm ob idealnih pogojih (linija vidljivosti med senzorjem in značko ter minimalna količina odbojev UWB signala od kovinskih predmetov), medtem ko so v realnih pogojih odstopanja še večja. Poleg običajnega odstopanja meritve od dejanskega položaja je v 1 % – 3 % meritev odstopanje mnogo večje (1 m in več), vendar je takšne napake možno izločiti z enostavnim filtriranjem. Na sliki 1 je prikazanih 81 zaporednih meritev (oz. 9 sekund) mirujoče značke v idealnih pogojih. Izmerjena povprečna hitrost med dvema zaporednima položajema je ~22 cm/s, čeprav značka miruje.



Slika 1: *Posnetek zaporednih položajev mirujoče značke.*

Na sliki 2 je predstavljen posnetek 11 s trajajočega enakomernega, premočrtnega gibanja mobilnega robota s hitrostjo ~40 cm/s v idealnih pogojih. Če bi na sliki 2 povečali manjši kos zaporedja, bi bil videti precej podoben sliki 1.



Slika 2: *Posnetek zaporednih položajev premočrtno gibajoče se značke.*

Iz primerjave slike 1 in 2 vidimo, da ni mogoče enostavno ločiti med gibanjem in mirovanjem opazovanega objekta niti ob idealnih pogojih. Če pogledamo več zaporednih položajev (npr. 20), opazimo, da je med gibanjem *povprečna hitrost* večja, da se *smer gibanja* spreminja manj in da je opravljena *pot* med začetnim in končnim položajem večja. Opisane lastnosti lahko strnemo v izračunljive količine, ki jih uporabimo kot atribute za ločevanje med gibanjem in mirovanjem opazovanega objekta.

3 ATRIBUTI

V tem razdelku bomo predstavili metode za omilitev šuma in atribute, s pomočjo katerih lahko ločimo med gibanjem in mirovanjem. V nadaljevanju dela bomo naleteli na številne konstante, ki jih bo potrebno primerno nastaviti, več o tem pa bomo povedali v naslednjem razdelku.

3.1 Kako omiliti šum

Kot smo omenili v prejšnjem razdelku, je potrebno najprej popraviti meritve z veliko napako. Za neko meritev položaja T_i ($t_{i,x}$, $t_{i,y}$) pravimo, da ima veliko napako, če je od predhodne in sledeče meritve oddaljena za več kot d. Konstanto d nastavimo glede na lastnosti gibanja opazovanega predmeta (pospešek in maksimalna hitrost). Meritve z veliko napako nadomestimo z linearno interpolacijo med predhodno in sledečo meritvijo.

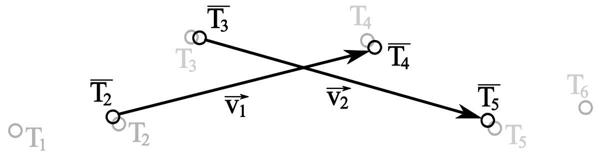
Običajen šuma v meritvah lahko omilimo s pomočjo povprečenja, kot prikazuje enačba 3.1. Položaj določimo kot uteženo vsoto položaja treh zaporednih meritev T_{i-1}, T_i in T_{i+1}, posebej za koordinati x in y.

$$\overline{T}_i = \frac{w}{2}T_{i-1} + (1-w)T_i + \frac{w}{2}T_{i+1};\ 0 \le w \le 1 \qquad [3.1]$$

Utež w je prva lastnost ciljnega algoritma, ki jo bomo določili s pomočjo strojnega učenja.

Šum lahko zmanjšamo tudi tako, da namesto vektorjev premika med dvema zaporednima meritvama $\overline{T_i T_{i+1}}$ upoštevamo vektorje med meritvami, ki so dlje narazen – npr. vektor med $\overline{T_i T_{i+n}}$, saj je v tem primeru razmerje med šumom in dejansko razdaljo ugodnejše. Tudi konstanto n bomo določili s pomočjo strojnega učenja.

Tretja konstanta, ki jo bomo določili s pomočjo strojnega učenja, je število zaporednih vektorjev premika N (oz. število meritev položaja zmanjšano za $n + 2$) iz katerih izračunamo potrebne atribute za ločevanje med gibanjem in mirovanjem značke. Premajhno število takšnih vektorjev povzroči premajhno zanesljivost ciljnega algoritma, medtem ko preveliko število poleg tega povzroči tudi večjo zakasnitev algoritma, ki za delovanje potrebuje več zaporednih meritev.



Slika 3: *Primer izračuna vektorjev za N = 2 in n = 2.*

Primer izračuna zaporedja dveh vektorjev premika iz šestih zaporednih meritev položaja je prikazna na sliki 3.

3.2 Hitrost gibanja

Očitno je, da je razlika med gibanjem in mirovanjem v tem, da je hitrost ob mirovanju 0, sicer pa je večja od 0. Vendar smo že opazili, da zaradi šuma, ki je posledica nenatančnosti meritev RTLS, tudi ob mirovanju izmerimo nezanemarljivo hitrost, ki je v rangu hitrosti ob počasni hoji. Zato poleg povprečne hitrosti, ki jo izračunamo kot povprečno dolžino opisanih vektorjev (enačba 3.2), izračunamo še standardni odklon hitrosti po enačbi 3.3 in vsoto razlik hitrosti po enačbi 3.4.

$$\bar{v} = \sum_{i=1}^{N} v_i \Big/ N \qquad [3.2]$$

$$stdDev_v = \sqrt{\sum_{i=1}^{N} (v_i - \bar{v}) \Big/ N} \qquad [3.3]$$

$$sumDif_v = \sum_{i=2}^{N} |v_i - v_{i-1}| \Big/ N \qquad [3.4]$$

Enačbi 3.3 in 3.4 vrneta podobne atribute, kateri je boljši, bomo ponovno določili s pomočjo strojnega učenja. Ker je povprečna hitrost med počasno hojo in mirovanjem podobna, bomo dodali atribut dolžina poti.

3.2 Dolžina poti

Dolžina poti je prav tako kot povprečna hitrost očitna lastnost, po kateri je mogoče ločiti med gibanjem in mirovanjem. Vendar atribut dolžina poti deluje bolje v primeru, ko se oseba giblje zelo počasi, saj je v tem primeru kljub podobni izmerjeni povprečni hitrosti dolžina poti različna. Dolžino poti izračunamo po formuli 3.5, v kateri pomeni $d(T_1,T_2)$ evklidsko razdaljo med točkama T_1 in T_2 v ravnini, položaji točk pa so izračunani po formuli 3.1.

$$d = d\left(T_2, T_{M/2}\right) + d\left(T_{M/2}, T_{M-1}\right) \qquad [3.5]$$

Pot računamo kot vsoto razdalj med prvo in srednjo ter srednjo in zadnjo točko in se tako izognemo napačnemu izračunu v primeru, ko se značka na koncu zaporedja položajev vrne v bližino začetne točke. V primeru, ki je prikazan na sliki 3, bi dolžino poti izračunali kot vsoto razdalj $d(T_2, T_3)$ in $d(T_3, T_5)$.

3.2 Smer gibanja

Manj očiten atribut za ločevanje med gibanjem in mirovanjem značke je smer gibanja. Do tega pride zaradi narave šuma v meritvah položaja z RTLS. Izmerjeni položaji mirujoče značke naključno poskakujejo okrog dejanskega položaja, kot to prikazuje slika 1. Zato se smeri zaporednih vektorjev premika med seboj močno razlikujejo. Med gibanjem (tudi med zavijanjem) so si zaporedne smeri dosti bolj podobne, ker v tem primeru na smer bolj vpliva gibanje kot šum. Podobno kot za hitrost lahko tudi za smer premika izračunamo dva atributa, in sicer standardni odklon kotov po enačbi 3.6 in vsoto razlik kotov po enačbi 3.7.

$$stdDev_{\varphi} = \sqrt{\sum_{i=1}^{N}[min(\varphi]_i - \bar{\varphi})/_N} \qquad [3.6]$$

$$sumDif_{\varphi} = \sum_{i=2}^{N}[min(\varphi]_i - \varphi_{i-1})/_N \qquad [3.7]$$

V enačbah 3.6 in 3.7 $min(\varphi_i - \varphi_j)$ pomeni minimalno razliko v kotnih stopinjah med smerema φ_i in φ_j, kot je definirano v enačbi 3.8.

$$min(\varphi) = \begin{cases} \varphi ; \varphi \leq 180^\circ \\ 360^\circ - \varphi ; \text{sicer} \end{cases} ; \varphi = |\varphi_i - \varphi_j| \qquad [3.8]$$

4 STROJNO UČENJE

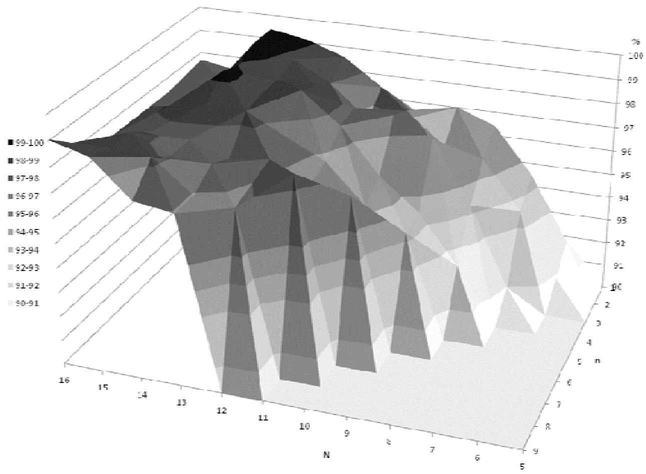
Strojno učenje smo izvedli v dveh fazah. V prvi fazi smo izbrali najprimernejši algoritem za strojno učenje, v drugi fazi pa smo določili optimalne vrednosti konstant w, n in N, opisanih v razdelku 3.1.

Prvo fazo strojnega učenja smo pričeli z zajemanjem učnih podatkov. Posneli smo po 4 sprehode po sobi velikosti 7 x 3,5 m z nizko, običajno in višjo hitrostjo. Med zaporednima sprehodoma smo posneli še po ~5 s mirovanja. Posnetke smo izvedli s pomočjo RTLS Ubisense s frekvenco osveževanja 9Hz in jih ročno označili – za vsako meritev položaja smo določili, ali gre za mirovanje ali gibanje.

Nato smo iz izmerjenih podatkov izračunali vseh 6 atributov opisanih v razdelku 3 in tako pridobili učno množico. Razred za vsak učni primer smo določili glede na število meritev, označenih kot mirovanje oz. gibanje, iz katerih smo izračunali atribute za dani učni primer. Učne množice smo izračunali za naslednje kombinacije parametrov: $w \in \{0; 0{,}333; 0{,}5; 0{,}75; 1\} \times n \in \{1; 4; 7; 10\} \times N \in \{9; 14; 19; 24\}$. Nato smo na vsaki učni množici pognali več algoritmov strojnega učenja z privzetimi nastavitvami v programskih paketih Orange [1] in Weka [9]: naivni Bayesov klasifikator, metodi podpornih vektorjev in 10-najbližjih sosedov, AdaBoost, odločitvena drevesa C4.5 in odločitvena pravila RIPPER. Rezultate smo preverili z 10-kratnim prečnim preverjanjem. Algoritme smo ocenili glede na klasifikacijsko točnost in ugotovili, da sta najuspešnejša algoritma C4.5 in JRip, ki na desetih najboljših učnih množicah v povprečju klasificirata z 97,6 % klasifikacijsko točnostjo. Tesno za njima je algoritem 10-najbližjih sosedov, najslabše pa sta se odrezala metoda podpornih vektorjev in naivni Bayesov klasifikator.

V drugi fazi strojnega učenja smo kot učni algoritem uporabljali le C4.5 [4], ki gradi odločitvena drevesa, ker je ob najboljšem in najslabšem izboru konstant w, n in N v prvi fazi poskusov deloval najbolje in ker je odločitve tega algoritma lahko interpretirati. Preveliko prileganje naučenega modela učnim podatkom smo preprečili tako, da smo omejili minimalno število primerov v listu drevesa na 10 ali več. Učenje in 10-kratno prečno preverjanje smo tokrat izvedli za vseh 3069 smiselnih kombinacij konstant w, n in N in tako določil optimalno kombinacijo konstant ter optimalno odločitveno drevo za ločevanje med gibanjem in mirovanjem. Utež w smo izbrali med 0 in 1 s korakom 0,1, število vektorjev za izračun učneg primera N med 5 in 28 s korakom 1 in razmik med meritvama položaja značke (za gradnjo vektorjev premika) n med 1 in 9 s korakom 1.

Na sliki 4 je prikazan graf odvisnosti klasifikacijske točnosti od parametrov n in N pri uteži $w = 0{,}5$. Podatki za del grafa manjkajo, ker določene kombinacije atributov niso možne ($n < N - 3$). Klasifikacijska točnost z naraščajočim N narašča do $N = 14$ in nato pade. Dvigne se šele pri $N > 21$. Ker želimo algoritem, ki bo deloval v realnem času, se odločimo za $N = 14$. Po drugem parametru klasifikacijska točnost narašča do $n = 3$ in nato pada do $n = 8$, nakar se ponovno dvigne. Tudi tu se odločimo za manjšo vrednost parametra, ker le-ta pri nespremenjenem številu meritev za en učni primer prinese večje število vektorjev premika, kar omogoča zanesljivejši izračun standardnega odklona hitrosti in kota.



Slika 4: *Klasifikacijska točnost v odvisnosti od parametrov n in N pri w = 0,5.*

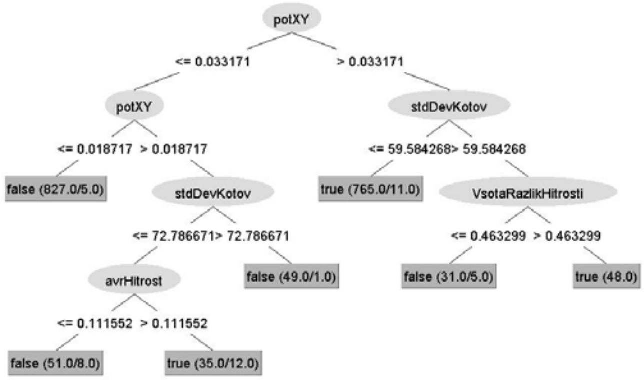
Grafa odvisnosti klasifikacijske točnosti od parametrov n in w pri $N = 14$ je potrdil, da je optimalna vrednost n 2 ali 3. Omenjeni graf je pokazal, da vrednost parametra w pri optimalni izbiri parametrov n in N ne igra ključne vloge, zato smo izbrali vrednost $w = 0{,}5$, ki tudi ob suboptimalni izbiri vrednosti parametrov n in N zagotavlja visoko klasifikacijsko točnost.

5 REZULTATI

Za potrebe testiranja robustnosti predstavljenega algoritma smo posneli testno množico podatkov. Posneta je bila v enakih pogojih kot učna množica, le da jo je posnela druga oseba, ki namenoma ni mogla vplivati na rezultate, ker ni vedela, kakšen algoritem načrtujemo. Zato so podatki v testni množici nekoliko drugačni od tistih v učni množici.

Učni algoritem, pognan na učnih podatkih in testiran na testnih podatkih, je deloval s klasifikacijsko točnostjo ~94 %. Testiranje algoritma, ki se je učil na združeni množici podatkov (učna + testna), z 10-kratnim prečnim preverjanjem je pokazalo 96,6 % klasifikacijsko točnost.

Eno izmed dreves, ki je bilo rezultat slednjega testiranja, je prikazano na sliki 5. Vidimo, da 87 % primerov konča v dveh najbolj zastopanih listih z največjo čistostjo. V teh primerih gre za enostavne primere daljšega mirovanja in gibanja. Primeri, ki se zgodijo na začetku ali koncu gibanja, so za predstavljeni algoritem težji, zato se v njih zgodi večina napačnih klasifikacij. Če večkrat poženemo učni algoritem na različnih podmnožicah učnih podatkov, vedno dobimo podobno odločitveno drevo, ki se razlikuje le v listih z majhnim številom primerov – v robnih primerih. Opozoriti je potrebno tudi na to, da ročno označevanje učnih in testnih podatkov ni popolnoma zanesljivo, saj je praktično nemogoče na desetinko sekunde natančno določiti, kdaj se značka začne ali preneha gibati. Testiranje algoritma na podatkih, iz katerih smo izločili primere, za katere je težko določiti, ali gre za gibanje ali mirovanje, je dalo še nekoliko boljše rezultate od predstavljenih.



Slika 5: *Primer klasifikacijskega drevesa, ki odgovarja na vprašanje ali se značka giblje.*

Dobra stran predstavljenega algoritma je tudi v tem, da je v velikem deležu primerov za pravilno klasifikacijo potrebno izračunati največ dva atributa, kar zagotavlja večjo hitrost algoritma.

Za končno verzijo algoritma bo potrebno posneti večjo učno množico podatkov o gibanju več različnih ljudi, ki jo bo neodvisno označilo več oseb. Odločitveno drevo, ki bo zgrajeno na taki učni množici, bo predvidoma bolj robustno in bo imelo večjo klasifikacijsko točnost. Zaradi željene robustnosti algoritma ni mogoče doseči 100 % klasifikacijske točnosti, vendar je dosežena klasifikacijska točnost dovolj visoka za praktično uporabo algoritma.

6 ZAKLJUČEK

V prejšnjih razdelkih smo predstavili postopek načrtovanja algoritma za ločevanje med gibanjem in mirovanjem RTLS značke ob predpostavki, da so meritve položaja razmeroma nenatančne, vendar dovolj pogoste. Da bi bolje razumeli problem, smo v začetku posneli nekaj testnih podatkov, ki smo jih nato predstavili grafično in jih statistično obdelali. Iz rezultatov te obdelave smo izpeljali množico atributov, ki so sposobni ločevati med gibanjem in mirovanjem ter so prilagojeni specifičnosti šuma v dani aplikaciji. Nato smo s pomočjo strojnega učenja izbrali optimalen algoritem in najprimernejše vrednosti parametrov. V zaključni fazi smo generirali učno množico primerov za klasifikacijo s prej določenimi atributi in vrednostmi parametrov. Pognali smo izbrani algoritem in kot rezultat dobili odločitveno drevo, ki optimalno ločuje med gibanjem in mirovanjem. Tako pridobljeno odločitveno drevo smo implementirali skupaj z delom programa za izračun potrebnih atributov. Kot končni rezultat smo izdelali robusten algoritem za reševanje specifične naloge. Pri tem smo izbiro primernih parametrov, atributov in vrednosti atributov, ki ločijo mirovanje od gibanja, določili s pomočjo strojnega učenja. Tako smo se elegantno izognili nehvaležni nalogi ročnega nastavljanja in izbiranja omenjenih vrednosti.

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Is Science Important for Economic Welfare?

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Abstract. In the era of knowledge based society, sectors like research and development (R&D) should have an important influence on country's economy. We are reexamining the relation between R&D and economic welfare, searching for R&D aspects with the highest impact on economic welfare using data mining (DM) methods of decision and regression trees. The results show strong connection between high level of investment in R&D and economic welfare. The quality of the best trees indicates that science has a crucial role in stimulating economic welfare.

Keywords: R&D, economic welfare, data mining, decision tree, regression tree

1. Introduction

Modern society puts a lot of effort in analyzing impact of different social sectors on economic welfare. Those with greater impact draw more attention and more investors [1]. Modern society is also based on knowledge, meaning that R&D probably plays an important role in it [9]. We reexamined the question "Is science important for economic welfare and what aspects of R&D have key importance?"

Similar question about benefits of R&D were posed by Dr. Marko Kos in Delo: "Is investing in R&D indeed unreasonable?" [5]. He used several simple correlation methods to show that the number of scientific publications per capita in a European country is not essential for its welfare. The major objection to such simple methods is that using just one indicator often reveals no relation at all although we know that there exists one and that it can be proven using more sophisticated methods.

Our analysis was based on DM methods. DM can be described as a process of analyzing data to identify patterns or relations. It is about solving problems by analyzing data already present in databases [10].

The availability of statistical data on the Internet motivated us to apply DM methods on the existing data seeking for a tree that will clearly and accurately describe the relations between R&D and economic welfare.

2. Data

The data was extracted from several statistical databases available on the Internet:

1. UNESCO Institute for Statistics – http://www.uis.unesco.org
2. WIPO – http://www.wipo.int/patentscope/en/
3. World Bank – http://www.worldbank.org

48 numeric indicators for 167 countries were selected and exported in the form of a spreadsheet table. Each country represents a row in the table and each indicator a column.

Two indicators of economic welfare used as the class were extracted in numeric and discrete form from the World Bank.

Economic welfare is represented with the indicator GNI per capita, calculated using the World Bank Atlas method. ***GNI*** stands for ***Gross National Income*** and represents the total value of goods and services produced within a country (Gross Domestic Product) together with the income received from other countries (notably interest and dividends) less similar payments made to other countries (Wikipedia entry for "gross national income"). World Bank Atlas Method assumes conversion of the GNI of each country to US$ by smoothing exchange rate fluctuations using a three year moving average, price-adjusted conversion factor (www.worldbank.com).

The World Bank registers GNI per capita both in numeric and discrete form [3]. The numeric form is expressed in US$, while the discrete form represents official classification of countries according to the income level into:

1. low – $745 or less
2. middle – $746 - 9,205
3. high – $9,206 or more.

The presented thresholds were based on the analysis of relation between summary measure of wellbeing (including e.g. poverty incidence and infant mortality) and GNI per capita based on the World Bank's Atlas method.

From the total of 167 countries, 50 are belonging to the low income countries, 79 to middle income and 38 to high income countries.

R&D indicators represent different aspects of R&D like performance (e.g. *Grants of patents, High-technology exports (percentage of manufactured exports)*), personnel (e.g. *Researchers per million inhabitants (FTE), Technicians per million inhabitants (HC)*), and financial resources (e.g. *GERD per capita (PPP$), Source of Funds for R&D - Business Enterprise (%)*)

3. Description of Experiments

Two types of trees were used, decision and regression trees. We chose them because they are comprehensible to human user, and they also offer two different views on the same data. Decision trees offer more concrete view by classifying countries in the predefined discrete categories, and regression trees show how countries converge around certain values allowing further differentiation of predefined decision tree categories.

J48 algorithm (the implementation of C4.5 [8]) was used for induction of decision, while M5P algorithm [7] for the induction of regression trees.

The quality of both decision and regression trees was measured by ten-fold cross validation [4]. Cross validation was chosen considering limited availability of data. In the case of decision trees it is expressed as “accuracy” (in percentages), and in the case of regression trees as “correlation coefficient” (value between 0 and 1). For comparison we multiplied correlation coefficient with 100 to scale it with accuracy.

Trees were pruned as much as possible to obtain small trees of high quality presenting the strongest relations and the indicators with the highest impact on economic welfare. The stopping criterion for pruning was a significant decrease in quality. A small decrease accompanied with the reduction of the tree’s structure was acceptable. The pruning was realized by increasing the value of machine learning algorithm parameter minimum number of instances per leaf (MNIL), meaning that to form the leaf the minimum number of countries that reached the leaf must be equal or higher than the value of the parameter.

The importance of indicators was tested by removing certain indicators, reinducing the tree on the rest of the indicators and measuring the fall in quality of a new tree.

4. Results

The regression tree in Figure 1 was induced on all 48 indicators by setting MNIL to 5.

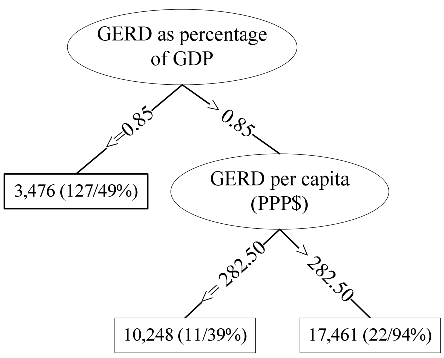

Figure 1 A regression tree induced on 48 indicators; correlation coefficient 0.73

From the regression tree it can be seen that the level of investment in R&D presents the key factor in differentiating countries. Namely, ***GERD*** stands for ***Gross Domestic Expenditure on R&D***, denoting expenditure on R&D performed on the national territory during given period. It includes R&D performed within a country and funded from abroad, and excludes payments for R&D performed abroad [2].

Those countries that invest in R&D less than or equal to 0.85% of their GDP have average *GNI per capita* of 3,477 US$. 127 countries (the first number in brackets) or 79% of them conform to that description. The deviation around the average value is 49% (the second number in brackets – presenting root mean squared error divided by global absolute deviation). In comparison to the categories of the World Bank, this group includes low (745 US$ or less) and middle (746 - 9,205 US$) income countries, meaning that all high income countries (9,206 US$ or more) invest in R&D more than 0.85% of their GDP.

High income countries are further divided in two groups according to the level of investment in R&D stated in PPP$, again showing that higher level of investment in R&D leads to the countries with even higher income. ***PPP$*** stands for purchasing power parity stated in American dollars. *GERD per capita* is expressed in PPP$ to allow fair comparisons between different countries.

Considering that both *GERD* indicators represent the same aspect of R&D – the level of investment in it – we removed both indicators and reinduced the tree on the rest of the 46 indicators. Correlation coefficient of new tree was for 3% lower, again showing the importance of the level of investment in R&D.

The decision tree in Figure 2 was induced using reduced error pruning [10] and by setting MNIL to 3.

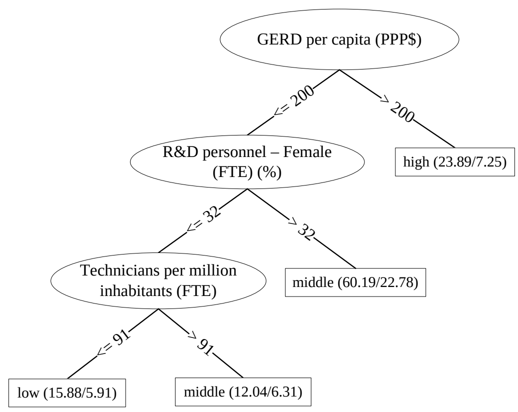

Figure 2 A decision tree induced on 48 indicators, 62% accurate

The tree presents relation similar to the one that appeared in regression tree, showing that countries with higher level of investment in R&D also have higher income. Namely, high income countries invest more than 200 PPP$ per capita in

R&D. In total, 24 countries conform to that description, presented with the first number in brackets, showing the number of countries of the majority class that reached the leaf; the second number describes the number of countries of other classes that reached the same leaf.

The difference between middle and low income countries is again blurred. Middle income countries can both have more or less females employed in R&D sector. A group of middle income countries is different from low income countries only when the number of technicians employed is added. ***FTE*** stand for full-time equivalent, representing a person working full-time in a given period [6].

Again certain indicators were removed to reexamine their importance. When both *GERD* indicators were removed the accuracy fell for 3% like in the case of regression tree. The impact of other aspects stayed unclear. Namely, after removal of two *GERD* indicators, an indicator *Researchers per million inhabitants* appeared at the top of the tree. This indicator stated in two forms (FTE and HC (head count [6])) was removed and accuracy fell for another 4% (56%). However, tree induced just on two *GERD* indicators was 66% accurate, while the tree induced on the combination of two *GERD* and two *Researchers per million inhabitants* indicators was less accurate (65%).

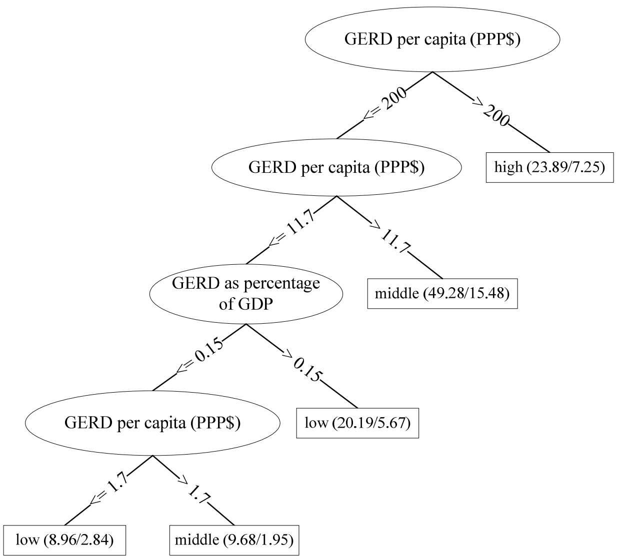

Figure 3 A decision tree induced on 2 *GERD* indicators, 66% accurate

Once more the results showed importance of high level of investment in R&D. Firstly, after the removal of *GERD* expressed in two forms (per capita in PPP$ and as percentage of GDP) the accuracy fell for 3%. Secondly, the highest quality tree induced just on these two indicators was for 3% more accurate than the highest quality tree induced on all 48 indicators.

The most accurate decision tree was induced on two *GERD* indicators using reduced error pruning and by setting MNIL to 3.

From the tree in Figure 3 it can be seen that high income countries are again characterized as countries with the highest level of investment in R&D (more than 200 PPP$ per capita). The difference between middle and low income countries is again blurred. However, if we compare them by the amount invested in R&D expressed in PPP$, middle income countries are always at higher than side of a tree.

5. Conclusion

In this paper we reexamined the relation between R&D and economic welfare with DM methods of decision and regression trees. Trees were induced on the set of indicators representing three aspects of R&D: performance, personnel and financial resources.

In summary, induced decision and regression trees show that high level of investment in R&D presents the key factor in differentiating high from middle and low income countries. Conversely, it is harder to distinguish middle from low income countries. The relevance of other R&D aspects is unclear.

The conclusion that the relative amount of financial support for R&D is the key factor for success of the country is not surprising since it is common knowledge that the most developed countries have also best science and best financial support. It is a bit surprising, though, that the form of that support is not important, nor it is so important the social form of science, e.g. if there is large amount of women in science, if it is largely done at private faculties or at governmental institutions etc. Not that these factors are not important, but DM uses them only when GERD is eliminated, meaning that the financial support is category 1 and then there are category 2 or 3 attributes.

If we scale accuracy and correlation coefficient in the same manner, the regression tree (0.73) performed 7% better than the highest quality decision tree (66%). The best accuracy of a decision tree is reasonably good considering the default accuracy of 47% obtained by classifying only into the majority (middle) class.

Although the obtained trees just show relations from one point of view and are far from the final proof, the performed analyses clearly show the important influence of science on economic welfare and vice versa. Regardless of the specific nature of this relation, which our methods do not display, the relation is very significant.

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UMETNA INTELIGENCA IN IGRALNI BOT-I V RAČUNALNIŠKIH IGROVJIH TIPA »PRVOOSEBNA STRELJANKA«

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Povzetek

Prispevek obravnava vlogo in prisotnost umetne inteligence in igralnih bot-ov v računalniških igrah. Skozi zgodovino razvoja so namreč računalniške igre postajale kompleksnejše in strojno zahtevnejše, zato so razvijalci z logiko in fiziko igranja, povezali vsa igralna pravila – okolje, interakcijo med objekti v igri, igro in uporabnikom ter vse podatke o svetu in objektih – v eno celoto. V to celoto oz. sklop pravil in logike uvrščamo tudi umetno inteligenco. Umetna inteligenca je modul, ki simulira človeško obnašanje in reakcije glede na dano situacijo, in s tem omogoča, da postaja računalnik vse bolj enakopravni nasprotnik uporabniku.

***Ključne besede**: računalniške igre, umetna inteligenca, igralni bot, algoritem*

1. Uvod

Za ljudi se igre pričnejo že v najzgodnejšem otroštvu z enostavnimi igračami, skupinskimi igrami, preko udejstvovanj v šolskih športnih aktivnosti, vse do bolj resnih iger kot je vožnja z avtomobilom ali letalom. Večina znanstvenikov je enotnega mnenja, da je igra ena izmed najpomembnejših človeških aktivnosti, ki pripomore tako k razvoju motoričnih sposobnosti kot mentalni rasti. Prav tako je lahko medij združevanja ljudi, ustvarjalec novih poznanstev in prijateljstva. Vsaka igra pa ima svojo igralno logiko, pravila in zakone, ki sestavljajo jedro vsake igre v svetu, ki ga živimo (Pečenko, 2005). To še posebej velja za računalniške igre. Le-te so zgrajene na osnovi določenih pravil. Ta pravila so v osnovi matematična in so kot taka osnova človeškega logičnega razmišljanja. Tako kot je realen svet določen z fizikalnimi, kemičnimi, biološkimi, in tudi drugimi pravili, ravno tako je potrebno določiti pravila in logiko, ki bodo veljala v virtualnem svetu računalniških iger. Industrija iger, ki se neprestano razvija, vključuje čedalje večje število strokovnih izdelovalcev ter uporablja modernejšo sodobno strojno tehnologijo in računalniško opremo. Igre so pridobile lepšo grafično podobo in kvalitetnejši zvok, sčasoma pa so svojo preprosto zasnovo pričele tudi presegati. Sprva preprosti algoritmi so postajali vse kompleksnejši in pojavila se je potreba po umetno zasnovani inteligenci, ki bi igralcu omogočila dostojno igro. Z logiko in fiziko igranja so razvijalci povezali vsa igralna pravila (okolje, interakcijo med objekti v igri, igro in uporabnikom ter vse podatke o svetu in objektih) v eno celoto, v katero uvrščamo tudi umetno inteligenco.

2. Umetna inteligenca in njeni sistemi

Raziskave igranja iger imajo relativno dolgo zgodovino in so močno vplivale tudi na druga področja, saj ne vključujejo le programov za igranje iger, temveč tudi razvoj in analizo iskalnih algoritmov, kot so pristopi minimaks, iskanje po in/ali drevesih, enoagentni in večagentni preiskovalni algoritmi, ter metod planiranja in računalniško podprtega odločanja. V računalniških igrah kot je »prvoosebna streljanka« smo v vlogi protagonista ali bojnega heroja postavljeni v virtualni svet, kjer se borimo proti »inteligenci«, ki je v obliki našega nasprotnika, bodisi vojaka, vesoljske pošasti ali vojnega robota, in mu rečemo igralni bot (angl. »gamebot«). Ta umetna inteligenca je ponavadi modul, ki simulira človeško obnašanje in reakcije glede na dano situacijo, in s tem omogoča da postaja računalnik vse bolj enakopravni nasprotnik uporabniku. Računalnik takrat izvaja samostojne akcije z uporabo določene metodologije in sistemov znanja. Zato se v svetu računalništva umetna inteligenca porodi v novi panogi – inteligentnih sistemih.

Torej, ko govorimo o inteligentnih sistemih, govorimo tudi o agentih, ki so del inteligentnega sistema. Pri opravljanju večine opravil ali akcij smo zadovoljni in sprejemamo računalnik kot poslušne in natančne pomočnike brez domišljije. Za veliko aplikacij kot je npr. plačevanje računov preko spleta to popolnoma zadostuje. Vendar se pa pojavljajo tudi aplikacije, ki zahtevajo sisteme, ki se lahko sami odločijo, kaj potrebujejo za dosego določenega cilja. Takšne sisteme ponavadi imenujemo agenti. Agenti, ki delujejo v robustnih, nepredvidljivih in hitro spreminjajočih se okoljih, z veliko stopnjo verjetnosti pojavljanja uspešnih akcij pa se imenujejo inteligentni agenti oz. včasih tudi avtonomni agenti (Weiss, 1999). Ker se agenti uporabljajo na številnih področjih, trenutno ne obstaja univerzalna definicija izraza agent, ampak obstaja splošno prepričanje, da je avtonomija ključna lastnost agenta, medtem ko ostale lastnosti niso tako enoumno določene, saj so na različnih področjih uporabe pomembne različne lastnosti. Najbolj primerno definicijo agenta je podal M. Wooldridge, ki se glasi: *»Agent je računalniški sistem, ki je nameščen v neko okolje in zmožen avtonomnih akcij v tem okolju z namenom, da doseže načrtovane cilje«* (Weiss, 1999).

Pri tej definiciji se je potrebno zavedati, da ne pove ničesar o tipu okolja, kjer se agent nahaja. Avtonomija v zgornji definiciji predstavlja dejstvo, da so agenti zmožni delovanja brez posredovanja ljudi ali drugih agentov.

***Slika 1**: Agent v svojem okolju*

Slika 1 prikazuje abstrakten pogled na agente. Iz slike je razvidno, da agent, ko tipa okolje, glede na stanje ustvari akcijo, s katero vpliva na to okolje, in to z namenom, da doseže zadane cilje. V večin primerov ima le delno kontrolo nad okoljem. Pri svojem delovanju ima agent na voljo množico možnih akcij, s katerimi lahko vpliva na okolje. Ključni problem je odločitev, katero od možnih akcij naj izvede, da bo le-ta kar najbolje ustrezala zadanim ciljem. Agente lahko razdelimo tudi glede na okolje, v katerem izvajajo svoje funkcije. Po Russell-u in Norving-u (2003) poznamo štiri tipe okolij: dostopni, nedeterministični, dinamični in diskretni. V našem primeru velja omeniti, da gre za zadnji tip okolja – okolje diskretnost, kar pomeni, da v njem obstaja končno število zaznavanj in akcij. Primer diskretnega okolja je tudi igranje šaha, kjer v vsakem stanju obstaja končno število akcij (možnih premikov figur).

V računalniških igrah se omejujemo predvsem na iskanje poti in navigacijo ali usmerjanje akterjev (bot-ov) na podlagi manjšega nabora podatkov. Vse te funkcije pa so v 3D svetu iger postale bolj zapletene od enostavnih implementacij algoritmov 2D sveta. Sicer so uporabljene metode odločanja še vedno enake, le veliko bolj kompleksne so postale s pridobljeno dimenzijo. Človeške oči, ki so prilagojene 3D pogledu, sicer hitro najdejo pravo pot po terenu, pripraviti računalniški program do tega, pa ni enostavno. Delovanje oteži razgiban teren, kompleksne animirane oblike objektov in zahteve modernih iger, kot so tehnike analize boja in terena, planiranje in učenje. Če te težave prepustimo visoko razvitemu računalniškemu programiranju, se pri realno-časovnih aplikacijah in simulacijah pač ni mogoče zanašati na dogodkovno vodeno ali sekvenčno programsko logiko. Sicer je pri igrah logika delovanja močno razširjena. Že sama »logika človeškega razmišljanja« je v igrah le manjši del delovanja. Le-ta zajema eno od mnogih bistvenih komponent, ki so potrebne za samo delovanje igre. Zato je pojav inteligentnih sistemov v tehnologiji računalništva ustvaril nove smernice v računalniških igrah – uvajanje umetne inteligence in njihovih agentov (igralnih bot-ov).

Glede na funkcionalnost agenta in njihovega okolja poznamo nekaj vrst agentov: vmesniški agenti, filtrirni agenti, agenti za planiranje in načrtovanje, posredovalni agenti, nakupovalni agenti – »shopingboti«, agenti za e-poslovanje, agenti za podporo odločanju, osebni pomočniki in agenti v igovjih – igralni bot-i (*angl. Gameboti*).

3. Računalniški igralni bot-i

Igralni bot-i, dandanes najbolje izraziti v računalniških »igrovjih« »prvoosebne streljanke« so robotsko računalniško vodena bitja, ki simulirajo in imitirajo človeško vodene nasprotnike oziroma se pojavljajo v vlogi sovražnika ali sovojaka v svoji bojni enoti. Njihova funkcionalnost je predvsem to, da lahko pomagajo PC igralcu, da se nauči voditi igro, spoznava pravila igre in da lahko vadi strelsko spretnost še preden se uporabnik odloči igrati »on-line« igro v več-igralskem (multiplayer) načinu, kjer igramo proti pravim, človeško vodenimi, nasprotnikom. Igralni bot-i delujejo s pomočjo umetno inteligentne skripte, ki je predhodno programirana z namenom, da ustreza različnim pravilom igre, tipu igre, zemljevidu igre in ostalim parametrom, ki so edinstveni za vsako igro. Bot-i so ponavadi napisani v C ali C++ jeziku, kompletno samostojnih aplikacijah, v vtičnikih ali pa so samo napisani z DLL knjižicami (Dynamical Linked Library) namenjene posebej za neko obstoječo igro. V igri Ragnok online je uporabljen program Pearl izključno za ustvarjanje bot-ov. Nekateri razvijalci tudi ustvarjajo aplikacije s katerimi lahko modificirajo ali ustvarjajo bot-ovo obnašanje, veščine ali druge karakteristike (node). Takšen primer je program Bot Studio za računalniško igro imenovano Quake 3 Arena.

***Slika 2**: Računalniški igralni bot v obliki univerzalnega vojaka v »prvoosebni streljanki« Unreal Turnament*

Na voljo imamo dve vrsti igralnih bot-ov: statični in dinamični bot. Statični bot-i so ponavadi načrtovani tako, da v vsaki sobi, v kateri igramo igro, sledijo po predhodno-izdelanih smernicah ali vozliščih. Ti bot-i morajo vsebovati svojo edinstveno smerniško datoteko, ki je usklajena z zemljevidi soban igrane igre ali pa izdelan vozliščni sistem, ki je vgrajen v zemljevide soban igrovja. Dinamični bot-i za razliko od statičnih bot-ov delujejo po principu dinamičnega učenja in spoznavanja prostora v katerem se igra oz. boj odvija. Tako se lahko premikajo naključno po kateri koli poti skozi igro. Tak primer bot-a, t.i. »RealBot« lahko srečamo v streljanki Counter-

Strike. Ponekod pa smo lahko priča tudi bot-om, ki so izdelani tako, da lahko uporabljajo karakteristike dinamičnega in statičnega bot-a (www.wikipedia.org).

3.1 »Prvoosebna streljanka«

Video igre, v katerih prevladuje 3D grafika in umetna inteligenca, veljajo za izredno kompleksen računalniški program. Osnova oz. jedro za delovanje moderne »prvoosebne streljanke« je igralni pogon (angl. *Game Engine*), ki simulira uporabo 3D grafičnega okolja. Je pomemben sestavni del na osnovi katerega igra deluje. V samem programu računalniške igre se nahajajo zbirke množice grafičnih in večpredstavitvenih ukazov, ki se posredujejo gonilnikom strojne opreme ali simulacijskim programom, da lahko igra deluje. Pri realno-časovnih aplikacijah in bojnih simulacijah se ni mogoče zanašati na dogodkovno ali sekvenčno programsko logiko. Program se večinoma nahaja v neskončni glavni zanki, ki procesira zbrane podatke in izrisuje sliko na ekran – FPS (frame per second). V primerih »prvoosebnih streljank« se upošteva na tisoče ali celo milijone poligonov, ki sestavljajo različne objekte na ekranu. Takšna količina podatkov zahteva delo kompleksnega grafičnega usmernika podatkovnega toka, ki se lahko izvaja v simulacijskih programskih knjižnicah ali direktno na strojni opremi, kot je običajno pri modernih Direct 3D (osnova in specifikacija programskih osnovnih grafičnih rutin za uporabo 3D grafike na izključno Windows platformi) in OpenGL (Open Graphic Library) igralnih sistemih. Sam igralni pogon, poleg grafičnega pogona, ki procesira podatkovne strukture 3D sveta, sestavlja tudi fizikalni model, umetno inteligenco, zaznavanje dotikov ali trkov, navigacijski sistem in podobno. (LaMothe, 2003). Vse te aktivnosti so medsebojno odvisne in združene v enoten igralni pogon. Izvajanje umetne inteligence in igralne logike obsega večino kode igralnega pogona. Umetna inteligenca, sistemi za fiziko in kontrola igre se izvajata na podlagi igralčevih akcij in preteklih stanj. V samo delovanje »prvoosebne streljanke« spada v večji meri sama interakcija med objekti/entitetami (igralnimi bot-i) in igralcem. Interakcija pa se lahko dogaja tudi med računalniško vodenimi entitetami (bot-i). Pod interakcijo igralec – igralni bot si razlagamo manipulacijo s predmeti/objekti, oziroma vse, kar lahko igralec sploh lahko počne s temi predmeti. Glede na prisotnost interakcije med objekti in entitetami pa je tudi potrebna umetna inteligenca. Rezultati so spremenjena stanja različnih objektov, ki se upoštevajo pri izrisovanju nove slike na ekran. Samo jedro izvajanja igralne logike in inteligence računalniškega bot-a je obseženo in sestavljeno iz več delov modula. Npr. prvi del izvajanja modula je posredovanje ustreznih podatkov vsem vključenim modulom, ki skrbijo za upoštevanje umetne inteligence in vnaprej določenega načina delovanje igre. Povratne strukture se nato posredujejo modulu, ki je odgovoren za grafično predstavitev. Seveda so pa skozi čas razvoja »prvoosebnih« streljank razvijalci vedno znova razvili novo različico igralnega pogona, ki je zahteval čedalje večjo grafično zmogljivost osebnih računalnikov. Nekaj znanih igralnih pogonov, na katerih delujejo »prvoosebne streljanke« so: Doom Engine, id Tech 3, Unreal 2 Engine, Source Engine in RAGE Engine.

3.2 Funkcionalnost igralnih bot-ov in njihovo obnašanje

Igralni bot-i v »prvoosebnih streljankah« so postali kompleksnejši in inteligentnejši. Začetniški originalni igralni bot-i so bili sprva popolnoma pozabljivi na svoje okolje in so zato potrebovali stalno dodajanje popravljenih skript, da so lahko izvršili napad na človeškega igralca. Trenutni modernejši bot-i, katere najdemo danes v aktualnih igrah kot so Quake 3, Unreal Turnament, Star Wars: Republic Commando in Call of Duty se pa že približujejo spretnosti igranja figure, ki jo vodi sam človek. Takoj, ko je bot postavljen v okolje, kjer se odvija boj, prične z spoznavanjem okolja. V programskih skriptah so mu dodeljeni algoritmi navigacije in gibanja ter algoritmi za odločanje v katerih mu delujejo senzorji za zaznavanje, razmišljanje in ukrepanje. V algoritmih navigacije in gibanja, bot-ovo obnašanje razdelimo na dva dela, in sicer na navigacijski/gibalni del in na bojevniški del. V navigacijskem/gibalnem delu je npr. pomembno, da bot zazna, da se lahko giblje skozi vrata medtem ko je zid, ograja, figura nasprotnika, skladiščni zaboji zanj definirano kot poligon skozi katerega ni mogoče priti. Vendar se težave pojavijo pri objektih kot so lestve, stopnice ali luknje na tleh. V takem kompleksnem okolju je bot-u omogočeno, da sledi izbrani poti od X-Y-Z koordinate do naslednje in sprejema povratne informacije o smeri poti, predmetih, ki jih lahko pobere na poti in pasteh, ki se nahajajo na poti.

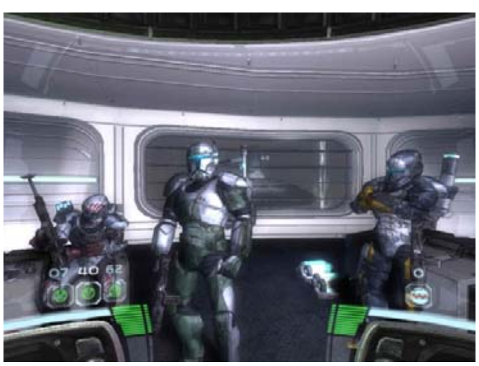
V drugem delu t.i. bojevniškem delu, pa je bot-u omogočeno predvsem, da si pridobi več taktik bojevanja – lahko te obkoli in napade ali pa se skriva izza vrat in na trenutke pomoli glavo ven, ko nameni svoj rafal proti sovražniku ali pa se sklanjajo in umikajo našim metkom, ko se nam približujejo. Z modifikacijo DLL knjižic (Dynamical Linked Library) bot-u lahko dodamo napredne specifikacije njegovega zaznavanja na okolje. Naj navedemo primer. Igralni bot lahko zasluti oz. zazna naše korake in naš prihod v določeno sobo in se k temu primerno pripravi na zasedo. V igri Call of duty, ko se gibljemo po ruševinah zapuščenega mesta, nas bot takoj napade, ko zazna našo lokacijo na ulici. V nasprotnem primeru pa lahko neskončno tava po ulicah mesta. V primeru, ko mu vržemo ročno granato, če je bot dovolj blizu, jo bo nemudoma pobral in nam jo vrgel nazaj. V igri Star Wars: Republic Commando se bot, v vlogi sovojaka odziva in zazna okolico na drugačen način: Ko se v boju zelo poškodovani zgrudimo na tla in z ukazno tipko pokličemo na pomoč, sovojaki takoj ocenijo trenutno situacijo bojnega okolja, ter se odzovejo našemu klicu kot primarna naloga če je situacija primerna ali pa nas zavrnejo, ko ocenijo oz. zaznajo, da je nadaljevanje streljanja na sovražnika večja prioriteta.

V boju je pomembno, da predvidevamo oz. napovemo nasprotnikove premike oz. akcije in s tem določimo najboljši potek akcije za bot-a. Pri temu se uporabljajo algoritmi za odločanje. Igralnemu bot-u je v njegovi skripti programiranja vedno napisana množica pravil, ki mu omogoča njegovo obnašanje, vodenje bojevanja ter zaznavanje okolja in njegovega sovražnika. Na osnovi množice pravil, ki se hierarhično dopolnjujejo, se lahko bot uči ter izvaja svoje akcije. Poleg osnovnih pravil kot so zbiraj, napadi, umik in išči nasprotnika (angl. *collect, attack, retreat, chase*), lahko navedemo na primer še nekaj pravil, ki jih ima bot implementirane v svoji zbirki ukazov:

- Poberi vedno boljše orožje;
- Odvrzi stran orožje, če orožje nima več municije;
- Poišči paket prve pomoči in municijo če je nivo vitalnosti in municije nizek;
- Umik če je stopnja vitalnosti nizka;
- Pojdi na lokacijo kjer je bil sovražnik nazadnje viden;
- Čakaj v skritem kotu ko ali če slišiš sovražnikove korake;

Skupek množic raznovrstnih pravil sproži igralnemu bot-u učni mehanizem tako, da si bot postavi novo pravilo. Ko igra postaja čedalje kompleksnejša ter bot spozna čedalje več različnih bojnih situacij, si hitreje lahko planira strategijo napada in porabi manj časa za odločanje. Spodaj je naveden primer pravila, ki si ga je Qaukebot (igralni bot v igri Quake 3. naučil med potekom naključne igre (John E. Laird, 2002): *ČE je napovedani sovražnik trenutni operater in je njegova stopnja vitalnosti 100 % in uporablja »blaster« pištolo v sobi št 11. Jaz sem v razdalji 2 (enoti) od sobe št. 3 POTEM napovem, da bo sovražnik šel v sobo št. 3 skozi vrata št.7.*

Iz predhodnega sklepanja se lahko bot odloči da pride v sobo št. 3 pred sovražnikom in ga tam pričaka v zasedi. S takšno modifikacijo bot-ovega zaznavanja in učenja okolja si lahko bot pridobi več izkušenj iz že naučenih se situacij, kar pa vodi k hitrejšemu zaznavanju in ustvarjanju novih pravil v nadaljnjih možnih situacijah.



***Slika 3**: Grafični prikaz treh elitnih bojevnikov v streljanki Star Wars: Republic Commando*

4. Zaključek

Igre so z razvojem računalniške tehnologije postale vse bolj dovršne in zapletene. S pregledom njihovega delovanja in metod igranja, lahko potrdimo, da sta stalno premikanje in sprememba igralnih bot-ov ter akcij, ki pogojujejo njihovo obnašanje in obnašanje samega igralca, postali eni izmed osnovnih značilnosti računalniških iger. Umetna inteligenca bot-ov je z napredkom igralnosti igre izjemno napredovala. Igralni bot postaja čedalje bolj samostojen in avtonomen v svojih akcijah ter v okolju, v katerem se giblje. Z množicami pravil, ki se nahajajo v skriptah programov in algoritmih odločanja, umetna inteligenca omogoča bot-u hiter in učinkovit potek akcije, ki je usmerjen v dosego zadanega cilja. Da se lahko znajde v novem okolju približno tako dobro in hitro kot človeški igralec, je zanj učenje in spoznavanje novih pravil nadvse pomembno.

Umetna inteligenca razvija nove strategije napada in izboljšuje protinapade na igralce – skratka, uči se na lastnih napakah. Tako pridobiva nove izkušnje in pravila za nadaljnje strategije bojevanja.

Če zaključimo, potem verjetno (zaenkrat) še ni računalnika, ki bi opravil Turingov test – test, v katerem so zastavljena vprašanja, na katere bi moral računalnik dati logične odgovore. Do prave umetne inteligence, ki bo konkurirala človeški, bo vsekakor preteklo še veliko časa. A kakorkoli, umetna inteligenca in inteligentni agenti so med nami že kar nekaj časa in so se s poplavo računalniško vodenih iger izkazali kot nadvse koristni.

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PHISHING EMAIL DETECTION USING GAUSSIAN AND NEAREST MEAN CLASSIFIERS

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ABSTRACT

Many tools and techniques are available for phishing detection but very few studies compare machine learning techniques. This study reviews a number of tools and techniques and compares Gaussian and nearest mean classifiers in terms of probability of error for phishing Email detection.

Keywords: Phishing, Machine learning, Gaussian classifiers, Nearest mean classifiers, antiphish toolbar.

1 Introduction

Hacking, cracking, phishing and cyber crimes are hot topics these days and will continue to be in near future. When the World Wide Web was mainly used to send e-mail and view remote data, the main concern was amateur hackers devising ways to break into large systems for bragging rights [1]. Cyber crime is getting organized, as known from the real world and a prominent example are phishing attacks [15]. There has been a dramatic increase in phishing, an attack in which victims are tricked by spoofed emails and fraudulent websites into giving up personal information. It is a rapidly growing problem, with 9,255 unique phishing sites reported in June of 2006 alone. It is unknown precisely how much phishing costs each year, estimates range from $1 billion to 2.8 billion per year [4]. According to APWG, Most of the phishing sites were hosted in U.S.A. and financial sector was the most targeted industry at 91.3% in month of September [2]. To respond to this threat, software vendors and companies have released a variety of anti-phishing toolbars. However, when an evaluation of ten anti-phishing tools was conducted for a study, it was found that only one tool could consistently detect more than 60% of phishing websites without a high rate of false positives. Thus there is a strong need for better automated detection algorithms. With more than 100 million Americans connected to the Internet [1], information security has become a top priority. Many applications – email, e-banking, medical databases and ecommerce – require the exchange of private information. As an example, when engaging in ecommerce, customers provide credit card numbers when purchasing products. Identity theft, the fastest growing type of fraud, affected 500000 Americans in 2001, resulting in over $2 billion in losses at an average cost of $17000 per victim of which roughly $1500 is required just to repair the damage to a victim's credit report [13]. There are many applications available for phishing detection. However, unlike predicting spam, there are only few studies that compare machine-learning techniques in predicting phishing. The present study will compare machine learning methods especially Gaussian and Nearest mean classifiers (GC and NMC).

2 How identity theft relates to phishing

Identity theft is a broad term used to describe the category of crimes in which the offender wrongfully acquires and uses the victim's personal identifying information for the purpose of fraud or other criminal activity. The stolen information can be used for a number of identity frauds like taking over or creating new financial accounts, purchasing goods and services etc. Often, the terms identity theft and identity fraud are used interchangeably [3]. Phishing is a form of online identity theft that aims to steal sensitive information from users such as online banking passwords and credit card information. Such attacks use a combination of social engineering and technical spoofing techniques to persuade users into giving away sensitive information that the attacker can then use to make a financial profit. Phishing scams have been receiving extensive press coverage because such attacks have been escalating in number and sophistication [17]. Since password-based user authentication has established on the Internet to grant users access to security critical services, identity theft and fraud attracted attackers. Hence, phishing - a colloquial abbreviation of password fishing - has become a prominent attack. Whereas classical phishing attacks primarily used spoofed emails to lure unwary users to faked websites where they reveal personal information, current attacks have become advanced in their number and technical sophistication. The new generation of phishing attacks does not solely address the weaknesses of careless Internet users, but also exploits vulnerabilities of the underlying computing platforms and takes advantage of legacy flaws of the Internet: Hostile profiling addresses specific email recipients to mount classical phishing attacks more precisely, pharming compromises DNS servers to resolve domain name requests to phishing sites, and malware phishing infiltrates customers' computers, e.g., to log their password stroking using malicious programs [19]. Internet users of average skill often do not understand security indicators and cannot distinguish between legitimate and faked websites [14].

3 Related Work

Here we will survey some antiphish solutions. One most common approach is the use of security toolbars, but they have already been proved ineffective due to several reasons

[5]. In a study by Wu et al., the effectiveness of security toolbars in preventing phishing attacks was evaluated. They performed experiments on three security toolbars, the browsers address bar, and the status bar. A total of 30 subjects were included in experiments. They showed that all tested security toolbars were ineffective in preventing phishing attacks. Users were spoofed 34% of the time. 20 out of 30 users got spoofed by at least one phishing attack. 85% of the spoofed users thought that websites look legitimate or exactly the same as they visited before. 40% of the spoofed users were tricked because of poorly designed websites, especially when using improper redirections [5].

In another study, the authors tested the effectiveness of 10 security toolbars and found that three of the 10 toolbars were able to identify over 75% of the phishing sites tested. However, four of the toolbars were not able to identify 50% of the tested sites [6].

Another approach is the use of two factor authentication and the use of visual similarity assessment [7, 10, 11]. One more approach to stop phishing at the email level as most attacks use broadcast of such mails to lure victims to a phishing website [12].

In a study, 22 participants were shown 20 websites and were asked to determine which ones were fraudulent, and why. Their key findings revealed that good phishing websites fooled most of participants, Existing anti-phishing browsing cues are ineffective, participants did not noticed the address bar, status bar, or the security indicators, Popup warnings about fraudulent certificates were ineffective [14].

4 Machine Learning Techniques

As explained in [16] most of the machine learning algorithms discussed here in context to phishing emails are categorized as supervised machine learning. That is where an algorithm (classifier) tries to map inputs to desired outputs using a specific function. In classification problems a classifier tries to learn several features (variables or inputs) to predict an output (response). In the case of phishing classification, a classifier will try to classify an email to phishing or legitimate (response) by learning certain characteristics (features) in the email. In the following we summarize two research studies that apply machine learning in phishing classification. A technique has been proposed to classify phishing based on structural properties of phishing emails. A total of 25 features mixed between style markers and structural attributes were used and 200 emails (100 phishing and 100 legitimate) were tested. Simulated annealing as an algorithm for feature selection was applied. After a feature set was chosen, information gain (IG) was used to rank these features based on their relevance. One-class SVM was applied to classify phishing emails based on the selected features. Their results claim a detection rate of 95% of phishing emails with a low false positive rate [8].

Another study compared a number of commonly used learning methods through their performance in phishing detection on a past phishing data set, and finally Random Forests were implemented in their algorithm PILFER. Their methods can be used to detect phishing websites as well. They tested 860 phishing emails and 6950 legitimate emails. The proposed method detected correctly 96% of the phishing emails with a false positive rate of 0.1%. They used ten features handpicked for training and their phishing data set was collected in 2002 and 2003. As pointed out by the authors themselves, their implementation is not optimal and further work in this area is warranted [9].

5 Our approach

In this section we describe the data set, how we constructed the testing data set from the raw phishing emails in addition to the classifiers and the evaluation metrics used. Similar to the spam email database available like spamassassin, we construct a phishing data set by processing a set of 500 raw phishing emails and almost equal number of legitimate emails. Each email is converted into a vector as explained later. Similar to the spam email database available on Internet, the spam email database available like SpamAssassin, a phishing data set is constructed by processing a set of 1000 raw phishing emails. This set of phishing emails covers many of the newer trends in phishing. Some messages collected from our own mailboxes. Each email is converted into a vector as explained before. Following steps were followed in construction of data set:

- ❖ Email collection using corpus and personal email collection was done.
- ❖ Email preprocessing using stopword removal and word stemming.
- ❖ Vector generation as explained in next section.
- ❖ Machine learning techniques used are implemented.
- ❖ Cross validation: 10 fold cross validation is done.
- ❖ Results are generated.

Either of the Gaussian or Nearest Mean Classifier are applied to the vectors in the training data set and the value for the given set of vector representing an email as phishing or non phishing is estimated. Cross validation is also done on the results and the mean or average probability of error is calculated.

5.1 Vector Generation

To find appropriate weights for a term, the term frequency, i.e. the number of occurrences of a term in the document is commonly used. Unfortunately, it is not sufficient to only count the number of occurrences of a term in the document. A useful term weight for a term T_k in document D_i is, e.g. defined as the term frequency multiplied by the inverse collection frequency, i.e. the number of occurrences of the term in the whole document collection. The two sources of weighting data are therefore:

❖ Collection frequency: Terms which occur in only a few documents are likely to be more useful than ones occurring in many.

❖ Term frequency: The more frequently a term appears in a document, the more important it is likely to be for that document.

❖ This means, that the more a term occurs in one document, and the less frequent it is in the whole document collection, the better is its discrimination value.

Salton defines the process of vector generation as:

❖ After having identified the individual words in a document collection, use a stopword list to eliminate the words that produce only noise, but are of no discrimination value (and, but, or, the, etc.,...).

❖ Use suffix stripping to get only the word stems (use only "philosoph*" instead of philosopher, philosophic, philosophical, philosophically, etc.).

❖ For each remaining word stem T_k (= term) in each document compute its term weight w_k using the formula give below:

$$w_k = \textit{term freq. x log(no. of docs/ collection freq.)}$$

❖ Represent each document by the vector containing the set of the weights of the terms as:

$$D_i = (w_1, w_2, w_3, w_4, w_5 \ldots w_k)$$

So, an email can be represented as a vector $D_i = (w_1, w_2, w_3, w_4, w_5 \ldots w_k)$, where

$$w_k = \textit{term freq. x log(no. of docs/ collection freq.)}$$

Here,

- w_k is weight of that term
- Term freq. is number of occurrences of a term in the email.
- No. of docs is the total no of emails.
- Collection freq. is no. of occurrences of the term in the whole collection of emails

6 Experimental Studies/Results

In this section experimental studies to investigate the predictive accuracy of GC and NMC are demonstrated. The plots generated for all the 30 simulations. The generalised results for each of the dataset is shown in Figure 6.1, 6.2, 6.3

6.1 Bare Emails: The plot for the dataset of bare emails is

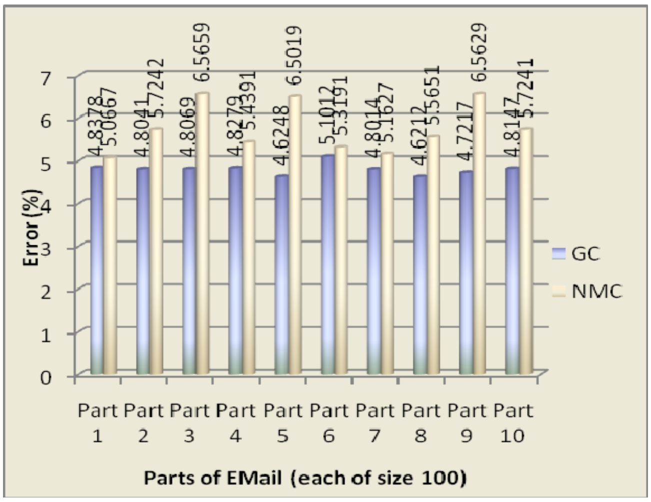

Figure 6.1: *Bare Emails/ Without Preprocessing*

shown in Figure 6.1. Bare emails are the one on which no preprocessing was done. An average error of 4.7961 for GC and 5.7631 for NMC was calculated. The peak or maximum probability of error for GC was .0933 and for that of NMC was .0867. GC is found to be the better one as the error is less in comparison to NMC.

6.2 Preprocessed With Stopword Removal: The plot for the dataset of emails preprocessed with stopword removal only is shown in Figure 6.2. Here, word stemming was not done. An average error of 4.9710 for GC and 5.7692 for NMC was calculated. The peak or maximum probability of error for GC was .1000 and for that of NMC was .1111. A noticeable increase in the peak or maximum probability of error can be seen for both GC and NMC in comparison to both in case of bare emails. Here also GC is found to be the better one as the error is less in comparison to NMC.

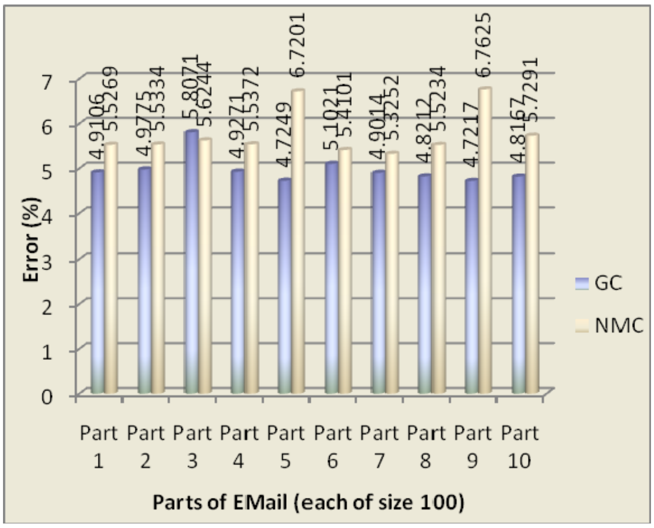

Figure 6.2: *Preprocessed with Stopword Removal*

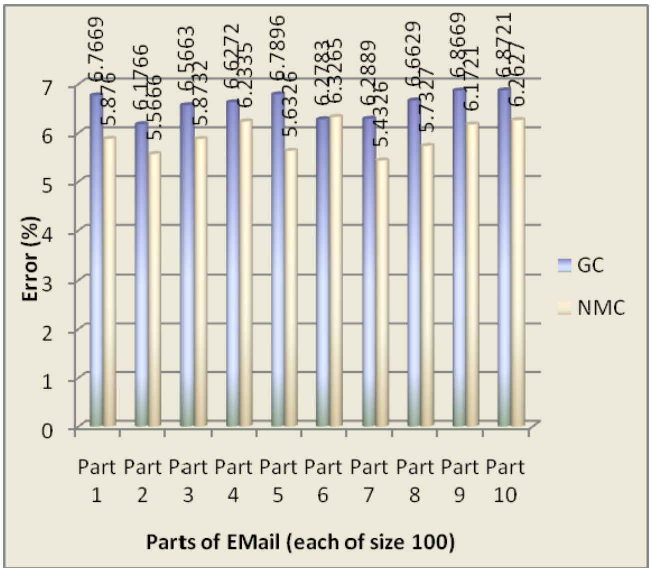

Figure 6.3: *Preprocessed with Stopword removal and Word Stemming*

6.3 Preprocessed With Stopword Removal and Word Stemming: The plot for the dataset of emails preprocessed with both stopword removal as well as word stemming is shown in Figure 6.3. An average error of 6.6681 for GC and 5.8717 for NMC was calculated. The peak or maximum probability of error for GC was .1667 and for that of NMC was .1333. A noticeable increase in the peak or maximum probability of error can be seen for both GC and NMC in comparison to both in case of bare emails as well as the one preprocessed with stopword removal only. Here GC performed the same way as it performed in the previous two cases but the performance of the NMC has seen an increased in comparison to that of GC. NMC is found to be the better one as the error is less in comparison to GC.

7 Conclusion and Future work

In the present study, we reviewed some of the techniques being used to detect phishing emails. We also compared Gaussian and nearest mean classifiers in a simulated environment using the metric probability of error. It is concluded that:

- Nearest Mean Classification Proved to be a better on for smaller vector lengths and maintained its efficiency in all the three cases studied.
- Gaussian Classification performed better than Nearest Mean Classification where the vector length was long or where no preprocessing was done. Its error increased as the data was processed or the vector length decreased.

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MERITVE KAKOVOSTI ZVOKA V TELEFONIJI ZA VERIFIKACIJO GOVORCEV V FORENZIČNE NAMENE

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POVZETEK

Članek predstavlja metode za merjenje kakovosti zvoka v telefoniji, razvito merilno okolje in prve rezultate meritev po metodi PESQ v fiksni in mobilni telefoniji za izdelavo specializirane govorne baze pogovorov za verifikacijo govorcev v forenzične namene.

1. UVOD

Meritve kakovosti zvoka v telefoniji so prvenstveno namenjene razvoju novih tehnologij in vzdrževanju telekomunikacijske infrastrukture. Nove informacijsko-komunikacijske tehnologije se lahko tudi zlorabljajo oz. uporabljajo v nedovoljene namene. Pri odkrivanju kriminalnih dejanj policija uporablja razne specialne metode in sredstva, med katere spada tudi prisluškovanje in snemanje telefonskih pogovorov. Vendar se kasneje v sodnih obravnavah pojavljajo številni dvomi o njihovi verodostojnosti, še težje pa je dokazati, da gre na nekem konkretnem posnetku za govor obtoženca in ne kakšne druge osebe. Pri tem so v veliko pomoč sodobne metode identifikacije in verifikacije govorcev v forenzične namene.

V okviru projekta »Razpoznavanje (identifikacija/ verifikacija) govorcev v forenzične namene« [7], ki se izvaja na Institutu Jožef Stefan, bo izdelana dovolj velika in specializirana govorna baza pogovorov, posnetih na različnih telefonijah (mobilni in klasični, VoIP, brezžični). Za boljšo analizo govornih parametrov in večjo zanesljivost rezultatov potrebujemo tudi podatke o kakovosti prenosa zvoka preko različnih komunikacijskih kanalov na katerih se prisluhi izvajajo.

2. VARIABILNOST GOVORNEGA SIGNALA PRI APLIKACIJAH V FORENZIČNE NAMENE

Pri razpoznavanju govorcev v forenzične namene imamo opravka s spornimi posnetki izgovarjav, ki predstavljajo dokazno gradivo in so posneti v »stvarnih pogojih« med samim izvajanjem kaznivih dejanj. V večini primerov govorni posnetki predstavljajo telefonske pogovore, pridobljene predvsem na dva načina: (i) anonimen klic, kadar je pričakovan ali kako drugače dostopen, (ii) prisluškovanje telefonskim pogovorom s strani policije. Pojem »stvarni pogoji« uporabljamo kot nasprotje »laboratorijskim pogojem«, ko ne moremo nadzirati, pričakovati ali predvidevati pogojev v katerih se bodo pridobili posamezni govorni posnetki. Celo več; obtoženec ponavadi ne želi korektno sodelovati in skuša ovirati ali preprečiti pridobitev kakršnihkoli zanj obremenilnih informacij.

Zaradi »stvarnih pogojev« pridobivanja posnetkov je govorni signal bolj spremenljiv oz. variabilen. Vire variabilnosti govornega signala lahko razvrstimo v naslednje kategorije [8]:

(i) svojske variabilnosti govornih signalov istega govorca: vrsta govora, staranje, časovni presledek med dvema posnetkoma, narečje, žargon, socialni status, čustveno stanje, uporaba omamnih sredstev itd.

(ii) izsiljene oz. umetne variabilnosti govornih signalov istega govorca: »Lombardov« učinek, stres zaradi zunanjega vpliva, »cocktail-party« učinek itd.

(iii) zunanja variabilnost odvisna od kanala: tip telefona ali mikrofona, fiksna/mobilna telefonija, komunikacijski kanal, pasovna širina, dinamični obseg oz. razpon, električni in akustični šum, odmev, popačenje itd.

Forenzični pogoji so doseženi, ko se dejavniki variabilnosti, ki predstavljajo t.i. »stvarne pogoje«, pojavljajo brez kakršnegakoli principa, pravila ali norme. Lahko so konstantni preko celotnega klica ali pa se hipoma pojavijo ali izginejo; na celoten proces vplivajo povsem nepredvidljivo.

Meritve kakovosti prenosa govora preko različnih komunikacijskih poti omogočajo boljši nadzor nad zunanjimi viri variabilnosti. Na primer pri mobilni telefoniji predstavljajo zunanje vire variabilnosti različni pogoji znotraj radijskega omrežja in zunanji pogoji, kot so šum iz ozadja in nelinerani akustični odmev. Poleg tega so v mobilnih telefonih vgrajeni različni dušilci šuma in izločevalniki odmeva, ki pa se razlikujejo glede na procesno moč aparatov in kapaciteto baterije. Poleg tega na kakovost zvoka in zmanjševanje šuma močno vpliva uporaba različnih kodekov, močno pa je odvisna tudi od pokritosti signala oziroma števila baznih postaj.

3. METODE, ORODJA IN STANDARDI ZA MERITVE KAKOVOSTI ZVOKA V TELEFONIJI

Zaznano kakovost zvoka v telefoniji je bilo do 90. let prejšnjega stoletja mogoče meriti le s poslušalnimi testi živega občinstva, pri čemer govorimo o tako imenovanih subjektivnih meritvah kakovosti zvoka. Prva splošno priznana tovrstna metoda za merjenje kakovosti zvoka v telekomunikacijah je metoda MOS (Mean Option Score), ki je standardizirana v priporočilu ITU-T P.800 [3]. Rezultat meritve MOS predstavlja statistično povprečje kakovosti prenešenega govornega zvočnega signala, ki je ocenjena s strani določene množice (cca. 20-50) človeških ocenjevalcev. Ocenjevalna lestvica MOS se giblje od 1 za popolnoma nesprejemljivo kakovost, do 5 za odlično kakovost govornega zvočnega signala glede na določene kriterije. S sodelovanjem velike množice ocenjevalcev in obsežnimi testnimi okolji je mogoče testiranje po metodi MOS izvajati dokaj uspešno, vendar je velika pomanjkljivost metode v nezmožnosti avtomatizacije meritev in posledično velike potrebe po človeških virih. Prav tako so rezultati metode subjektivni, meritve pa neponovljive.

Zaradi potrebe po izboljšanju zgoraj navedenih slabosti so bile kasneje razvite objektivne metode za ocenjevanje kakovosti zvoka na osnovi primerjave izvornega referenčnega in merjenega degradiranega signala. Ta koncept je prvi predstavil Karjalainen [5] in predstavlja jedro večine kasnejših metod, ki so standardizirane v priporočilih ITU-T z oznakami P.861 (metoda PSQM), P-862 (metoda PESQ), G.107 (metoda E-model), P.563 in drugih.

Od omenjenih metod bomo izpostavili metodo PESQ, ki je najbolj razširjena v meritvah kakovosti zvoka v ozkopasovni telefoniji.

Algoritem metode PESQ vsebuje računalniški psihoakustični model poslušalca, s katerim na osnovi računske primerjave referenčnega (vhodnega) in testiranega (izhodnega) zvočnega signala objektivno izračuna oceno MOS. Lestvica ocen po metodi PESQ je zaradi statistične primerjave z lestvico metode MOS v razponu od 1 za najnižjo, do 4,5 za najboljšo kakovost, in ne do 5, kot je to v primeru metode MOS pri poslušalnih testih.

Rezultat ocene kakovosti zvoka je podan preko indikatorjev, kot so zakasnitve, trepetanje, porezovanje, akustični odmev in drugi.

Osnovna prednost metode PESQ je v mehanizmu za časovno poravnavanje referenčnega in popačenega signala, kar izboljša natančnost meritev v pogojih variabilnih zakasnitev, ki so značilni za paketne prenose, npr. VoIP [4]. Iz tega razloga daje ta metoda tudi najbolj objektivne in primerljive rezultate, neodvisno od tehnologije prenosa govornih podatkov (GSM, PSTN, ISDN, DECT ali VOIP).

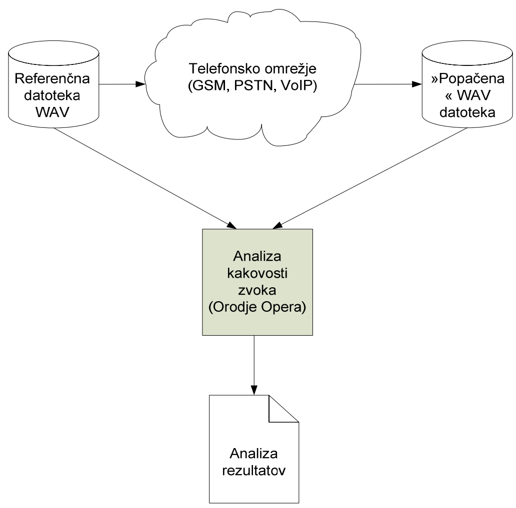
Na tržišču je veliko specializiranih orodij za meritve kakovosti zvoka po priporočilih ITU-T, ki omogočajo simulacije različnih delovnih pogojev, optimizacijo omrežij, detekcijo in lokalizacijo napak ter vzrokov za poslabšano kakovost prenosa zvoka v omrežjih [9].

Velika večina teh orodij, predvsem tista, ki so osnovana na namenski strojni opremi, je praviloma predraga za akademsko okolje. Iz tega razloga je bila tudi sprejeta odločitev za uporabo cenovno sprejemljivega programskega orodja Opera [1].

4. TESTNO OKOLJE IN IZVEDBA MERITEV

Za meritve kakovosti zvoka v različnih telefonijah smo prilagodili testno okolje za meritve kakovosti zvoka v lokalnih brezžičnih omrežjih (WLAN), ki smo ga zgradili v okviru mednarodnega projekta Windect v 6OP [2].

Kot prikazuje slika 1, smo posneti referenčni signal v formatu WAV iz izvorne strani govorne telefonske povezave primerjali s posnetim zvočnim signalom po prenosu v izbranem telefonskem omrežju (GSM, fiksna telefonija, VoIP). Analiza obeh digitaliziranih signalov je bila izvedena po metodi PESQ z orodjem Opera. Prednost omenjene metode je v neodvisnosti od tipa telefonske povezave, saj je meritev izvedena z analognim signalom predvajanega referenčnega govornega posnetka.

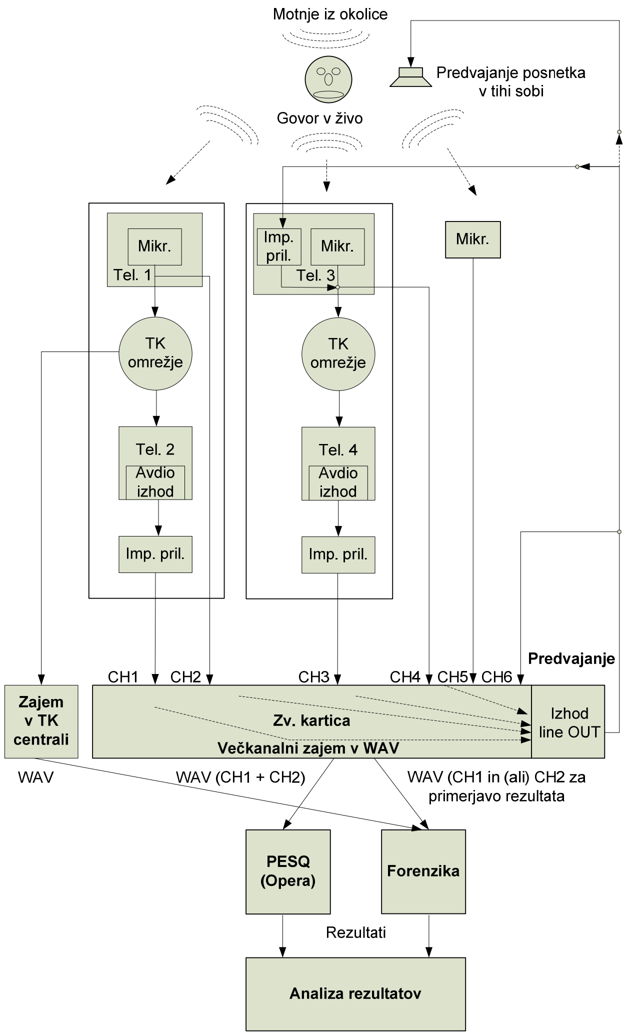


Slika 1: Osnovna shema metode za meritev kakovosti zvoka

Meritve so obsegale naslednje korake:

1. izbor in konfiguracija merjenega omrežja,
2. vzpostavitev komunikacijske povezave,
3. predvajanje govornega posnetka,

4. zajem govornega posnetka na drugi strani komunikacijske povezave hkrati z referenčnim signalom v stereo WAV datoteko,
5. analiza WAV datoteke s programom Opera po metodi PESQ in,
6. analiza in predstavitev rezultatov meritev.



Slika 2: Testno okolje za meritve kakovosti zvoka

V testnem okolju, kot je prikazano na sliki 2 smo uporabili naslednje gradnike:

1. prilagojena GSM telefona Nokia 3510i s priključkom na mikrofonski avdio vhod za predvajanje analognega referenčnega signala,
2. analogna fiksna telefona Kingtel KT-404,
3. osebni računalnik z zvočno kartico in programom za sinhronizirano predvajanje in zajem analognega referenčnega in popačenega signala v WAV format,
4. vmesnik za impedančno prilagoditev telefonov na zvočno kartico,
5. testne referenčne posnetke v WAV formatu,
6. programsko orodje Opera za meritve kakovosti zvoka.

V testnem okolju smo predvideli tudi možnost uporabe večkanalne A/D - D/A PCI kartice, s katero bomo omogočili ustrezno izolacijo diferencialnih vhodov, izboljšali zvočno kakovost zajemanja signala, predvsem v pogledu odpravljanja popačenj zaradi previsoke amplitude in hkrati povečali funkcionalnost obstoječega testnega okolja s hkratnim zajemom več kanalov različnih prenosnih poti.

Posnetek govora v datoteki WAV smo predvajali na testnem računalniku in ga pripeljali v obliki analognega signala iz "line OUT" izhoda zvočne kartice preko impedančne prilagoditve na mikrofonski vhod telefonskega aparata (mobilni aparat, fiksni telefon ali VoiP telefon) na izvorni strani govorne telefonske povezave. Hkrati smo isti analogni signal iz "line OUT" izhoda pripeljali vzporedno na enega od vhodov »line IN« zvočne kartice. Popačeni signal na drugi strani telefonske povezave smo iz zvočnega izhoda telefonskega aparata pripeljali preko impedančne prilagoditve na drugi prosti vhod zvočne kartice "line IN". Na ta način smo sinhronizirano zajeli desni nepopačeni referenčni kanal in v telefonskem omrežju popačeni levi kanal v stereo datoteko WAV. Pri pošiljanju referenčnega signala preko komunikacijskega omrežja je pomembno, da sta oba signala, torej izvorni signal in posneti signal, popolnoma časovno sinhronizirana, saj je zakasnitev prenosa na telefonski povezavi izmerjena na osnovi časovnih razlik med obema signaloma.

Slika 3: Izvedba testnega okolja za meritve kakovosti zvoka v telefoniji

Na sliki 3 je prikazano realizirano testno okolje za meritve kakovosti zvoka v mobilni GSM in fiksni analogni telefoniji. Štiri telefone, od tega dva za fiksno telefonijo in dva za mobilno GSM telefonijo, smo za potrebe meritev poljubno kombinirali v željeni način povezave (klici z GSM telefona na GSM telefon, s fiksnega telefona na GSM telefon in s fiksnega telefona na fiksni telefon). Fiksna analogna telefona sta bila povezana v omrežje Centrex, ponudnika Telekom Slovenije. Mobilna GSM telefona Nokia sta bila povezana v omrežje ponudnika Mobitel. Mobilna telefona je bilo potrebno prilagoditi za potrebe meritev. Za povezavo mobilnih telefonov na prilagoditveno vezje je bilo potrebno speljati analogni signal iz zvočnega izhoda mobilnega telefona GSM 1 na vhod vezja za impedančno prilagoditev. Analogni signal izhoda impedančne prilagoditve pa smo pripeljali na mikrofonski predojačevalec mobilnega telefona GSM 2. Impedančna prilagoditev je potrebna zaradi prilagoditve moči analognih avdio signalov in ločitve napetostnih potencialov osebnega računalnika in telefonske linije. Ustrezno niveliranje zvočnih signalov na “line IN” izhodu zvočne kartice smo s poskušanjem nastavili na najbolj optimalno vrednost, ki ni povzročala popačenj na »line IN« vhodu.

5. REZULTATI MERITEV

Za verifikacijo testnega okolja smo najprej izvedli meritev v fiksni telefoniji med dvema fiksnima telefonoma v omrežju Centrex.

Rezultat PESQ MOS je bil pričakovano dober in se je gibal od 4,24 do 4,38, odvisno od izbrane referenčne datoteke WAV. Pri različnih datotekah lahko zaradi značilnosti v govoru, jeziku, premorih ipd. prihaja do malenkostno različnih rezultatov, kar je posledica preračunavanja v algoritmu PESQ, na kar nimamo vpliva. Zakasnitev je bila prav tako minimalna in je znašala cca 3ms.

V nadaljevanju smo izvedli meritev pri klicni povezavi iz fiksnega telefona v omrežju Centrex na GSM mobilni telefon. Pri tem smo naleteli na težavo, saj naše hišno telefonsko omrežje vse klice iz fiksnega v mobilna omrežja preusmerja na GSM vmesnik, ki je v meritvah povzročal velik odmev in motnje na merjenem GSM telefonu, zato so rezultati kakovosti slabi. Rezultat za meritev PESQ MOS je 2,58, kar je popolnoma nezadovoljivo. Hkrati pa je izmerjena zakasnitev 206 ms pričakovana za omrežje GSM.

V nadaljevanju smo izvedli meritev pri povezavi dveh mobilnih telefonov v GSM omrežju. Pri zajemu WAV datoteke smo naleteli na oscilacije na avdio vhodu na telefonu, kar je imelo za posledico nekoliko slabši rezultat MOS 3,18. Zakasnitev 200 ms pa je bila v mejah pričakovane. Rezultat MOS 3,18 je v mejah pričakovanega, kar potrjuje tudi primerjava s sorodnimi meritvami kakovosti zvoka v GSM omrežjih, ki so bile izvedene v bistveno večjem obsegu za potrebe ocenjevanja kakovosti kodekov in naprav za izboljševanje kakovosti zvoka v GSM telefonih [6].

Glede na uspešno izvedbo meritev in primerljivost rezultatov s sorodnimi viri je potrjena ustreznost testnega okolja za nadaljnje izvajanje meritev v različnih konfiguracijah merjenega omrežja.

6. ZAKLJUČKI

V zaključku lahko ugotovimo, da je kakovost komunikacijske poti in zaznana kakovost prenešenega signala eden od pomembnih elementov pri snemanju govora za potrebe forenzičnih preiskav. V ta namen smo zgradili testno okolje za meritve kakovosti prenosnih poti s standardizirano metodo PESQ in komercialnim orodjem Opera. Prvi rezultati meritev so potrdili ustreznost metode in testnega okolja. V nadaljevanju bodo izvedene še meritve na dodatnih telefonskih linijah in različnih telefonskih aparatih z uporabo večkanalnega zajema signala, kar bo omogočilo še kakovostnejšo analizo in kvantitativno opredelitev nezanesljivosti ter vrednotenje razlik v različnih snemalnih pogojih, ki zaradi »stvarnih pogojev« nastopajo pri posnetkih iz sodne prakse.

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RULE INDUCTION IN MEDICAL DATA WITH HYBRID HEURISTIC ALGORITHMS

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ABSTRACT

This work proposes an algorithm for rule induction called SA Tabu Miner (Simulated Annealing and Tabu Search based Data Miner). The goal of the algorithm is to extract classification rules from data. The algorithm is inspired by both research on heuristic optimization algorithms and some data mining concepts and principles. We compare the performance of SA Tabu Miner with CN2, a well-known data mining algorithm for classification and Ant-Miner, a recently proposed ACO based algorithm, on public domain data sets. The results provide evidence that: our algorithm is competitive with CN2 and Ant-Miner with respect to predictive accuracy; and the rule lists discovered by our algorithm are considerably simpler (smaller) than those discovered by other algorithms.

1 INTRODUCTION

Rule induction as a type of data mining aiming to extract knowledge from data. It is an inter-disciplinary field combining machine learning, statistics and databases. Machine learning is a subfield of artificial intelligence concerned with the development of algorithms that allow computers to "learn". Generaly, there are two types of learning: inductive and deductive. Inductive machine learning methods extract rules and patterns out of massive data sets. This paper describes an algorithm for rule induction called SA Tabu Miner (Simulated Annealing and Tabu Search based Data Miner). The goal of the algorithm is to extract classification rules from data.

In this work, SA and Short-term TS algorithm [1] [2] [3] [4] are used to develop an algorithm for the classification task of data mining. The goal is to assign each case (record or instance) to one class, out of a set of predefined classes, based on the values of some attributes for the case. In the classification task of data mining, discovered knowledge is often expressed in the form of IF-THEN rules, as follows:

IF <conditions> THEN < class>

The rule antecedent (IF part) contains a set of conditions, usually connected by a logical conjunction operator (AND). The rule antecedent is a logical conjunction of terms in the form: IF term1 AND term2 AND ... Each term is a triple <attribute, operator, value>, such as <Age = 58>. The rule consequent (THEN part) specifies the class predicted for cases whose predictor attributes satisfy all the terms specified in the rule antecedent. This kind of knowledge representation has the advantage of being intuitively comprehensible for the user, as long as the number of discovered rules and terms within are not large.

The rule discovery problem is NP-hard. Therefore, the optimal solution cannot be guaranteed to be acquired except when performing an exhaustive search in the solution space, which is impossible in reasonable time limits. Currently used algorithms (CN2, C4.5) suffer from the problem of trapping into local optimal solutions for large-scale problems when the number of attributes of the dataset is large (>100). Modern iterative heuristics such as SA, TS and genetic algorithms have been found effective in tackling this category of problems which have an exponential and noisy search space with numerous local optima [1] [2]. Recently Zhang et al.[1] have used TS with short-term memory to solve the optimal feature selection problem. The experimental results on synthetic data have shown that this algorithm not only has a high possibility to obtain the optimal or near-optimal solution, but also requires less computational time than the other suboptimal methods [1]. Ant Colony Optimization has recently been successfully used for rule induction by Parepinelli [11].

To the best of our knowledge, the use of SA and TS algorithms for discovering classification rules in data mining, is a research area still unexplored. We believe that the use of these algorithms for data mining is a promising research area, and can produce a robust system capable of finding high-quality solutions for problems with a large search space. Heuristic algorithms have the ability to perform a flexible search for a good combination of terms involving the predictor attributes.

2 SA TABU MINER

The SA Tabu miner algorithm incrementally constructs and modifies a solution - a classification rule of the form:

IF < term1 AND term2 AND ...> THEN <class>

Each term is a triple <attribute, operator =, value>. Since the operator element in the triple is always "=", continuous (real-valued) attributes are discretized in a preprocessing step using the C4.5 algorithm [10]. Each attribute can occur only once in each rule, to avoid invalid rules such as "IF (Sex = male) AND (Sex = female) ...".

A high level description of the SA Tabu Miner algorithm is shown in Algorithm 1. The algorithm performs a sequential covering process to discover a list of classification rules covering as many as possible training cases with as big quality as possible. At first, the list of discovered rules is empty and the training set consists of all the training cases. Each iteration of the outer WHILE loop of SA Tabu miner, corresponding to a number of executions of the inner WHILE loop, discovers one classification rule. The rule found is added to the list of discovered rules, and the training cases that are covered by this rule are removed from the training set. This process is iteratively performed while the number of uncovered training cases is greater than a user-specified number called Max_uncovered_cases, usually 5% of all cases.

The choice of the term to be added to the current partial rule depends on both a problem-dependent heuristic function, a tabu timeout for the recently used attribute values and on the metropolitan function based on the Boltzman distribution of probability. The algorithm keeps adding one-term-at-a time to its current partial rule until one of the following two stopping criteria is met:

• Any term to be added to the rule would make the rule cover a number of cases smaller than a user-specified threshold, called Min_cases_per_rule.

• The parameter temperature has reached its lowest value

```
TrainingSet = {all training cases};
DiscoveredRuleList = [ ]; /*initialized with an empty list*/
While (TrainingSet > Max_uncovered_cases)
        Start with an initial feasible solution S ∈ Ω.
        Initialize temperature
        While (temperature > MinTemp)
           Generate neighborhood solutions V* ∈ N(S).
           Update tabu timeouts of the recently used terms
           Sort by (quality/tabu order) desc sol-s S* ∈ V*
           S* = the first solution ∈ V*
           While(move is not accepted or V* is exhausted)
                If metrop(Quality(S) - Quality(S*)) then
                   Accept move and update best solution.
                   Update tabu timeout of the used term
                   break while
                End if
                S* = next solution ∈ V*
           End while
           Decrease temperature
        End While
        Prune rule S
        Add discovered rule S in DiscoveredRuleList
        TrainingSet = TrainingSet - {cases covered by S};
End while
```

Algorithm 1: *SA Tabu Miner, the rule induction algorithm.*

Where

(i) Ω is the set of feasible solutions,

(ii) S is the current solution,

(iii) S* is the best admissible solution,

(iv) Quality is the objective function,

(v) N(S) is the neighborhood of solution S,

(vi) V* is the sample of neighborhood solutions.

3 HEURISTIC FUNCTIONS

An important step in the rule construction process is the neighborhood function that generates the set V* of neighborhood solutions of the current solution (rule) S. Here the neighborhood consists of all possible rules generated by adding one more term to the current rule in every attribute position. The neighborhood contains as many rule proposals as there are values of attributes in the dataset. Every attribute has several available values. Let $term_{ij}$ be a rule condition of the form $A_i = V_{ij}$, where Ai is the i-th attribute and Vij is the j-th value of the domain of A_i. The choice of the value of the attribute placed in the term is dependent on the probability given in formula 1:

$$P_{ij} = \frac{\varphi_{ij}}{tabu\ timeout} \qquad (1)$$

where

$$\varphi_{ij} = \frac{\log_2 k - H_{ij}}{\sum_{j=1}^{b_i} (\log_2 k - H_{ij})} \qquad (2)$$

where:

- b_i is the number of values for attribute i.
- k is the number of classes.
- H_{ij} is the entropy $H(W|A_i=V_{ij})$.

For each $term_{ij}$ that can be "added" to the current rule, SA Tabu-Miner computes the value H_{ij} of a heuristic function that is an estimate of the quality of this term, with respect to its ability to improve the predictive accuracy of the rule. This heuristic function is based on Information Theory [5]. More precisely, the value of H_{ij} for $term_{ij}$ involves a measure of the entropy (or amount of information) associated with that term. For each $term_{ij}$ of the form $A_i=V_{ij}$, its entropy is given in formula 3:

$$H_{ij} \equiv H(W|A_i = V_{ij}) = -\sum_{w=1}^{k} (P(w|A_i = V_{ij}) \cdot \log_2 P(w|A_i = V_{ij}))$$

where:

- W is the class attribute (i.e., the attribute whose domain consists of the classes to be predicted).

- $P(w|A_i=V_{ij})$ is the empirical probability of observing class w conditional on having observed $A_i=V_{ij}$.

The higher the value of $H(W|A_i=V_{ij})$, the more uniformly distributed the classes are and so, the smaller the probability that $term_{ij}$ would be part of the new solution. $H(W|A_i=V_{ij})$ of $term_{ij}$ is always the same, for a constant dataset. Therefore, in order to save computational time, the $H(W|A_i=V_{ij})$ of all $term_{ij}$ is computed as a preprocessing step to every while loop.
If the value V_{ij} of attribute Ai does not occur in the training set, then $H(W|A_i=V_{ij})$ is set to its maximum value of $\log^2_k$. This corresponds to assigning to $term_{ij}$ the lowest possible predictive power. Second, if all the cases belong to the same class then $H(W|A_i=V_{ij})$ is set to 0. This corresponds to assigning to $term_{ij}$ the highest possible predictive power. This heuristic function used by SA Tabu-Miner, the entropy measure, is the same kind of heuristic function used by decision-tree algorithms such as C4.5 [6]. The main difference between decision trees and SA Tabu-Miner, with respect to the heuristic function, is that in decision trees the entropy is computed for an attribute as a whole, since an entire attribute is chosen to expand the tree, whereas in SA Tabu-Miner the entropy is computed for an attribute-value pair only, since an attribute-value pair is chosen to expand the rule.
Once a solution proposal is constructed it is evaluated using the quality measure of the rule. The quality of a rule, denoted by Q, is computed by the formula: *Q = sensitivity • specificity* [7], defined in formula 4 as:

$$Q = \frac{TP}{TP + FN} \cdot \frac{TN}{FP + TN} \qquad (4)$$

where:

TP (true positives) is the number of cases covered by the rule that have the class predicted by the rule.

FP (false positives) is the number of cases covered by the rule that have a class different from the class predicted by the rule.

FN (false negatives) is the number of cases not covered by the rule but having the class predicted.

TN (true negatives) is the number of cases that are not covered by the rule and that do not have the class predicted by the rule.

Q´s value is within the range $0 < Q < 1$ and, the larger the value of Q, the higher the quality of the rule.
The quality of the rule is the value that participates in the SA metropolitan function that decides if the new solution proposal will be accepted as the next solution. As is usuall in SA, while the parameter temperature is high, even worse solutions have the chance to be accepted, therefore diversifying the search. As temperature drops, only solutions with better quality have any chance to be accepted, intensifying the search in the promising region.

Rule pruning is a commonplace technique in data mining [8]. The main goal of rule pruning is to remove irrelevant terms that might have been unduly included in the rule. Rule pruning increases the predictive power of the rule and improves the simplicity of the rule, since a shorter rule is easier to be understood by the user than a longer one.
As soon as our algorithm completes the construction of a rule, the rule pruning procedure is called. The strategy for the rule pruning procedure is similar to that suggested by [9], but the rule quality criteria used in the two procedures are very different.
The basic idea is to iteratively remove one-term-at-a-time from the rule while this process improves the quality of the rule. More precisely, in the first iteration one starts with the full rule. The term whose removal most improves the quality of the rule is effectively removed from it, completing each iteration. This process is repeated until there is no term whose removal will improve the quality of the rule. This step might involve replacing the class in the rule consequent, since the majority class in the cases covered by the pruned rule can be different from the one in the original rule.

4 EXPERIMENTAL RESULTS AND DISCUSSION

To justify our research, we compared the performance and results of our SA Tabu miner with CN2 and Ant Miner[11] developed by Parepinelli.
The comparison was carried out across two criteria, namely the predictive accuracy of the discovered rule lists and their simplicity. Predictive accuracy was measured by a well-known 10-fold cross-validation procedure [12]. Each data set is divided into 10 mutually exclusive and exhaustive partitions and the algorithm is run once for each partition. Each time a different partition is used as the test set and the other 9 partitions are grouped together and used as the training set. The predictive accuracies (on the test set) of the 10 runs are then averaged and reported.
The comparison of predictive accuracies after the 10-fold cross-validation procedure is given in figure 1:

	Predictive accuracies (%)		
Data Sets	SA Tabu-miner	CN2	Ant Miner
Ljubljana breast cancer	65,1	67,69	75.28
Wisconsin breast cancer	90,3	94,88	96.04
tic-tac-toe	84,7	97,38	73.04
Dermatology	91,3	90,38	94.29
Hepatitis	89,2	90,00	90.00

Figure 1: *The predictive accuracy of the SA Tabu Miner algorithm compared with the predictive accuracy of CN2 and Ant miner.*

An important feature of classification algorithm is the simplicity of the discovered rule list, measured by the number of discovered rules and the average number of terms (conditions) per rule. The results comparing the simplicity of the rule lists discovered by SA Tabu-Miner and by CN2 are reported in figure 2.

	No. of rules; and terms per rule		
Data Set	SA T miner	CN2	Ant Miner
Ljubljana breast cancer	8.55;1.70	55.40;2.21	7.10; 1.28
Wisconsin breast cancer	6.10;2.15	18.60;2.39	6.20;1.97
tic-tac-toe	8.62;1.30	39.70;2.90	8.50;1.18
dermatology	6.92;4.08	18.50;2.47	7.30;3.16
hepatitis	3.21;2.54	7.20; 1.58	3.40;2.41

Figure 2: *Simplicity of rules discovered by the compared algorithms. The number of rules and terms per rule.*

Taking into account the predictive accuracy of the discovered rules, SA Tabu miner achieved comparable and in some cases better results than the other two algorithms. However, in terms of rule simplicity, SA Tabu miner achieves quite simpler and more comprehensible rules than the other two.

5 CONCLUSIONS AND FUTURE WORK

This work has proposed an algorithm for rule discovery called SA Tabu Miner. The goal is to discover classification rules in data sets. The algorithm is based on Simulated Annealing and Tabu Search, mathematical, local search, optimization methods.

We have compared the performance of SA Tabu Miner with CN2 and Ant miner algorithms, on public domain data sets. The results showed that, concerning predictive accuracy, SA Tabu Miner obtained similar and often better results than the other approaches.

Since comprehensibility is important whenever discovered knowledge will be used for supporting a decision made by a human user, SA Tabu Miner often discovered simpler (smaller) rule lists than CN2 and Ant Miner. Therefore, SA Tabu Miner seems particularly advantageous when it is important to minimize the number of discovered rules and rule terms (conditions), in order to improve comprehensibility of the discovered knowledge. Furthermore, while CN2 has its limitations when large datasets with big number of attributes are in question, the heuristic SA Tabu Miner can still be applicable and will obtain good results due to the heuristic local search.

Important directions for future research include extending SA Tabu-Miner to cope with continuous attributes, rather than requiring that this kind of attribute be discretized in a preprocessing step using C4.5.

The second direction for improvement is the intensification of the search. The search should be accentuated in the promising regions of the feasible domain. Intensification is based on some intermediate-term memory. When the solution space is extremely large (initial feature vector n > 100), it is important to intensify the search in the promising regions by removing poor features from the search space. The following steps are proposed:

Step 1. Store M best solutions in intermediate memory for T1 number of iterations.

Step 2. Remove features that are not included in the best M solutions for N times.

Step 3. Rerun the tabu search with the reduced set of features for another T2 iterations.

Step 4. Repeat Steps 1, 2, and 3 until the optimal or near-optimal solution is achieved.

The values of M and N can be determined empirically.

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MULTIPLE CRITERIA DECISION-MAKING FOR SELECTION OF MOBILE BASE STATION LOCATION

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Abstract. *The selection of base station location is one of the most important decision issues for mobile operators. We propose in this paper a new multiple criteria decision-making method in order to solve the location of base station problem under fuzzy environment. In the proposed method, the ratings of each alternative and the weight of each criterion are described by linguistic variables which can be expressed by triangular fuzzy numbers. The final evaluation value of each base station (BS) location is also expressed by a triangular fuzzy number. By calculating the difference of final evaluation value between each pair of BS locations, a fuzzy preference relation matrix is constructed to represent the intensity of the preferences of one location over another. And then, a stepwise ranking procedure is proposed to determine the ranking order of all candidate locations. Finally, we have realized simulation in Matlab, and solved different examples of decision-making for selecting the base station location.*

Keywords: Fuzzy decision making, linguistic variables, selection of the best alternative.

1. INTRODUCTION

Base station (BS) location is a common problem faced by mobile operators, in terms of coverage and better signal. In recent years, increased use of cell phones has focused attention on base stations location. Base station is viewed as a tool for gaining more customers and increasing the quality of service. In order to cover larger area, and to strengthen the signal, selecting a suitable BS location has become one of the most important decision issues for mobile operators. In the process of selection it is necessary first and foremost to identify the set of influential factors relevant to the BS location selection. Many influential factors are considered for the selection of a particular BS location, e.g. investment cost, area coverage, covered population, interference with other signals, etc. [8]. Multiple criteria decision-making (MCDM) methods were provided to deal with the problem of ranking and selecting the BS location under multiple criteria [4]. All the methods stated above are based on the concept of accurate measure and crisp evaluation, i.e. the measuring values must be exact and numerical.

In general, the selection of a best BS location from among two or more alternative locations on the basis of two or more factors is a multi-criteria decision-making problem. Under many situations, the values for qualitative criteria are often imprecisely defined for the decision-makers. Besides, the desired value and importance weight of criteria are usually described in linguistic terms, e.g. “very low”, “medium”, “high”, “fair”, etc. It is not easy to precisely quantify the rating of each alternative location and the precision-based methods as stated above are not adequate to deal with the plant location selection problem. This fuzziness in the BS location selection process motivated us to develop a fuzzy decision-making method.

By using the pair-wise preference relations, we present a new fuzzy decision-making method to deal with BS location selection problem in this paper. The decision-making criteria are divided into quantitative and qualitative criteria in our method. The importance weights of decision criteria and the ratings of qualitative criteria are assessed in linguistic variables which are described by triangular fuzzy numbers. In the proposed method, we aggregate the ratings (fuzzy and crisp) and fuzzy weights to calculate the final fuzzy evaluation values of all candidate locations. A preference relation is defined to indicate the over degree of preference of each pair of BS locations by comparing the difference between their final fuzzy evaluation values for all possibly occurring combinations. According to the preference relations, we construct a fuzzy preference relation matrix and use a stepwise ranking procedure to determine the ranking order of a large number of plant locations.

The organization of this paper is as follows. First, we introduce the basic definitions and notations of fuzzy numbers and linguistic variables. Next, we define a fuzzy preference relation to derive the fuzzy preference relation matrix, and propose a stepwise ranking procedure to determine the ranking order of all BS locations. And then, an example is solved in Matlab to illustrate the working of the proposed method. Finally, we give some conclusions at the end of this paper.

2. FUZZY DECISION MAKING

In this section, a systematic approach to the BS location selection problem by using the concepts of fuzzy set theory and multiple-criteria decision analysis, is proposed. This method is very suitable for decision-making under fuzzy environment. Knowing the fuzziness of the BS location selection problem, the importance weights of various criteria and the ratings of qualitative criteria are considered as linguistic (fuzzy) variables in this paper.

The linguistic variables can be expressed as triangular fuzzy numbers – given in Tables 1 and 2. We suggested that the decision maker easily uses the linguistic variables (shown in Table 1 and 2) to evaluate the importance of the criteria and the ratings of alternatives with respect to various subjective criteria.

Let $A_1,\ldots, A_m$ be possible alternatives (number of feasible BS locations) and $C_1,\ldots, C_n$ be criteria with which alternative performances are measured. As stated above, a fuzzy multi-criteria decision-making method for the selection of BS location problem can be concisely expressed in matrix format as:

$$\underline{D}=\begin{bmatrix} \underline{x}_{11}\ \underline{x}_{12} & \cdots \underline{x}_{1n} \\ \underline{x}_{21}\ \underline{x}_{22} & \cdots \underline{x}_{2n} \\ \vdots\quad \vdots & \cdots \\ \underline{x}_{m1}\ \underline{x}_{m2}\cdots & \underline{x}_{mn} \end{bmatrix} \quad \underline{W}=[\underline{w}_1, \underline{w}_2, \ldots, \underline{w}_n]$$

where $\underline{x}_{ij}$, $\forall i,j$ is the fuzzy rating of alternative A_i $(i=1, 2, \ldots,m)$ with respect to criterion C_j and $\underline{w}_j$ $(j=1, 2,\ldots,n)$ is the weight of criterion C_j. These fuzzy ratings and the weights of each criterion are linguistic variables which can be described by triangular fuzzy numbers, $\underline{x}_{ij}=(a_{ij}, b_{ij}, c_{ij})$ and $\underline{w}_j=(w_{j1}, w_{j2}, w_{j3})$.

Therefore, we can obtain the normalized fuzzy decision matrix denoted by $\underline{\boldsymbol{R}}$ as:

$$\underline{\boldsymbol{R}}=[\underline{r}_{ij}]_{m \times n}$$

$$\underline{r}_{ij} = (a_{ij}/c_j^*, b_{ij}/c_j^*, c_{ij}/c_j^*), j\in B$$

$$\underline{r}_{ij} = (a_j/c_{ij}, a_j/b_{ij}, a_j/a_{ij}), j\in C \qquad (1)$$

$$c_j^*=max_i\ c_{ij},\ if\ j\in B,\ \ a_j=min_i\ a_{ij},\ if\ j\in C$$

where B and C are the set of benefit criteria and cost criteria, respectively.

The normalization method mentioned above is to preserve the property that the ranges of normalized fuzzy numbers belong to [0, 1].

Considering the different importance of each criterion, we calculate the final fuzzy evaluation value of each alternative as:

$$\underline{P}_i=\sum_{j=1}^{n}\underline{r}_{ij}(\cdot)\underline{w}_j\ ,\ i=1, 2, \ldots, m \qquad (2)$$

where $\underline{P}_i$ is the final fuzzy evaluation value of alternative A_i.

After the calculation of the final fuzzy evaluation value of each alternative, the pairwise comparison of the preference relationship between the alternatives A_i and A_j can be established as stated in the following section.

To define a preference relation of alternative A_i over alternative A_j we do not directly compare the membership function of $\underline{P}_i$ and $\underline{P}_j$. Instead, we use the membership function of $\underline{P}_i(-)\underline{P}_j$ to indicate the preferability of alternative A_i over alternative A_j and then compare $\underline{P}_i(-)\underline{P}_j$ with zero. The difference $\underline{P}_i(-)\underline{P}_j$ here is the fuzzy difference between two fuzzy numbers. Using the fuzzy number, $\underline{P}_i(-)\underline{P}_j$, one can compare the differences between $\underline{P}_i$ and $\underline{P}_j$ for all possibly occurring combinations of $\underline{P}_i$ and $\underline{P}_j$.

Here, the final fuzzy evaluation values $\underline{P}_i$ and $\underline{P}_j$ are triangular fuzzy numbers. The difference between $\underline{P}_i$ and $\underline{P}_j$ is also a triangular fuzzy number and can be calculated as:

$$\underline{Z}_{ij}=\underline{P}_i(-)\underline{P}_j \qquad (3)$$

$$\underline{Z}^{\alpha}_{ij}=[z^{\alpha}_{ijl}, z^{\alpha}_{iju}] \qquad (4)$$

$$\underline{P}_i^{\alpha}=[p^{\alpha}_{il}, p^{\alpha}_{iu}],\ \underline{P}_j^{\alpha}=[p^{\alpha}_{jl}, p^{\alpha}_{ju}],$$
$$z^{\alpha}_{ijl}=p^{\alpha}_{il}-p^{\alpha}_{ju},\quad z^{\alpha}_{iju}=p^{\alpha}_{iu}-p^{\alpha}_{jl}$$

If $z^{\alpha}_{ijl}>0$ for $\alpha\in[0, 1]$, then alternative A_i is absolutely preferred to A_j. If $z^{\alpha}_{ijl}<0$ for $\alpha\in[0, 1]$, then alternative A_i is not absolutely preferred to A_j. If $z^{\alpha}_{ijl}<0$ and $z^{\alpha}_{ijl}>0$ for some α values, we define e_{ij} as a fuzzy preference relation between alternatives A_i and A_j to represent the degree of preference of alternative A_i over alternative A_j. The e_{ij} is defined as:

$$e_{ij}= S_1/S,\ S>0 \qquad (5)$$

$$S_1=\int_{x>0}\mu_{\underline{Z}ij}(x)dx\ ,\ S_2=\int_{x<0}\mu_{\underline{Z}ij}(x)dx\ ,$$

$$S=S_1+S_2$$

The value of e_{ij} is the degree of preference of alternative A_i over alternative A_j and $\mu_{\underline{Z}ij}(x)$ is the membership function of $\underline{P}_i(-)\underline{P}_j$.

Intuitively, S_1 indicates the portion where alternative A_i is preferred to alternative A_j in the most favorable situation. The e_{ij} indicates the over degree of preference of alternative A_i over alternative A_j. An illustration of calculating e_{ij} is shown on Fig.1. Therefore, $e_{ij}>0.5$ indicates the alternative A_i is preferred to alternative A_j. If $e_{ij}=0.5$ then there is no difference between alternatives A_i and A_j. If $e_{ij}<0.5$ then alternative A_j is preferred to alternative A_i.

Table 1 – Linguistic variables for the importance weight of criterions

Very low (VL)	(0, 0, 0.1)
Low (L)	(0, 0.1, 0.3)
Medium low (ML)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium high (MH)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.9, 1.0)
Very high (VH)	(0.9, 1.0, 1.0)

Table 2 – Linguistic variables for the ratings

Very poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very good (VG)	(9, 10, 10)

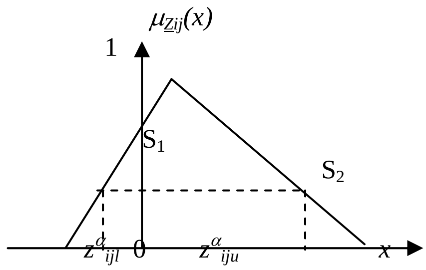

Fig. 1. An illustration of calculating e_{ij}

Using the fuzzy preference relation, we can construct a fuzzy preference relation matrix as:

$$\boldsymbol{E} = [e_{ij}]_{\mathrm{m \times m}} \qquad (6)$$

The fuzzy preference relation matrix represents the degree of preference of each pair alternatives. According to the fuzzy preference relation matrix $\boldsymbol{E}$, the fuzzy strict preference relation matrix can be defined as:

$$\boldsymbol{E}^{S} = [e^{S}_{ij}]_{\mathrm{m \times m}} \qquad (7)$$

$$e^{S}_{ij} = \begin{cases} e_{ij} - e_{ji}, \textit{when } e_{ij} \geq e_{ji} \\ 0, \quad \textit{otherwise} \end{cases} \qquad (8)$$

The value of e^{S}_{ij} is a degree of strict dominance of alternative A_i over alternative A_j. Then, the non-dominated degree of each alternative A_i $(i=1, 2, \ldots, m)$, can be determined by using the fuzzy strict preference relation matrix as:

$$\mu^{ND}(A_i) = \min_{j \in \Omega}\{1 - e^{S}_{ji}\} = 1 - \max_{j \in \Omega} e^{S}_{ji} \qquad (9)$$

where $\mu^{ND}(A_i)$ is the non-dominated degree of each alternative A_i and Ω is a set of alternatives.

A large value of $\mu^{ND}(A_i)$ indicates that the alternative A_i has a higher non-dominated degree than others. Therefore, we can use the $\mu^{ND}(A_i)$ values to rank a set of alternatives. The ranking procedure is described as follows:

(i) Set K=0 and $\Omega=\{A_1,\ldots,A_m\}$.

(ii) Select the alternatives which have the highest non-dominated degree, say A_h, $\mu^{ND}(A_h) = \max_i\{\mu^{ND}(A_i)\}$. Set the ranking for A_h as $r(A_h) = K$+1.

(iii) Delete the alternatives A_h from Ω, i.e. $\Omega=\Omega \backslash A_h$. The corresponding row and column of A_h are deleted from the fuzzy strict preference relation matrix.

(iv) Recalculate the non-dominated degree for each alternative A_i, $A_i \in \Omega$. If $\Omega=\emptyset$, then stop. Otherwise, set K=K+1, and return to step (ii).

3. SIMULATION RESULTS

We have developed application in Matlab that enables selection of a city for establishing a new base station. A graphical output will be obtained in order to enable easy and effective application of our work for end-users. We will illustrate a problem with three decision-makers D_1, D_2 and D_3, three alternative locations, and five decision criteria. After preliminary screening, three candidate-cities A_1, A_2 and A_3 remain for further evaluation. The company considers the following five criteria to select the most suitable candidate:

(1) investment cost (C_1),
(2) area coverage (C_2),
(3) population covered (C_3),
(4) location reachability (C_4),
(5) interference with other signals (C_5),

The benefit and cost criteria set are $B=\{C_2, C_3, C_4, C_5\}$ and $C=\{C_1\}$, respectively. The hierarchical structure of this decision problem is shown in Fig. 2.

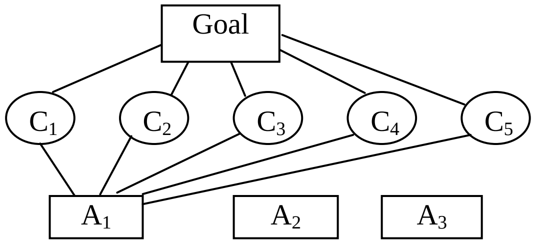

Fig. 2. The hierarchical decision structure.

The proposed method is currently applied to solve this problem. The computational procedure is summarized as follows:

Step 1: The decision-makers use the linguistic weighting variables (from Table 1) to assess the importance of the criteria and present it in Table 3. The fuzzy weight of each criterion calculated is given in Table 4.

Step 2: The decision-makers use the linguistic rating variables (shown in Table 2) to evaluate the rating of alternatives with respect to each criterion and reset in Table 5.

Step 3: According to Table 4, the fuzzy decision matrix is constructed as shown in Table 6.

Step 4: Construct the fuzzy normalized decision matrix as shown in Table 7.

Step 5: The final fuzzy evaluation values of three alternatives are calculated as:

$\underline{P}_1$=(1.83, 2.97, 3.91)
$\underline{P}_2$=(2.61, 3.89, 4.73)
$\underline{P}_3$=(2.46, 3.77, 4.63)

Step 6: The difference between two final fuzzy evaluation values are calculated as:

$\underline{P}_1$ (-) $\underline{P}_2$=(-2.90, -0.92, 1.30)
$\underline{P}_1$ (-) $\underline{P}_3$=(-2.80, -0.80, 1.45)
$\underline{P}_2$ (-) $\underline{P}_3$=(-2.02, 0.12, 2.27)

Step 7: Construct the fuzzy preference relation matrix:

$$\boldsymbol{E} = \begin{bmatrix} 0.50 & 0.18 & 0.22 \\ 0{,}82 & 0.50 & 0.58 \\ 0.78 & 0.42 & 0.50 \end{bmatrix}$$

Step 8: Construct the fuzzy strict preference relation matrix as:

$$\boldsymbol{E}^{S} = \begin{bmatrix} 0 & 0 & 0 \\ 0{,}64 & 0 & 0.16 \\ 0.56 & 0 & 0 \end{bmatrix}$$

Step 9: Compute the non-dominated degree of each alternative A_i (i=1, 2, 3) as:

$\mu^{ND}(A_1)$ = 0.36; $\mu^{ND}(A_2)$ = 1.00; $\mu^{ND}(A_3)$ = 0.84;

Table 3 – The importance weight of the criteria

	D_1	D_2	D_3
C_1	H	VH	VH
C_2	H	H	H
C_3	MH	H	MH
C_4	MH	MH	MH
C_5	H	H	H

Table 4 – The fuzzy weights of the criteria

	C_1	C_2	C_3	C_4	C_5
Weight	(0.83, 0.97, 1)	(0.7, 0.9, 1)	(0.57, 0.77, 0.9)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1)

Table 5 – The ratings of the three candidates by decision-makers under all criteria

Criteria	Candid.	D_1	D_2	D_3
C_1	A_1	6 mil	8 mil	7 mil
	A_2	3 mil	4 mil	5 mil
	A_3	4 mil	5 mil	6 mil
C_2	A_1	G	VG	F
	A_2	VG	VG	VG
	A_3	MG	G	VG
C_3	A_1	F	G	G
	A_2	G	G	G
	A_3	G	MG	VG
C_4	A_1	VG	G	G
	A_2	G	G	G
	A_3	G	VG	VG
C_5	A_1	F	F	F
	A_2	G	F	G
	A_3	G	G	G

Table 6 – The fuzzy decision matrix

C_1	C_2	C_3	C_4	C_5
A_1 7m.	(6.3,8,9)	(5.7,7.7,9)	(7.7,9.3,10)	(3,5,7)
A_2 4 m.	(9,10,10)	(7, 9, 10)	(7, 9, 10)	(5.7,7.7, 9)
A_3 5 m.	(7, 9,10)	(7, 9, 10)	(8.3,9.7,10)	(7, 9, 10)

Table 7 – The fuzzy normalized decision matrix

	C_1	C_2	C_3	C_4	C_5
A_1	0.6	(0.6,.8,.9)	(0.6,0.77,0.9)	(0.77,0.9, 1)	(0.3,0.5, 0.7)
A_2	1	(0.9,1, 1)	(0.7, 0.9, 1)	(0.7,0.9,1)	(0.57,0.7, 0.9
A_3	0.8	(0.7,0.9,1)	(0.7, 0.9, 1)	(0.8,0.97, 1)	(0.7,0.9,1)

Step 10: The alternative A_2 has the highest non-dominated degree and set $r(A_2)=1$.
Step 11: Delete the alternative A_2 from the fuzzy strict preference relation matrix.
Step 12: After deleting the alternative A_2, the new fuzzy strict preference relation matrix is:

$$\boldsymbol{E}^S = \begin{array}{c} \\ A_1 \\ A_3 \end{array} \begin{array}{c} \begin{array}{cc} A_1 & A_3 \end{array} \\ \begin{bmatrix} 0 & 0 \\ 0.56 & 0 \end{bmatrix} \end{array}$$

The non-dominated degree of alternatives A_3 and A_1 are 1.0 and 0.44 respectively. Therefore, $r(A_3)=2$ and $r(A_1)=3$. The ranking order of the three alternatives is $\{A_2\}>\{A_3\}>\{A_1\}$. Therefore, the city A_2 is the best location to establish a new base station. We can see that the proposed method not only allows decision-makers to determine the ranking order of alternative alternatives but also can indicate the degree of preference of each pair of alternatives. Therefore, it is more suitable and effective in dealing with subjective judgments in an imprecise environment.

4. CONCLUSION

In this paper we have proposed a new fuzzy multiple criteria group decision-making method for solving the problem of base station (BS) location. In BS location selection, very often, the assessment of alternatives with respect to criteria and the importance weight of criteria are given in linguistic variables. We have presented a stepwise and objective method to determine the ranking order of fuzzy numbers. Even though seven levels of linguistic values are designated in the rating and weighting scales of this study, based on the need of cognitive perspectives and the available data characteristics, the number of levels can be adjusted correspondingly.

In this paper – a systematic and objective method is proposed to deal with BS location selection problem. The proposed method can help the decision-maker to make a suitable decision under fuzzy environment. In addition, the proposed method can also be performed easily with other aggregation functions [6], to aggregate the fuzzy ratings of experts or decision-makers.

We have realized simulation in Matlab, and solved different examples of decision-making tasks for selecting the base station location. We've illustrated a problem with three decision-makers, three alternative locations, and five decision criteria. A graphical output is obtained in order to enable easy and effective application of our work for end-users.

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PROJECT ASSIGNMENT PROBLEM SOLVED BY NEURO-FUZZY INFERENCE SYSTEM

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Abstract. *The project assignment problem is one of the most important decision issues for the managers in the large corporations. In this paper we propose a new neuro-fuzzy inference system that will help human decision-makers. We show that human-like decisions can be achieved with the proposed method. ANFIS (adaptive neuro-fuzzy inference system) is a method for fuzzy modeling that learns information about a data set, in order to compute the membership functions that best allow the associated fuzzy inference system to track the given input/output data. We have applied two methods for generating the rule base – starting from empty rule base (command line version) and starting with initial rule base (GUI version). For the training and testing sets – we have used student polls about job preference. Finally, we have realized simulation in Matlab, and solved different examples of decision-making for the project assignment problem.*

Keywords: Neuro-fuzzy inference system, project assignment problem, adaptive systems, uncertain decision-making.

1. INTRODUCTION

The composition of project teams is one of the key roles of the project managers in the large corporations. It is an essential task to assign the right job to a right person. There are many factors that have impact on the assignment process. Sometimes – conflict criteria appear that make the decision process more complex. In many companies – the managers are doing these assignments manually – without taking into consideration the personnel expertise, their experience, type of the project, employees' preferences etc. Our work is a try to create an automated tool that will assist during the project assignment process, i.e. intelligent decision-making technique.

The job assignment problem (JAP) is non-trivial and known to be a member of the class of NP-hard problems, and therefore in many cases it is even very difficult to find a "reasonable solution in a reasonable time". Also, this problem is omnipresent in and highly relevant to many industrial application domains like product manufacturing and workflow organization. This is because the JAP constitutes the core of most scheduling tasks, and the effectiveness and efficiency of whole companies and organizations is therefore often considerably affected by the way in which they solve this problem in its concrete appearance. The basic variant of the JAP studied here requires assigning jobs to executing staff such that the overall completion time is reduced, where there may be dependencies among the individual jobs and differences in the execution abilities of the individual workers. Obviously, the JAP inherently allows parallelism and distributivity, simply because the jobs to be executed can be distributed over several people, and, because the workers can execute different jobs in parallel.

There are several attempts to employ intelligent techniques for solving the job assignment problem – Jain [7] used learning machines, Kondadadi et all. [1] applied evolutionary computing, while Liang et all. [8] used neural nets for US Navy personnel assignment model.

We propose here – an adaptive neuro-fuzzy inference system (ANFIS) which can learn to make human-like decisions and uses fuzzy membership functions for the soft constraints (input variables). For our study – we chose three widely used soft constraints. The goal is to find the most appropriate decisions resulting from fuzzy rules, for matches between projects and employees. Further goal is to extract a small number of fuzzy rules, which are still very effective without giving up robustness.

Even though managers may face some difficulties in defining the real factors, the use of fuzzy membership functions is convenient, because they can easily express their decisions in terms of linguistic descriptions (low, medium, high) for the input constraints, as well as for the overall match between the projects and the employees. However, some managers may provide fairly diverse decisions, due to their personal experience, not to mention emotions, subjective factors, mistakes etc. Moreover, manager decisions are highly correlated and virtually non-deterministic. One manager can make 20% difference in decision even if the same data would be presented to him at a different time. Such indeterminate subjective component makes the optimization a very sophisticated task, very suitable for artificial intelligence solution.

This paper is organized as follows: in Section 2 – the problem of project assignment is described; in Section 3 – the design of an adaptive neuro-fuzzy inference system (ANFIS) is given. In Section 4 – the simulation results are presented, and in Section 5 – concluding remarks are provided.

2. PROJECT ASSIGNMENT PROBLEM

In this section we'll give short overview of the project (job) assignment problem. The JAP as it is considered within the frame of the work described here can be formally described as follows. Let J = {J1,…, Jn} be a set of jobs and N = {N1,…,Nm} be a set of workers, where each job can be executed by at least one of the workers (n, m $\in$ N). The problem to be solved is to find an assignment of the jobs to the workers such that the overall time required for completing all jobs contained in J is minimal. Because this problem is NP-hard, usually it is reformulated such that it is just required to find an almost optimal solution in polynomial time.

Here, for solution of the project assignment problem - we mainly consider supervised learning methods. In large corporations – usually all projects and all employees are put in two separate databases. First automation of the decision process can be done if every employee is joined with all possible projects – that satisfy his hard constraints (preferences = desires). So – we can form unique group for each employee, and we'll denote it with a group id. The numbers of projects in each group will be counted and normalized to fit the unit interval [0, 1]; this will be used later for decision refinement. This is important because the outputs (decisions made by managers) are highly correlated: there is typically one project offered to each employee. The data can be presented to a manager, who will make decisions (project offers), based on the following three widely used soft constraints (input variables):

- Duration of the project (in weeks);
- Type of the project (its complexity);
- Pay-grade match (the earning that the employee will get from the project).

Note that decisions can be made sequentially and independently. This simulates the typical task a manager normally faces: offer a project to a given employee at the given time from a given list of possible projects, not considering other employees, projects that will be available in future etc. Of course, the employee does not have to accept the offered project and various other things may happen until the project starts.

For our adaptive neuro-fuzzy inference systems, we've performed training using students polls about project preferences (30 students were questioned). Decisions for projects to be offered have been individually evaluated for the best result in our model, and it was determined that even the misclassified predictions would make sense as real human-like decisions based on the given soft constraints. Due to the fact that we use fuzzy membership functions and that sometimes – two or more jobs could equally or nearly equally satisfy the given soft constraints, the highest value may not be easily available. In our simulation – we would prefer to come up with a small set (from 1 to 4 possible projects) offered to a given employee. Actually – in real life, it is also acceptable to offer 3 projects to employees to choose from.

3. ADAPTIVE NEURO-FUZZY INFERENCE SYSTEM (ANFIS)

The basic idea behind these neuro-adaptive learning techniques is very simple. These techniques provide a method for the fuzzy modeling procedure to learn information about a data set, in order to compute the membership function parameters that best allow the associated fuzzy inference system to track the given input/output data. This learning method works similarly to that of neural networks. The adaptive neuro-fuzzy inference system uses a given input/output data set, and constructs a fuzzy inference system (FIS) whose membership function parameters are tuned (adjusted) using either a back-propagation algorithm alone, or in combination with a least squares type of method. This allows your fuzzy systems to learn from the data they are modeling. The parameters associated with the membership functions will change through the learning process. The computation of these parameters (or their adjustment) is facilitated by a gradient vector, which provides a measure of how well the fuzzy inference system is modeling the input/output data for a given set of parameters. Once the gradient vector is obtained, any of several optimization routines could be applied in order to adjust the parameters so as to reduce some error measure (usually defined by the sum of the squared difference between actual and desired outputs).

Applying a neuro-fuzzy inference system for the project assignment problem is quite natural, because of the similarity to real life human decision-making. Some of the design issues were the following:

- Number of input membership functions: the fuzzy membership functions were set up based on knowledge of the managers. We determined that three membership functions (low, medium, high) for each of the three input variables model manager's decisions well.

- Type of input membership functions: based on the properties of the input variables – we considered triangular membership functions, but trapezoid, Gaussian and bell-shaped MFs were tested as well.

- Type of the output membership function: we used a single output, obtained using weighted average defuzzification. All output membership functions had the same type and were either constant or linear.

- The output variable is "employee-project likelihood" and the number of output membership functions ranged from 2 to 81.

- The number of rules: for a well defined fuzzy system – we need to define fuzzy output for every possible combination of input MFs values. If the training set doesn't include examples for given combination of values, but the testing set does, then in the testing phase we may still guess the output value using the aggregate distance function from all the learned fuzzy rules. This can be done before the actual testing phase begins resulting in a fully defined fuzzy system. In our case (3 input variables and 3 MFs) – there are $27=3^3$ fuzzy rules, where the linguistic values were not negated, and they were connected with "and" relation.

However, through rule extraction and combination of rules – we will drastically decrease the number of rules.

- Performance function: some of the widely used performance functions in neural networks are Sum of the squared error and Mean squared error. To verify training performance – we can also verify the correct classification rate.

- Optimization methods: back-propagation and hybrid (mixed least squared and back-propagation) methods were used as optimization methods.

- The data was partitioned into 3 sets: training, testing and cross-validation: the range of the training data set size was 50-90%. The cross-validation and the testing data sets each took half of the rest of the data (5-25%). The use of cross-validation is optional, but in our simulation is important, to avoid over-training.

- Number of training epochs – in most runs it was set up to 50 epochs.

Through an adaptive neuro-fuzzy inference system, the range of the membership functions are learned, fuzzy rules are created, and their weights are adjusted in order to better model the training data. The performance function values are calculated and classification is provided.

4. SIMULATION RESULTS

Our simulation was made in Matlab/ Fuzzy Toolbox. We used triangular, trapezoid and Gaussian as input membership functions, but triangular performed best in comparison with other types of MFs. Linear output membership functions performed better than constant ones.

For optimization method – the back-propagation and hybrid method performed similarly regarding the performance function and classification, but the hybrid method's running time was about 5 times as long as that of back-propagation's.

We have applied two methods for generating the rule base – starting from empty rule base (command line version) and starting with initial rule base (GUI version). The obtained results in both cases were very similar (comparison is given bellow).

Fig. 1 shows the ANFIS structure with its generated rules. The layered structure from left to right is the following:

Layer 1 – input neurons, three input neurons for the three input variables.

Layer 2 – input membership functions – three triangular membership functions for each input neuron.

Layer 3 - fuzzy rule left hand sides, each connected to 3 input membership functions.

Layer 4 - output membership functions (right hand sides) – the right hand side rules are in one to one relation with the left hand side rules.

Layer 5 – aggregated output, each output membership function gets aggregated along with the weight they carry.

Layer 6 – Output (decision).

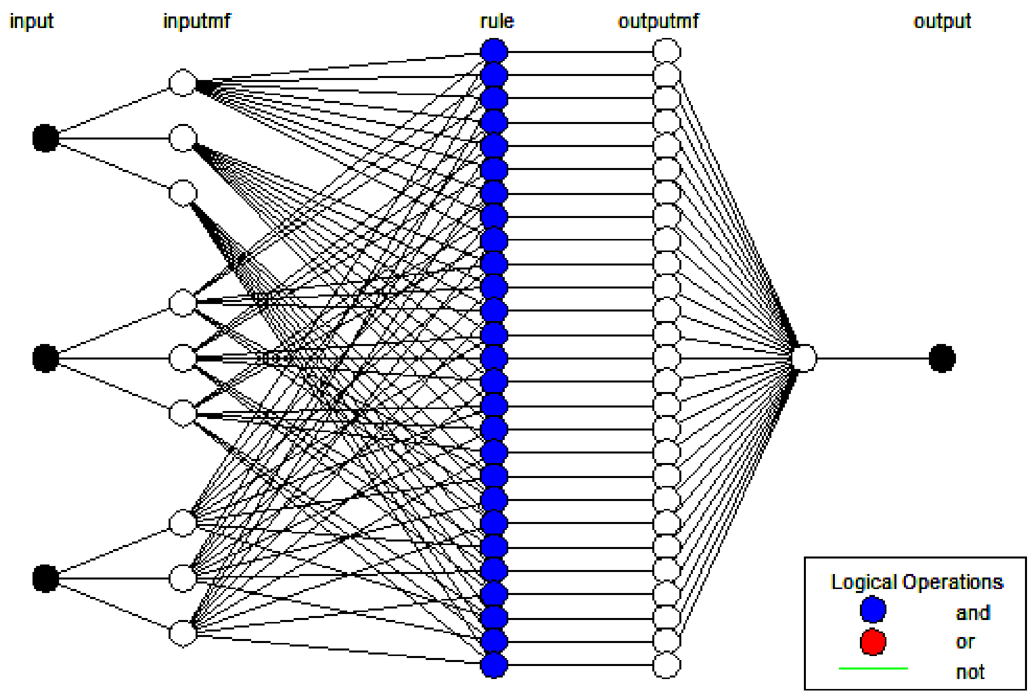

Fig. 1. ANFIS structure with the generated rules.

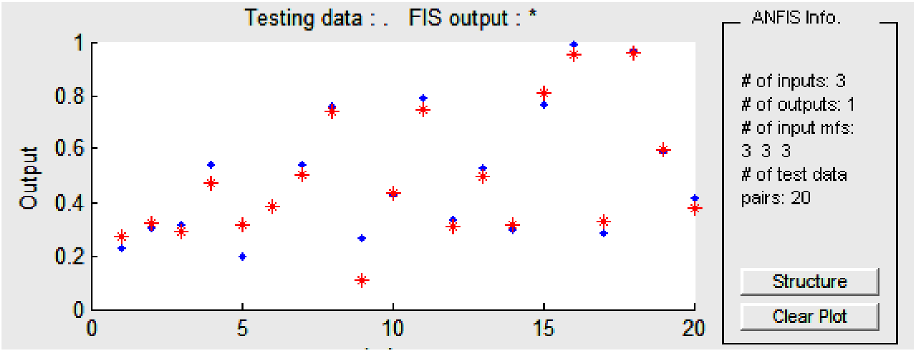

Fig. 2. Testing data vs. actual FIS output.

The training data are obtained from students and employees polls about their preference of certain projects. Table 1 shows the learned triangle membership function values after rounding. It is obvious that for all three constraints (input variables) – the leftmost membership functions maximum is close to 0. On Fig. 2 is shown the set of testing data vs. the real values of the FIS output.

Table 1 – Membership functions after training

mf1	mf2	mf3
dur_low= [-9.6 0 9.6]	comp_low= [-4 0 4]	pay_low= [-40 0 40]
dur_med= [2.4 12 21.6]	comp_med= [1 5 9]	pay_med= [10 50 90]
dur_hi= [14.4 24 33.6]	comp_hi= [6 10 14]	pay_hi= [60 100 140]

Table 2 – Comparison of output values before and after ANFIS training.

	Before training	After training
Largest difference	mf6= [0.0004 0.0001 0.0056 5e-05]	mf6= [-0.00052 -0.00029 -0.0046 -5.83e-05]
Smallest difference	mf1= [0.017 0.016 0.021 0.0045]	mf1= [0.01678 0.01062 0.0221 0.004419]
Average difference	mf19= [0.00012 .0007 0.001 1e-05]	mf19= [0 0 0 0]

Further improvement of this research will be to extract a small number of rules, which can reliably predict projects to be offered based on fuzzy membership function values. Rule extraction can not further improve performance, but it can increase speed and efficiency for further training.

5. CONCLUSION

In this paper – the project assignment problem is solved by an adaptive neuro-fuzzy inference system. We showed that human-like decisions can be achieved with the proposed method. ANFIS (adaptive neuro-fuzzy inference system) is a method for fuzzy modeling that learns information about a data set, in order to compute the membership functions that best allow the associated fuzzy inference system to track the given input/output data. We have applied two methods for generating the rule base – starting from empty rule base (command line version) and starting with initial rule base (GUI version). For future research purposes – the number of fuzzy rules will be reduced, but it should held good performance as the original set of rules trained by the ANFIS for decision-making. For the training and testing sets – we have used employees' polls about job preference. Finally, we have realized simulation in Matlab, and solved different examples of decision-making for the project assignment problem.

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ANALIZA PREVERJANJA ZNANJA PLAVANJA PLAVALNIH TEČAJEV V REPUBLIKI SLOVENIJI S POMOČJO STROJNEGA UČENJA V PROGRAMU “ORANGE”

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POVZETEK

V prispevku želim prikazati primer s pomočjo orodja za strojno učenje kot ene od metod umetne inteligence pri reševanju problema oddaljenosti bazenov od osnovnih šol. Vsako leto poteka program »Preverjanje znanja plavanja« v osnovnih šolah, kjer osnovne šole oddajajo poročila prek spletne aplikacije. Za obdelavo podatkov in raznih analiz je bil uporabljen program »Orange«. S pomočjo orodja orange sem postavil hipotezo, kjer sem postavil temelje za nadaljnjo obdelavo podatkov. V drugi fazi sem analiziral podatke o preverjanju znanja plavanja in ugotovil, s katerimi parametri oz. atributi vplivajo na končni rezultat »uspešno opravljeno plavanje«. Na koncu sem podal svoje zaključke in vizijo za nadaljnje raziskave v področju preverjanja znanja plavanja.

Ključne besede:
Orange, strojno učenje, preverjanje znanja plavanja

1 UVOD

V Sloveniji od leta 1994/1995 poteka program »Odpravljanje plavalne nepismenosti«, ki se je z Zakonom o športu in Nacionalnem programom športa preimenoval v interesni program »Naučimo se plavati« [1] [2]. Z leti je postal sistematično organiziran sistem dejavnosti na področju plavanja, ki vsebuje izpeljavo učenja plavanja, preverjanja znanja plavanja, analizo o znanju plavanja, skrb za strokovni kader, literature, plavalno infrastrukturo in osveščanje prebivalcev o pomenu znanja plavanja [8].

Iz spletne aplikacije je znanje plavanja v šolskem letu 2006/2007 po preverjanju je 89,7%. Od 450 slovenskih šol so popolne podatke o preverjanju znanja plavanja poslale 403 šole. Tako je bila 89,6 % udeležba šol. Tako je bilo v šeste razrede in pete osemletke vpisanih 18531 otrok. Skupaj smo zbrali podatke od 16805 otrok, kar predstavlja 90,6 odstotkov vseh slovenskih šestošolcev in petošolcev osemletke [3].

2 NAMEN IN CILJ

Namen seminarske naloge je reševati problem uspešnosti skupine, ki se udeležila preverjanja znanja plavanja, s pomočjo strojnega učenja. Strojno učenje (angleško *Machine Learning*, nemško *Maschinelles Lernen*) pomeni pridobivanje znanja na podlagi izkušenj [7]. Ne gre za učenje na pamet, ampak za iskanje pravil v učnih podatkih. Tako lahko dobimo odgovor tudi na vprašanje, ki ni sodelovalo pri učenju. Med drugim se ta pristop danes uspešno uporablja na področju analize podatkov in iskanja zakonitosti v podatkih [4]. Strojno učenje izhaja iz podatkov, ki praviloma opisujejo konkretne primere preteklih dogodkov, odločitev ali aktivnosti. Algoritem strojnega učenja iz teh primerov zgradi (“se nauči”) splošno pravilo, ki naj bi praviloma:

- na človeku čim bolj razumljiv način opisalo zakonitosti, ki nastopajo v množici primerov, ter
- omogočilo odločanje oziroma napovedovanje izida pri novih dogodkih modeliranega sistema.

Poleg tega se med postopkom strojnega učenja pogosto pokažejo protislovja in “praznine” v učnih primerih, kar je lahko znak in opozorilo na napačno ravnanje v preteklosti [5].

Strojno učenje bom uporabil v področju interesnega programa »Naučimo se plavati – Preverjanje znanja plavanja«. Namreč, vsako leto osnovne šole izvajajo preverjanje znanja plavanja, kjer na podlagi izvedenih tečajev ugotovijo koliko so uspešni učenci/učenke in v kolikšni meri imajo odstotek plavalcev (po področnih centrih, po občinah ipd.). Ugotoviti bi bilo smiselno, ali vpliva oddaljenost bazena (tisti, ki imajo bazen v sami šoli oz. se morajo zapeljati do 10 km ali pa tisti, ki se morejo peljati več kot 10km) na uspešnost preverjanja znanja plavanja. Prav tako ali vpliva število udeležencev na samo uspešnost plavanja.

3 METODOLOGIJA

Podatke sem pridobil iz spletne aplikacije, kjer osnovne šole uporabljajo za izpolnjevanje in izdajo zahtevkov za sofinanciranje tečajev. Podatke sem analiziral s pomočjo računalniškega programa Orange. Metodološko sem pripravil v štirih fazah:

- Priprava podatkov iz spletne aplikacije (izvoz in obdelava)
- Strojno učenje s pomočjo programa Orange
- Analiza podatkov v računalniškem program
- Analiza končnih rezultatov

3.1 Priprava podatkov

Podatke sem pridobival iz spletne aplikacije »Naučimo se plavati«. Aplikacija je namenjena vsem osnovnim šolam, vrtcem, osnovnim šolam s prilagojenim programom in srednjim šolam. Podatke sem izvozil iz spletne aplikacije v MS Excel datoteko (samo tečaje iz preverjanja znanja plavanja ter iz šolskega leta 2007/2008).

Nabor podatkov:

- Seznam vsebuje podatke iz 13 področnih centrov (skupaj jih je 16).
- Iz baze je zajetih 120 tečajev preverjanj znanj plavanja.
- Tabela vsebuje podatke o oddaljenosti bazena od šole (do 10 km in nad 10km).
- V stolpcu »Preverjanje« sem definiral diskretno spremenljivko (Uspešno, Neuspešno). V Nacionalnem programu, ki ga je opredelil Ministrstvo za šolstvo in šport piše, da se odstotek plavalcev v Sloveniji »dvigne« na 81%. Tako sem upošteval, da če je odstotek plavalcev (iz stolpca »% plav.«) do 80% je preverjanje neuspešno, če je nad 80% pa je preverjanje uspešno.

3.2 Strojno učenje s programom "Orange"

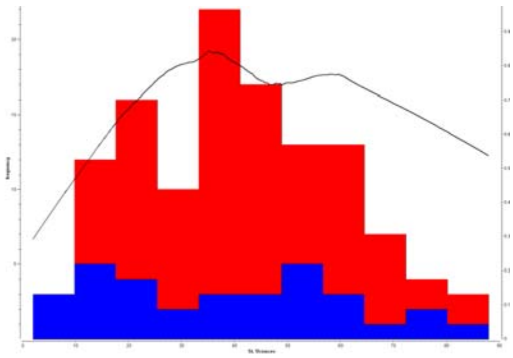
Gre za dobro dokumentirano in obsežno orodje, zgrajeno na principu odprte kode, ki uporablja komponentno zasnovo, z uporabniške strani pa podpira skriptiranje v programskem jeziku Python in vizualno programiranje. Orange je odlično orodje za izdelavo in testiranje prototipnih rešitev, ter zaradi obilice že razvitih komponent primerno okolje za uporabo v okviru raznih nalog [6]. V seminarski nalogi bi tako lahko uporabili Orange za reševanje kakšnega praktičnega problema, ali pa ga nadgradili s kakšno novo metodo (npr., novega načina vizualizacije podatkov, nove metode za strojno učenje, izboljšavo obstoječih metod, ipd.). Orange grafični uporabniški vmesnik, ki uporablja princip vizualnega programiranja.

Orange orodje se uporablja tako, da na »PLATNO« (ang. Canvas) postavljamo iz različnih zavihkov komponente (ang. WIDGETS). Vsaka komponenta ima svojo funkcionalnost. Povezujemo jih tako, da z miško kliknemo na »modri kvadratek« poleg same komponente in držimo do naslednje komponente ter spustimo. Predno se lotimo uporabe orodja Orange je potrebno Excel tabelo s podatki uvoziti v »tab delimited« formatu (prenos v beležnico z presledki (končnica je .tab).

3.3 Postavitev hipoteze

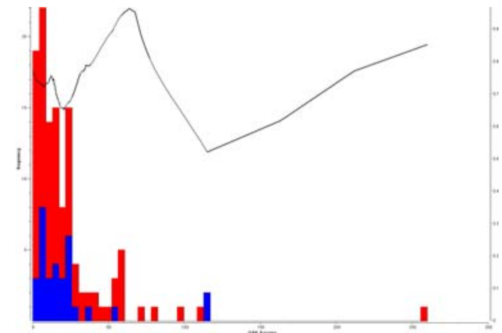
Podatke oz. datoteko s podatki prenesemo v prvo komponento »File« (glej sliko 4). Komponenta samo prebere vse podatke iz datoteke. Tukaj sem imel težave pri prenosu, kjer sem ugotovil, da ima orodje Orange težave z prepoznavanjem šumnikov (š, č, ž). Ko sem odpravil vse šumnike med podatki, sem lahko prenesel podatke v komponento »File«. Da bi preveril ali sem vse podatke prenesel, sem si pomagal z komponento »Data Table«, kjer vidim vse svoje prenesene podatke. S komponentami »Distribucija« (ang. Distributions) in »Razsevni diagram« (ang. Scatterplot) si lahko nastavljam poljubne grafe, kjer si postavim hipotezo za nadaljnjo raziskavo.

S pomočjo grafa »Distribucije« (ang. Distributions) sem najprej raziskal kaj lahko ugotovim s podatki. Slika 1 prikazuje, da se uspešnost preverjanja znanja plavanja najbolj izvede, če se tvori skupina med 35 in 45 udeleženci (to se vidi kako velik je rdeči stolpec, ki prikazuje uspešnost preverjanja). Graf mi predstavlja prvi značilni atribut, ki mi bo napovedoval dogodke pri nadaljnji analizi.



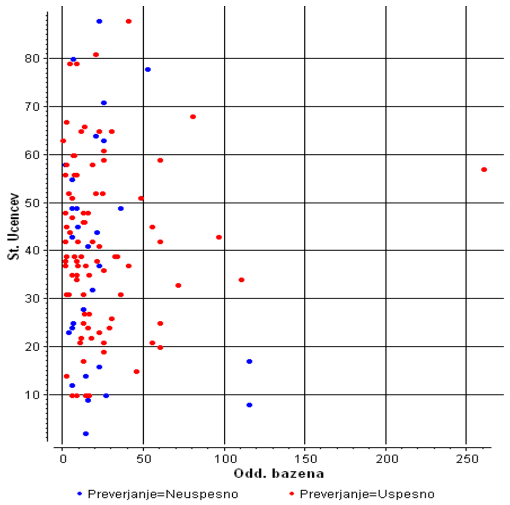
Slika 1: uspešnost preverjanje glede na število udeležencev

Slika 2 prikazuje naslednji atribut, in to je oddaljenost bazena od šole. Kakor se vidi iz samega grafa, lahko sklepam, da je največja verjetnost, da se uspešno opravi tečaj plavanja, če se bazen nahaja v sami šoli (to pomeni 0 km) oz. da je oddaljen do 10 kilometrov. To je tudi drugi zelo pomemben atribut za postavitev moje hipoteze in nadaljnje obdelave podatkov.



Slika 2: oddaljenost bazena od osnovne šole

Še najbolje pa pokaže naslednja komponenta »Razsevni diagram«. Zelo zanimiva komponenta (meni osebno najbolj všeč), kjer se podatki za razliko od predhodnih dveh grafov prikazujejo v točkah (glej sliko 3). Vsaka točka prikazuje tečaj plavanja (bodisi uspešno ali neuspešno opravljen). Zanimivo pri tem grafu je to, da lahko primerjamo atribute med seboj. V mojem primeru sem primerjal kako oddaljenost bazena vpliva na število udeležencev. Kar je bilo ugotovljeno iz slike 1 in slike 2 se na tem grafu zelo dobro vidi, če skupino tvorijo 35 do 45 udeležencev se rdeče točke (pomeni uspešno opravljen tečaj) zelo bližajo ordinatni osi. To pomeni, da skupina uspešno opravi tečaj, če je bazen v šoli ali oddaljen do 10 km.

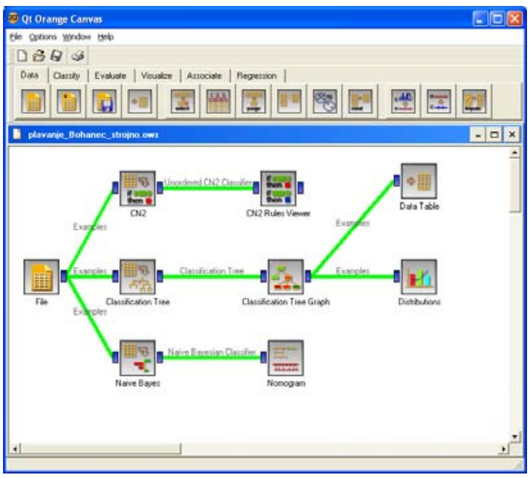


Slika 3: oddaljenost bazena od osnovne šole (razsevni diagram)

Zato lahko postavim naslednjo hipotezo: Skupina, ki bo sestavljena iz 35 do 45 udeležencev in bo imela bazen oddaljen do 10 km, bo uspešno opravila tečaj preverjanja znanja plavanja. Odstotek plavalcev bo več kot 80%.

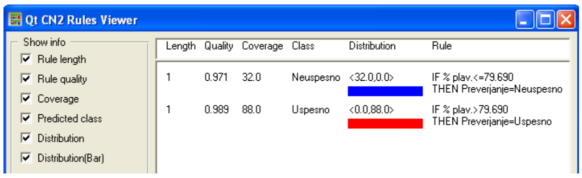
3.4 Analiza in rezultati

Ko sem postavil hipotezo za ta primer, se od tukaj pričnе »strojno učenje«. Slika 4 prikazuje komponente s katerimi si pomagam izdelati odločitveno drevo, odločitvena pravila in Naivni Bayesov model z komponento »Nomogram«.



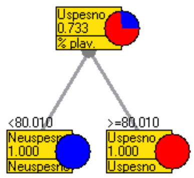
Slika 4: predstavitev sheme za pridobitev odločitvenih dreves

Komponenta »CN2« mi pomaga sestaviti odločitvena pravila, ki jih posreduje naprej »CN2 Rules Viewer«, kateri mi prikaže katera so to pravila. CN2 Rules Viewer nam avtomatsko prikazuje generirano hipotezo, ki nam služi za napovedovanje dogodka. V mojem primeru mi je komponenta odkrila samo dva odločitvena pravila (glej sliko 5). To ne pomeni, da je to slabo, ampak pomeni, da so podatki dobro zastavljeni in da se lahko na podlagi tega zelo dobro napovedujejo dogodki, kar priča tudi odločitveno drevo (glej sliko 6).



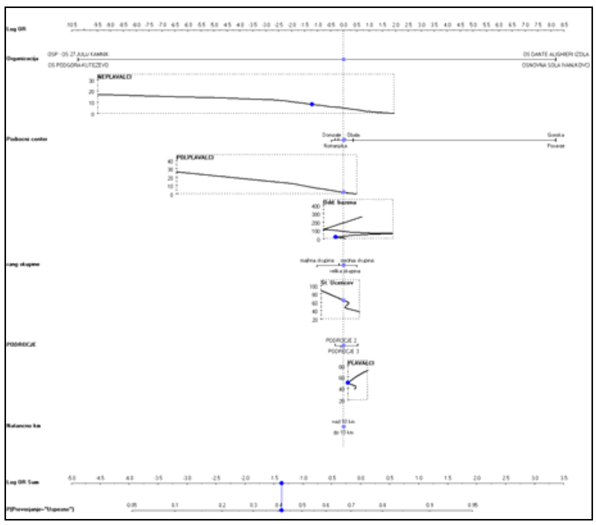
Slika 5: Odločitvena pravila

Naslednji komponenti »Classification Tree« in »Classification Tree Graph« nam sestavita oz. zgradita klasifikacijsko oz. odločitveno drevo. Odločitveno drevo nam pomaga pri napovedi dogodkov, s pomočjo podatkov, ki jih je prebral iz komponente »File«. Komponenta »Data File« nam v tabeli prikazuje rezultate, ki jih želimo videti na določenem delu odločitvenega drevesa (slika 4). Se pravi, kliknemo na enem delu odločitvenega drevesa ter opazujemo kateri so tisti podatki v komponenti »Data File«, ki so značilni za ta del drevesa. Iz slike 6 se vidi, da je na prvi ravni »%plavalcev«, kjer se deli na uspešno (nad 80%) in na neuspešno (do 80%).



Slika 6: Odločitveno drevo

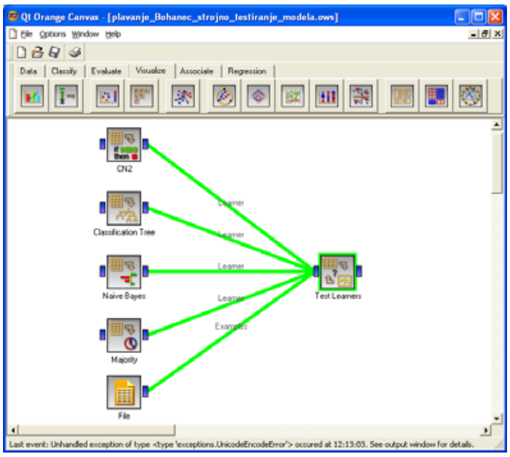
Naslednja slika (slika 7) prikazuje »Naivni Bayesov model«, ki je sestavljen iz dveh komponent (Naive Bayes, Nomogram).



Slika 7: Naivni Bayesov model

S pomočjo grafa iz slike 7 lahko vidim Apriorno verjetnost. Apriorna verjetnost pri »0« vrednosti je 73% napovedana uspešnost plavanja. Tukaj lahko na podlagi podatkov, ki jih dobim s strani pedagoga napovedujem, kakšna bo uspešnost za določeno skupino. To pedagogu predstavlja dodano

vrednost in si s tem že lahko pomaga pri oceni posamezne skupine. S pomočjo drsnikov, ki jih ima vsak atribut, si nastavi določene vrednosti ter ugotovi napovedano verjetnost uspešnosti plavanja.
Lahko se postavi vprašanje s strani pedagoga ali je dejansko moj model res dober, da mi v Naivnem Bayesovem modelu daje tako dobre rezultate. S pomočjo naslednje sheme (slika 8) lahko opravim test mojega modela in ugotovim klasifikacijsko točnost.
Vsem trem komponentam dodam še komponento »Večina« (ang. Majority), ki v bistvu vedno kaže pravilen rezultat in se nikoli ne zmoti (to komponento sem namenoma dal, da lahko primerjam z ostalimi komponentami). Komponenta »Test Learners«, pa mi naredi prečno preverjanje (v mojem primeru sem nastavil na 10 kratni test). To se izvede tako, če imamo 100 enot jih ta komponenta razdeli na 5 enakih delov. Eno petino skrije in ostalih štiri petine obdeluje, kjer se »nauči« napovedovati na podlagi teh podatkov. Na podlagi dobljenih rezultatov napoveduje dogodke za preostalo »skrito« petino in primerja dobljene rezultate.



Slika 8: shema za Klasifikacijsko točnost

Tako po testu imamo:
- za odločitvena pravila CN2 Klasifikacijsko točnost okoli 99%
- Odločitveno drevo ima klasifikacijsko točnost 98%
- Naivni Bayesov model ima klasifikacijsko točnost 96,7%

Rezultate, ki smo jih dobili iz slike 9 kažejo zelo visoke rezultate. Pomeni, da je moj model zelo dober in bo zelo dobro napovedoval uspešnost preverjanja znanja plavanja.
AUC nam pove kako dobro bi se odločali v praksi, če bi imeli dve skupini iz iste šole in enakega števila udeležencev, pri katerem bi se odločati kdo bo opravil uspešno preverjanje znanja plavanje in kdo ne.

4 ZAKLJUČEK

V zaključku bi rad poudaril, da je analiziranje in postavljanje hipotez za preverjanje znanja plavanja dalo zelo zanimive rezultate. Ne samo, da se iz hipoteze ugotovil, da uspešno skupino tvori med 35 in 45 udeleženci in da se uspešnost zazna tudi tam, kjer imajo blizu bazen (do 10km). Ampak s pomočjo metode umetne inteligence, kjer sem za strojno učenje izbral program Orange, sem lahko ugotovil tudi to, ko sem spreminjal podatke (nekatere stolpce sem zbrisal– področni center, oddaljenost bazena, naziv organizacije, % plavalcev), da so se v vseh komponentah spremenili podatki in prikazovali nove rezultate in nove ugotovitve. Pri spremenjenem odločitvenem drevesu sem opazil, kako je na prvem mestu (prva raven) postavljen atribut "NEPLAVALCI". To pomeni, da je program Orange ugotovil, da je zelo pomemben atribut in da se od neplavalcev naprej deli kateri so uspešni in kateri ne. Zakaj je do tega prišlo? Če ponovno pogledam Naivni Bayesov model (slika 7) lahko na tem grafu nastavim funkcijo, kjer mi prikazuje kateri atribut je najpomembnejši oz. najbolj vpliva na uspešnost plavanja. Prav tako dobim rezultat »NEPLAVALCI«.
Da bi dobil še bolj izpopolnjen model v Orange-u, bi moral za nadaljnje raziskave moj model nadgradil. To bi naredil tako, da bi posebej analiziral neplavalce in ugotovil atribute, ki vplivajo na »status« neplavalca. Tako bi ugotovil, kateri so tisti atributi znotraj neplavalcev, ki so pomembni in vplivajo pri napovedi dogodka za uspešnost. Mogoče vpliva na neplavalca atributi kot so motivacija, bojazen od vode, nima gibalnih sposobnosti ipd. Ko bi dobil tudi te podatke o neplavalcih, bi jih dodal namesto stolpca »Neplavalci« in umestil vse novo pridobljene atribute in nato opazoval, kaj se dogaja z modelom. Lahko bi bil to ključ za pridobitev celotne slike pri napovedi preverjanja znanja plavanja.

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TOWARDS RELATIONAL DATABASE SYSTEMS PERFORMING APPROXIMATE SEARCHES

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ABSTRACT

We enrich sets with an integrated notion of similarity, measured in a (complete) lattice, special cases of which are *reflexive sets* and *bounded metric spaces.* Relations and basic relational operations of traditional relational algebra are interpreted in such richer structured environments. An objective similarity measure between relations is introduced. In the case of reflexive sets, it turns out to be just the well known Egli-Milner ordering, but, in the case of bounded metric spaces, the Hausdorff metric.

1 INTRODUCTION

There are several applications that have evolved beyond the capabilities of traditional relational and object-oriented databases, such as applications that require databases to *cooperate* with the user by suggesting answers which may be helpful but were not explicitly asked for. The so-called *cooperative behaviour* or *cooperative answering* techniques [5] may be differentiated into the following categories:

i.) consideration of specific information about a user's state of mind,

ii.) evaluation of presuppositions in a query,

iii.) detection and correction of misconceptions in a query,

iv.) formulation of intensional answers,

v.) generalization of queries and of responses.

The cooperative behaviour plays an important part, for instance, in certain kinds of natural-language interfaces and dialogue systems [6], where the most vital cooperative-answering technique leading to user satisfaction is *query relaxation* as shown by Hajdinjak and Mihelič [7].

Another kind of development not covered by traditional data models are applications which require the database to be enhanced with a notion of *similarity* that allows one to perform *approximate* searches [8]. The goal in these applications is often one of the following:

i.) Find objects whose feature values fall within a given range or where the distance from some query object falls into a certain range (range queries).

ii.) Find objects whose features have values similar to those of a given query object or set of query objects (nearest neighbour queries and approximate nearest neighbour queries).

iii.) Find pairs of objects from the same set or different sets which are sufficiently similar to each other (closest pairs queries).

Examples of such approximate-matching or similarity-search applications are databases storing images, fingerprints, audio clips or time sequences, text databases where we look for words and phrases allowing a smaller number of typographical or spelling errors, or we look for documents that are similar to a given document, machine learning and classification applications where a new object must be classified according to the closest existing object, and computational-biology applications where we want to find a DNA or a protein sequence in a database allowing some errors due to typical variations.

This article focuses on traditional relational algebra [4] equipped with extra features that allow query relaxation and similarity searches. We will talk about domains, similarity, approximate answers, and nearness of data in a highly systematic and comprehensive way.

2 SETS WITH SIMILARITY

Traditional relational algebra [3,8] considers sets and relations between them, equipped with five basic operations: *Cartesian product* $\times$, *projection* π, *selection* σ, *union* $\cup$, and *set difference* $-$. A large body of work has addressed how to extend the relational data model to incorporate cooperativity, neighbouring information, and/or orderings [3,9,10,11] but neither of them have succeeded to fit into the representational and operational uniformity of traditional relational algebra or even to reach a certain degree of generality.

However, most applications and proposed solutions of non-exact matches and similarity search, which are not covered by traditional relational algebra, have some common characteristics – there is a universe of objects and a non-negative distance or distance-like function defined among them. The distance function, which can also be used to produce a ranked listing of non-exact matches to a query (top-k matches), measures how close are the non-exact matches to the exact specifications that were given by the user willing to accept approximate answers. Note, we speak of *similarity* instead of distance – if a point x moves toward a point y, the distance between x and y gets smaller, but their similarity gets larger.

Definition 1 *A* set with similarity *is an ordered triple*

$$\underline{A} = (A, L_A, \rho_A),$$

where A is the underlying set*,* L_A *is a complete lattice with the least element* 0_A *and the greatest element* 1_A*, and*

$$\rho_A : A \times A \to L_A$$

is a measure of similarity *in A satisfying the* reflexivity *condition*

$$\rho_A(x, x) = 1_A$$

for all $x \in A$.

For the domain of possible similarity values we have choosen complete lattices, i.e., partially ordered sets in which all subsets have both a least upper bound and a greatest lower bound. The definition works with partially ordered sets other than complete lattices (all that is required is a top element).

In the trivial case, if we take the complete lattice L_2 of boolean values $\{0, 1\}$ equipped with minimum and maximum as the operations meet and join, respectively, ordered with relation $\leq$, and define the similarity by $\rho(x, y) = 1$ if $x = y$, and $\rho(x, y) = 0$ if $x \neq y$, the resulting set with similarity gains no additional structure.

There are also non-trivial similarities, such as *reflexive sets* and *bounded metric spaces.*

Definition 2 *A* reflexive set *is an ordered pair* $(A, \lhd_A)$, *where A is the underlying set, and* $\lhd_A : A \times A \to L_2$ *is a reflexive relation in A. Habitually, instead of* $\lhd_A(x, y) = 1$ *we write* $x \lhd_A y$.

The reflexive set $(A, \lhd_A)$ can be transformed to the set with similarity $(A, L_2, \lhd_A)$ and embedded into sets with similarities.

Definition 3 *A* bounded metric space *is an ordered pair* (A, d_A), *where A is the underlying set, and*

$$d_A : A \times A \to [0, \infty]$$

is a distance function, which satisfies the conditions of non-negativity, symmetry, and triangle inequality.

While the modest generalization of allowing ∞ as a similarity value does not pose a serious restriction, it makes the set $[0, \infty]$, when ordered by the usual $\geq$ relation, a complete lattice $L_{[0,\infty]}$. The meet is computed as supremum and the join as infimum. Note that we turned $[0, \infty]$ *upside down* so that the least element is ∞ and the greatest is 0.

Hence the bounded metric space (A, d_A) can be transformed to the set with similarity $(A, L_{[0,\infty]}, d_A)$ and embedded into sets with similarities.

3 RELATIONS AND SIMILARITY

3.1 Generalized Relational Algebra

In order to use sets with similarity instead of (ordinary) sets we need a suitable notion of relation between sets with similarity. Hence we first need to know how to interpret Cartesian products and subsets of sets with similarity in a natural and effective way. Our proposal, which has proven successful, at least from the theoretical point of view, is contained in the following two definitions.

Definition 4 *The* Cartesian product *of sets with similarities* $\underline{A} = (A, L_A, \rho_A)$ *and* $\underline{B} = (B, L_B, \rho_B)$ *is the set with similarity*

$$\underline{A} \times \underline{B} = (A \times B, L_A \times L_B, \rho_{A\times B}),$$

where $A \times B$ *is the Cartesian product of sets,* $L_A \times L_B$ *is the product of complete lattices, and the measure of similarity* $\rho_{A\times B}$ *is given by*

$$\rho_{A\times B}((x_1, y_1), (x_2, y_2)) = (\rho_A(x_1, x_2), \rho_B(y_1, y_2)).$$

The corresponding canonical projections *are* $(\pi_1, p_1) : \underline{A} \times \underline{B} \to \underline{A}$ *and* $(\pi_2, p_2) : \underline{A} \times \underline{B} \to \underline{B}$*, where* π_1 *and* π_2 *are projections of sets, but* p_1 *and* p_2 *are projections of complete lattices.*

Definition 5 *A* subset *of the set with similarity* $\underline{A} = (A, L_A, \rho_A)$ *is a set with similarity* $\underline{I} = (I, L_A, \rho_A)$ *where* $I \subseteq A$*. Subsets of sets with similarities will also be called* induced subobjects.

Thus we only consider those subobjects $\underline{I}$ whose similarity is induced by the structure of $\underline{A}$. Such a subobject may be simply thought of as a subset $I \subseteq A$ of the underlying set A. The family of induced subobjects of $\underline{A}$, we will denote it by $IndSub(\underline{A})$, is essentially just the power set $\mathcal{P}(A)$. Consequently, for us a *relation* between $\underline{A}$ and $\underline{B}$ is determined by a subset $R \subseteq A \times B$, which induces a subobject $(R, L_A \times L_B, \rho_{A\times B})$.

In addition, selection, union, and difference are calculated as usual $(A_1, A_2 \subseteq A)$:

- $\sigma_F(A_1, L_A, \rho_A) = (\sigma_F(A_1), L_A, \rho_A)$,
- $(A_1, L_A, \rho_A) \cup (A_2, L_A, \rho_A) = (A_1 \cup A_2, L_A, \rho_A)$,
- $(A_1, L_A, \rho_A) - (A_2, L_A, \rho_A) = (A_1 - A_2, L_A, \rho_A)$.

Second, in order to properly interpret Cartesian products, projections, selections, unions, and differences of induced subobjects, they must satisfy all the abstract properties that are axiomatized by relational calculus [12,13]. This is shown by an easy calculation [6].

3.2 Similarity of Relations

We attempt to compare and measure the difference between induced subobjects of a set with similarity.

Definition 6 *Let $\underline{A_1}$ and $\underline{A_2}$ be two induced subobjects of the set with similarity $\underline{A} = (A, L_A, \rho_A)$. The* measure of similarity *ρ between them is defined as follows:*

$$\rho(\underline{A_1}, \underline{A_2}) = \\ = \Big(\bigwedge_{x \in A_1} \bigvee_{y \in A_2} \rho_A(x, y) \Big) \wedge \Big(\bigwedge_{y \in A_2} \bigvee_{x \in A_1} \rho_A(x, y) \Big),$$

where all the meets and joins are computed in the complete lattice L_A.

Note that arbitrary meets and joins appearing in the definition 6 require the lattice L_A to be complete. This was the reason why we decided to measure similarities in complete lattices and not in partially ordered sets or other structures with the top element (see definition 1).

Theorem 1 *Let $\underline{A_1}$ and $\underline{A_2}$ be two induced subobjects of the reflexive set $\underline{A} = (A, \lhd_A)$. The measure of similarity ρ from definition 6 reduces to $\lhd$, where:*

$$\underline{A_1} \lhd \underline{A_2} \iff (\forall x \in A_1\ \exists y \in A_2 : x \lhd_A y) \text{ and } (\forall y \in A_2\ \exists x \in A_1 : x \lhd_A y).$$

Observe that this naturally integrated ordering is well known as the *Egli-Milner ordering* [1].

Theorem 2 *Let $\underline{A_1}$ and $\underline{A_2}$ be two induced subobjects of the bounded metric space $\underline{A} = (A, d_A)$. The* measure of similarity *ρ from definition 6 reduces to d, where:*

$$d(\underline{A_1}, \underline{A_2}) = \\ = \max\{ \sup_{x \in A_1} \inf_{y \in A_2} \{d_A(x, y)\}, \sup_{y \in A_2} \inf_{x \in A_1} \{d_A(x, y)\} \}.$$

Metric d is well known as the *Hausdorff metric* [2]. It has several applications, for instance, in fractal geometry, in numerical mathematics, and in pattern recognition.

The following proposition states that the empty induced subobject is completely dissimilar to any other induced subobject, i.e., the degree of similarity is the lowest possible. For proofs see [6].

Theorem 3 *The similarity between the empty subobject $\underline{\emptyset}$ and any other induced subobject $\underline{A'}$ of the set with similarity $\underline{A} = (A, L_A, \rho_A)$ is equal to the least element of the complete lattice L_A:*

$$\rho(\underline{\emptyset}, \underline{A'}) = \rho(\underline{A'}, \underline{\emptyset}) = 0_A.$$

On the other hand, every induced subobject is most similar to itself.

Theorem 4 *For every induced subobject $\underline{A'}$ of the set with similarity $\underline{A} = (A, L_A, \rho_A)$, including the least induced subobject $\underline{\emptyset}$, it holds*

$$\rho(\underline{A'}, \underline{A'}) = 1_A,$$

where 1_A is the greatest element of the complete lattice L_A.

Note that a relation between two sets with similarities, namely $\underline{A} = (A, L_A, \rho_A)$ and $\underline{B} = (B, L_B, \rho_B)$, is determined by a subset $R \subseteq A \times B$, which induces a subobject

$$(R, L_A \times L_B, \rho_{A \times B})$$

of the Cartesian product $\underline{A} \times \underline{B}$. Hence tables and answers to queries are modeled as induced subobjects. Consequently, each column is equipped with its own measure of similarity, and from all these we build the measure of similarity for the whole table (see definition 4), which can be used to make comparisons between pairs of rows, find rows whose distance from some origin falls into a certain range, find nearest neighboring rows or closest pairs of rows. In short, we can perform all types of similarity search. Moreover, being able to measure the similarity between rows gives us the opportunity to arrange the rows of the relaxed answer by relevance, nearness, or exchangeability in regard to the exact answer. But, due to heterogeneous user preferences, it is not always possible to produce a completely ranked listing of non-exact matches to a query. This could be surmounted by composing the similarity measure (integrated within sets with similarity) with a preference map from the given (possibly) non-linear lattice to a linearly ordered set. Yet this topic still needs to be studied and explained in greater detail.

Sets with similarity enjoy additional constructions, which do not exist at the level of underlying sets. An example is the similarity ρ (see definition 6) between induced subobjects (subtables). It could serve as an objective measure of similarity between the exact and the *relaxed answer* to a query, for comparing instances of a time-dependent table, or track changes made to a table. While, in the case of reflexive sets, the Egli-Milner relation tells us only when a table or an answer is interchangeable with another one, in the case of bounded metric spaces, the Hausdorff metric allows a more fine-grained control of relaxation.

4 CONCLUSION

We have defined the mathematical structure of sets with similarity that allows us to treat the features of richly-structured data, such as order, distance, and similarity, in a theoretically sound and uniform way. Tables and answers to queries have been modeled as induced subobjects. Each column has been equipped with its own measure of similarity, and from all these we have built the measure of similarity for the whole table, which could be used to make comparisons between pairs of rows, find rows whose distance from some origin falls into a certain range, find nearest neighboring rows or closest pairs of rows.

We have defined the similarity ρ between induced subobjects (subtables), which could serve as an objective measure of similarity between the exact and the *relaxed answer*, for comparing instances of a time-dependent table, or track changes made to a table. In the case of reflexive sets, it has turned out to be just the well known Egli-Milner ordering, and, in the case of bounded metric spaces, the Hausdorff metric.

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COMPARISON OF AUTOMATIC SHOT BOUNDARY DETECTION ALGORITHMS BASED ON COLOR, EDGES AND WAVELETS

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ABSTRACT

Shot boundary detection is fundamental to video analysis since it segments a video into its basic components. This paper presents a comparison of several shot boundary detection techniques and their variations including color histogram, edge directions histogram and wavelet transformations statistics. The performance and ease of selecting good thresholds for these algorithms are evaluated based on a wide variety of video sequences with different object and camera motions. Threshold selection is performed using sliding window. We used TV news, sports and documentary, music, movie and nature video sequences to estimate the performance of the algorithms. The experimental results indicate that the algorithm based on color histograms is most suitable for shot boundary detection in film and documentary categories, but the algorithm based on wavelet is preferable for nature and sports categories.

1 INTRODUCTION

In multimedia information retrieval, shot boundary detection is a very active research topic [1], [2], [3]. Today, a typical end-user of a multimedia system is overwhelmed with video collections. Organizing these collections, so they are easily accessible, is a major problem. Thus, to enable efficient browsing of multimedia materials, it is necessary to design techniques and methods for indexing and retrieving this kind of data. We focus on video data, as it is one of the richest, but also most resource consuming part of multimedia content. Digital video information often consists of series of 25 frames or images per second and an associated and synchronized audio track. To develop any content-based manipulations on digital video information, the video information must be structured and broken down into components. Digital video can be described with four different levels of details: complete video, video scenes, video shots and frames (Figure 1). At the lowest level, the video consists of a set of frames. At the next, higher level, frames are grouped into shots. Consecutive shots are aggregated into scenes based on story-telling coherence. All scenes together compose the entire video sequence.

Shots are basic structural building blocks in video. A shot in video information may be defined as a sequence of continuous images (frames) from a single camera at a time. A shot boundary is the gap between two shots. Naturally, boundaries between shots need to be determined automatically [4]. After the boundaries are found, each shot can be represented with an appropriate key frame. Key frames are used to encapsulate the content of the video sequence, and to apply indexing and browsing.

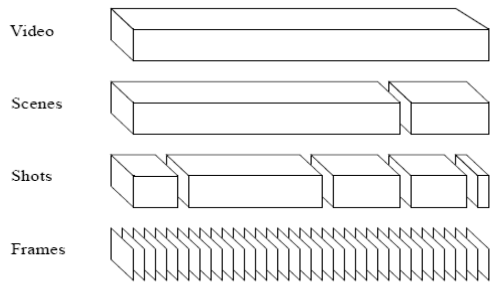

Figure 1: *Video structuring model*

A shot cut is a shot boundary where one shot abruptly changes to another. In shot cuts there is a sudden transition from one shot to another, i. e. one frame belongs to the first shot and the following frame belongs to the second shot. Other types of shot boundaries include fades, dissolves or wipes [5]. These shot boundaries types include gradual transition between two shots, i. e. there exists a sequence of frames that belongs to both the first and the second shot. "Detecting a cut" means precise positioning of the change of shots. In this paper we focus on detecting shot cuts, since they contribute roughly 90% of all shot boundaries present in video collections, as opposed to 10% presence of gradual transitions.

The remainder of the paper is organized as follows. Section 2 introduces several shot boundary algorithms; Section 3 describes the algorithm evaluation technique and the data used for testing methods. Section 4 presents the experimental results and Section 5 gives a conclusion of the paper.

2 SHOT BOUNDARY DETECTION ALGORITHMS

The task of any shot boundary detection method applied on video sequence is to detect the visual discontinuities along the time domain. During the detection process, it is crucial to extract the visual features that measure the degree of similarity between consecutive frames in a given shot.

2.1 Color histogram

The color histogram-based shot boundary detection is one of the most reliable variants of histogram-based detection algorithms [6]. It considers that color content does not change rapidly within, but across shots. Thus, shot cuts and also gradual transitions, can be detected as single peaks in the time series of the differences between color histograms of continuous frames. Often, digital images are represented in RGB color space. In our work, we used 24 bits/pixel images (8 bits for every color channel). The overall number of possible colors levels is 2^{24} bins. Due to the limited response of human visual system, we are not able to distinguish the whole levels of possible colors. A simple solution considers only the most significant bits of each RGB component (Figure 2). This solution reduces computational overhead and increases robustness toward simple camera and object motion.

R_7	R_6	R_5	R_4	R_3	R_2	R_1	R_0
G_7	G_6	G_5	G_4	G_3	G_2	G_1	G_0
B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0

Figure 2: *Color quantization*

With this quantization method all possible colors are grouped into 2^{12} different color levels in RGB space. This corresponds to 4096 colors.

2.2 Edge direction histogram

Edges characterize boundaries and therefore are a problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrasts. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. There are many ways to perform edge detection [7]. The most convenient way to represent the distribution of edges in image is by using edge direction histogram. The edge direction histogram is composed of 72 bins corresponding to intervals of 2.5 degrees. Two Sobel filters are applied to obtain the gradient of the horizontal and the vertical edges of the luminance frame image [8]. These values are used to compute the gradient of each pixel. Those pixels that exhibit a gradient above a predefined threshold are taken to compute the gradient angle and then the histogram.

2.3 Multiresolution wavelet analysis

Multiresolution wavelet analysis provides representations of image data in which both spatial and frequency information are present [9]. In multiresolution wavelet analysis we have four bands for each level of resolution resulting from the application of two filters, a low-pass filter (L) and a high-pass filter (H). The filters are applied in pairs in the four combinations, LL, LH, HL and HH, and followed by a decimation phase that halves the resulting image size. The final image, of the same size as the original, contains a smoothed version of the original image (LL band) and three bands of details. Each band corresponds to a coefficient matrix that can be used to reconstruct the original image. These bands contain information about the content of the image in terms of general image layout (the LL band) and in terms of details (edges, textures, etc...). In our procedure the features are extracted from the luminance image using a three-step Daubechies multiresolution wavelet decomposition that uses 16 coefficients and producing ten sub-bands [10] (Figure 3). Two energy features, the mean and standard deviation of the coefficients, are then computed for each of the 10 sub-band obtained, resulting in a 20-valued descriptor.

Figure 3: *Example image with applied wavelet transformation*

2.4 Threshold selection

The shot boundary detection method is based on the difference between histograms of frames belonging to a video sequence. This difference is computed using Manhatan distance:

$$d\ (H_i, H_{i-1}) = \sum_{j=1}^{M} \left| H_i(j) - H_{i-1}(j) \right|$$

or Euclidean distance:

$$d\ (H_i, H_{i-1}) = \sqrt{\sum_{j=1}^{M} \left(H_i(j) - H_{i-1}(j) \right)^2}$$

where H_i and H_{i-1} are the histograms for frame $F(i)$ and $F(i-1)$.
We use Manhatan distance for color histograms and Euclidian distance for edge direction histograms and wavelet statistic parameters.
Most of the existing approaches for shot boundary detection that are based on frame differences compare peaks in the histogram difference graph with a previously obtained threshold value. Differences that reach above the threshold value represent detected shot cuts. Figure 3 shows the result of computing the histogram difference for a given video sequence. In the figure a peak appears when a large discontinuity occurs between histograms. These peaks are usually associated to an abrupt transition. From all appearing peaks in Figure 4, a real shot cut is represented only with the peak appearing at frame 4090. All other peaks are caused by the intensive object movement in front of the camera. It is evident that selecting the threshold value is a problem of its own. Selecting too high threshold value increases the number of missed shot cuts. Using a lower threshold results in increasing the number of false alarms. A way to eliminate the peaks caused by the camera or objects motion, has to be derived.
Figure 4 shows that an abrupt scene transition produces only one peak value within a period of time. Therefore, we consider a sliding window of size $2n+1$ along the axis that covers frame transitions Dif[i-n], ..., Dif[i+n]. Next we compute the local mean-ratio within the sliding window, for each frame:

$$M_i = \frac{\sum_{j=i-n, j\neq i}^{j=i+n} Dif[j]}{2n}$$

Then we map the histogram difference curve into the local mean-ratio space. The histogram difference value at frame i is now equal to its original value Dif[i] divided by the mean M_i of the appropriate sliding window:

$$Dif^*[i] = \frac{M_i}{Dif[i]}$$

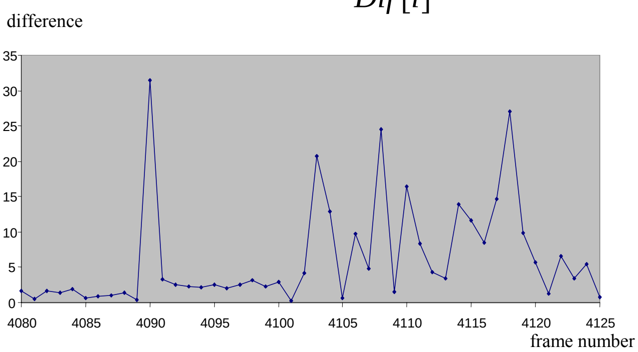

Figure 4: *Frame difference*

Figure 5 shows the transformed color histogram difference for a window of size n=5 applied on the same video sequence from the Figure 4.

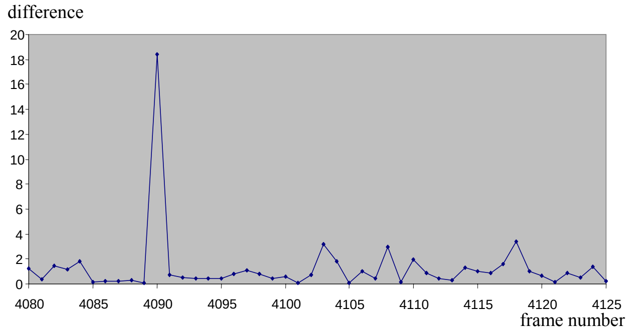

Figure 5: *Transformed frame difference*

It is evident that false alarms appearing in the original difference graph are eliminated. The only peak that appears in this curve is the actual shot cut at frame 4090. The chosen value of 5 for the half length of the sliding window n, is empirically derived from various experiments. Choosing a greater value than 5 increases the danger of including two shot cuts in a single sliding window.

3 QUALITY OF DETECTION

When evaluating our shot boundary detection methods we compared results with a listing of the actual shot cuts (when and where they occur). There are a number of parameters that should be considered when evaluating shot boundary detection methods, but the most important are:

- N_i – number of false shot boundaries detected by the method
- N_d – number of shot boundaries not detected by the method
- N_t – number of actual shot boundaries

Having these values, the measures can be calculated. In our work we used the following:

$$\text{Recall} = \frac{N_t - N_d}{N_t} \qquad \text{Precision} = \frac{N_t - N_d}{(N_t - N_d) + N_i}$$

The recall measure looks at the percentage of actual shot cuts that has been detected by the method, while the precision measure is a percentage showing how accurate the method is at detecting only the actual shot boundary.

4 EXPERIMENTAL RESULTS

To conduct a comprehensive test of the implemented algorithms, we selected a variety of video clips as test data. The categories of the selected videos are presented in Table 1. The locations of the actual shot boundaries in the test videos were determined by a manual visual analysis.
We conducted numerous experiments with a variety of video contents to compare the performance of automatic shot boundary detection algorithms based on color, edges and wavelet transformation. The videos are mainly with low resolution and contain the difficult aspects that challenge the scene change detection algorithms like

camera motions, rapid moving objects, zooms, flickers, and often combinations of these. Our results are presented in Table 1. The shot boundary detection algorithm based on edge direction histogram gave the worst results. These results are expected because of the low resolution and quality of our test videos. The best value for the recall parameter is obtained with the algorithm based on wavelet transformation. The precision parameter is the best for the algorithm based on color histograms. The algorithm based on color histograms is most suitable for film and documentary. On the other hand, the algorithm based on wavelet is preferable for nature and sports categories. We obtained the worst results for the music category because of the fast transitions and fast camera movements. The results for news category are not satisfactory because of the low resolution and bad quality for the videos from this category.

Number of frames	Number of Shots	Type	Recall - %	Precision - %
edge direction histogram				
7900	35	News	85	56
3000	103	Music	78	97
6760	49	Film	89	80
5570	96	Documentary	87	79
2665	11	Nature	73	40
3000	29	Sport	90	53
color histogram				
7900	35	News	85	100
3000	103	Music	85	98
6760	49	Film	98	100
5570	96	Documentary	96	95
2665	11	Nature	91	83
3000	29	Sport	97	100
wavelet statistic parameters				
7900	35	News	97	79
3000	103	Music	87	99
6760	49	Film	96	66
5570	96	Documentary	95	98
2665	11	Nature	100	100
3000	29	Sport	97	100

Table 1: *Experimental results*

5 CONCLUSION

In this paper we present comparison results of shot boundary detection algorithms based on color, edges and wavelet transformation. It has been demonstrated that different algorithms performed differently for various video categories. The video quality is crucial for accurate shot boundary detection, especially for the algorithm based on edge direction histogram. Sport and nature categories are much easier for shot boundary detection compare to rest of the categories. This is because of the small number of shots and presence of long video sequences without fast transitions.

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A MULTI-CLASS SVM CLASSIFIER UTILIZING BINARY DECISION TREE

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ABSTRACT

In this paper a novel architecture of Support Vector Machine classifiers utilizing binary decision tree (SVM-BDT) for solving multiclass problems is presented. The hierarchy of binary decision subtasks using SVMs is designed with clustering algorithm. For consistency between the clustering model and SVM the clustering model utilizes distance measures at the kernel space, not at the input space. The proposed SVM based Binary Decision Tree architecture takes advantage of both the efficient computation of the decision tree architecture and the high classification accuracy of SVMs. The performance of the proposed SVM-BDT architecture was measured on a problem of recognition of handwritten digits and letters. The experiments were conducted with samples from MNIST, Pendigit, Optdigit and Statlog databases of segmented digits and letters. The results of the experiments indicate that maintaining comparable accuracy, SVM-BDT is faster to be trained than the other methods. Especially in classification, due to its Log complexity, it is much faster than the widely used multi-class SVM methods like "one-against-one" and "one-against-all" for multiclass problems. The experiments showed that this method becomes more favorable as the number of classes in the recognition problem increases.

1 INTRODUCTION

Recent results in pattern recognition have shown that Support Vector Machine (SVM) classifiers often have superior recognition rates in comparison to other classification methods. However, the SVM as a classifier was originally developed for binary decision problems, and its extension to multi-class problems is not straight-forward. The main idea of SVM is to find an optimum hyperplane that separates two classes. This hyperplane is decided by the support vectors which are obtained by solving a quadratic programming problem.

The popular methods for applying SVMs to multi-class classification problems usually decompose the multi-class problems into several two-class problems that can be addressed directly using several SVMs. Although, approaches that address a multi-class problem as a single "all-together" SVM optimization problem exist [1], they are computationally much more expensive than solving several binary problems.

Adapting the SVM classifier to the multi-class scenario is still an ongoing research topic [2]. The conventional way is to decompose the N-class problem into several two-class problems and construct several binary classifiers whose outputs are then mixed to decide the patterns class.

A variety of techniques for decomposition of the multi-class problem into several binary problems using Support Vector Machines as binary classifiers have been proposed, and several widely used are:

• One-against-all

For the N-class problems (N>2), N 2-class SVM classifiers are constructed [3]. The i^{th} SVM is trained while labeling all the samples in the i^{th} class as positive examples and the rest as negative examples. In the recognition phase, a test example is presented to all N SVMs and labeled according to the maximum output among the N classifiers. The disadvantage of this method is that the number of training samples is too large, so it is difficult to train.

• One-against-one

This algorithm constructs N(N-1)/2 2-class classifiers, using all the binary pair-wise combinations of the N classes. Each classifier is trained using the samples of the first class as positive examples and the samples of the second class as negative examples. To combine these classifiers, it naturally adopts Max Wins Algorithm that finds the resultant class by first voting the classes according to the results of each classifier and then choosing the class that is voted most [4]. The disadvantage of this method is that every test sample has to be presented to large number of classifiers (N(N-1)/2). This results in faster training but slower testing, especially when the number of the classes in the problem is big [5].

• Directed acyclic graph SVM (DAGSVM)

Introduced by Platt [6], the algorithm for training a N(N-1)/2 classifiers is the same as in one-against-one. In the recognition phase, DAGSVM depends on a rooted binary directed acyclic graph to make a decision. When a test sample reaches the leaf node, the final decision is made. A test example is presented only to the N-1 SVMs in the nodes on the decision path. This results in significantly faster testing while keeping very similar recognition rate as One-against-one.

• Binary Tree of SVM (BTS)

This method uses multiple SVMs arranged in a binary tree structure [7]. A SVM in each node of the tree is trained using two of the classes. The algorithm then employs probabilistic outputs to measure the similarity between the remaining samples and the two classes used for training. All samples in the node are assigned to the two subnodes derived from the previously selected classes by similarity. This step repeats on every node until each node contains only one class samples. The main problem that should be considered seriously here is training time, because, one has to test all samples in every node to find out which classes should be assigned to which subnode while building the tree. This may decrease the training performance considerably for huge training datasets.

In this paper we propose a binary decision tree architecture that uses SVMs for making the binary decisions in the nodes. The proposed classifier architecture SVM-BDT (Support Vector Machines classifier utilizing Binary Decision Tree), takes advantage of both the efficient computation of the tree architecture and the high classification accuracy of SVMs. Utilizing this architecture, N-1 SVMs need to be trained for an N-class problem (like in one-against-all), but on the average only $\lceil \log_2 N \rceil$ SVMs are required to be consulted to classify a sample. This can lead to a dramatic improvement in recognition speed when addressing problems with big number of classes.

The Kernel-based clustering introduced to convert the multi-class problems into decision tree problem with SVM classifiers in the nodes of the binary decision tree is explained in Section 2. The results of the experiments of recognition of hanwriteen digits and letters using different multi-class SVM aprroaches are presented in Section 3. Section 4 gives a conclusion of the paper.

2 A MULTI-CLASS SVM CLASSIFIER UTILIZING BINARY DECISION TREE

As shown on (Figure 1), the SVM-BDT solves an N-class pattern recognition problem utilizing a binary decision tree, in which each node makes binary decision using a SVM. The hierarchy of binary decision subtasks should be carefully designed before the training of each binary SVM classifier.

The recognition of each pattern starts at the root of the tree. At each node of the binary tree a decision is being made about the assignment of the input pattern into one of the two possible groups represented by transferring the pattern to the left or right sub-tree. Each of these groups may contain multiple classes.

There exist many ways to divide N classes into 2 groups, and it is critical to have proper grouping for the good performance of SVM-BDT.

For consistency between the clustering model and the way SVM calculates the decision hyperplane the clustering model utilizes distance measures at the kernel space, not at the input space. Because of this, all training samples are modified with the same kernel function that is to be used in the training phase.

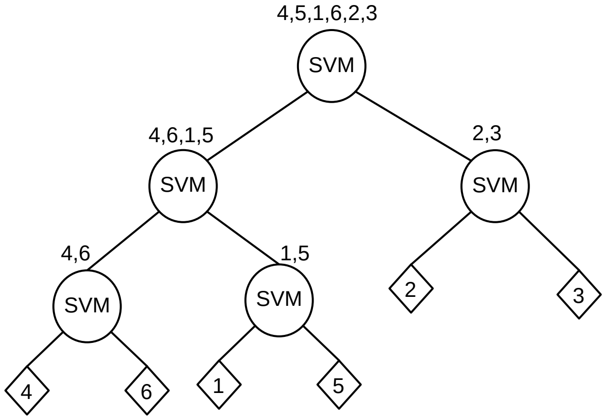

Figure 1: *Illustration of SVM-BDT.*

The SVM-BDT method that we propose is based on recursively dividing the classes in two disjoint groups in every node of the decision tree and training a SVM that will decide in which of the groups the incoming unknown sample should be assigned. The groups are determined by a clustering algorithm according to their class membership.

Let's take a set of samples $x_1, x_2, ..., x_n$ labeled each one by $y_i \in \{c_1, c_2, ..., c_k\}$ where k is the number of classes. The first step of SVM-BDT method starts with dividing the classes in two disjoint groups g_1 and g_2. This is performed by calculating k gravity centers for the k different classes. Then, the two classes that has the biggest Euclidean distance from each other are assigned to each of the two clustering groups. After this, the class with the smallest Euclidean distance from one of the clustering groups is found and assigned to the corresponding group. The gravity center of this group is then recalculated to represent the addition of the samples of the new class to the group. The process continues by finding the next unassigned class that is closest to either of the clustering groups, assigning it to the corresponding group and updating the group's gravity center, until all classes are assigned to one of the two possible groups. This defines a grouping of all the classes in two disjoint groups of classes that are used to train a SVM classifier in the root node of the decision tree. The classes from the first clustering group are being assigned to the first subtree, while the classes of the second clustering group are being assigned to the second subtree. The process continues recursively (dividing each of the groups into two subgroups following the same procedure as explained above), until there is only one class per group which defines a leaf in the decision tree.

For example, on Figure 1 which illustrates clustering of 6 classes, the SVM classifier in the root is trained by considering samples from the classes $\{c_1, c_4, c_5, c_6\}$ as positives examples and samples from the classes $\{c_2, c_3\}$ as negative examples. The SVM classifier in the left child of the root is then trained by considering samples from the classes $\{c_4, c_6\}$ as positives and samples from the classes $\{c_1, c_5\}$ as negative examples. This way, we will train (k−1) SVMs for k-class problem.

3 EXPERIMENTS

In this section, we present the results of our experiments with several multi-class problems. The performance was measured on the problem of recognition of handwritten digits and letters.

Training and testing of the SVMs was performed using a custom developed application that uses the Torch library [8]. For solving the partial binary classification problems SVMs using Gaussian kernel were used.

Here, we compare the results of the proposed SVM-BDT method with the following methods:

1) one-against-all (OvA);
2) one-against-one (OvO);
3) DAGSVM;
4) BTS;

The most important criterion in evaluating the performance of a classifier is usually its recognition rate, but very often the training and testing time of the classifier are equally important.

In our experiments 4 different multi-class classification problems were addressed by each of the 5 previously mentioned methods. For every method the training and testing time and the recognition performance were recorded.

The first problem was recognition of isolated handwritten digits from the MNIST database. The MNIST database [9] contains grayscale images of isolated handwritten digits. From each digit image, after performing a slant correction, 40 features were extracted. The features are consisted of 10 horizontal, 8 vertical and 22 diagonal projections [10]. The MNIST database contains 60.000 training samples, and 10.000 testing samples.

The second and the third problem are 10 class problems from the UCI Repository [11] of machine learning databases: optdigit and pendigit. Pendigit has 16 features, 7494 training samples, and 3498 testing samples. Optdigit has 64 features, 3823 training samples, and 1797 testing samples.

The fourth problem was recognition of isolated handwritten letters – a 26-class problem from the Statlog collection [12]. Statlog-letter contains 15.000 training samples, and 5.000 testing samples, while each sample is represented by 16 features.

The classifiers were trained using all available training samples for the set and were evaluated by recognizing all the test samples for the corresponding set. All tests were performed on personal computer with Intel Core2Duo processor at 1.86GHz on Windows XP.

Tables 1 to 4 show the results of the experiments using 5 different approaches on each of the 4 data sets. The first column of each of the tables describes the combining method of binary SVM classifiers: one-against-all (OvA), one-against-one (OvO), DAGSVM, BTS and SVM-BDT. In the second column the training parameters σ and C are given. The last three columns present the error-rate, the training time and the testing time for the corresponding method.

The results in table 1 show that for the MNIST database (10 classes, large number of samples) OvA method shows the lowest error rate, but is also slowest to train. The other methods show higher but similar error rates. The DAGSVM method shows fastest training and testing times.

Classifier	σ, C	Error-rate(%)	Time(s)	
			Test	train
OvA	2, 100	1.93	23.56	468.94
OvO	2, 100	2.43	26.89	116.96
DAGSVM	2, 100	2.50	9.46	116.96
BTS	2, 100	2.24	26.89	240.73
SVM-BDT	2, 100	2.45	25.33	304.25

Table 1. Recognition results, training and testing times for the MNIST dataset

Classifier	σ, C	Error-rate(%)	Time(s)	
			Test	Train
OvA	60, 100	1.70	1.75	4.99
OvO	60, 100	1.94	3.63	3.11
DAGSVM	60, 100	1.97	0.55	3.11
BTS	60, 100	1.94	0.57	5.21
SVM-BDT	60, 100	1.94	0.54	1.60

Table 2: *Recognition results, training and testing times for the Pendigit, Uci Repository dataset*

From the results in table 2 and table 3 we can see that methods one-against-one (OvO), DAGSVM, BTS and our method SVM-BDT can reach almost the same accuracy. The method one-against-all (OvA) is more accurate than the other methods, which is apparent in both cases. Among all the methods, SVM-BDT is the fastest one in the training phase. Testing time is comparable in methods DAGSVM, BTS and SVM-BDT and they are noticeably better then testing time of one-against-all (OvA) and one-against-one (OvO) methods. However, if the number of the classes is relatively small, the advantage of SVM-BDT is not that evident.

Classifier	σ, C	Error-rate(%)	Time(s)	
			Test	Train
OvA	25, 100	1.17	1.63	3.94
OvO	25, 100	1.55	1.96	2.02
DAGSVM	25, 100	1.67	0.68	2.02
BTS	25, 100	1.51	0.73	5.65
SVM-BDT	25, 100	1.61	0.70	1.59

Table 3: *Recognition results, training and testing times for the Pendigit, Uci Repository dataset*

Classifier	σ, C	Error-rate(%)	Time(s)	
			test	Train
OvA	1.1, 100	3.20	119.5	554.2
OvO	1.1, 100	4.72	160.5	80.9
DAGSVM	1.1, 100	4.74	12.5	80.9
BTS	1.1, 100	4.70	17.2	387.1
SVM-BDT	1.1, 100	4.54	13.1	63.3

Table 4: *Recognition results, training and testing times for the Statlog dataset*

For the three 10-class problems it can be noticed that OvA approach has the lowest error rate. On the other hand, the time needed to train the 10 classifiers for the OvA approach took about 4 times longer than training the 45 classifiers for the OvO and DAGSVM methods. The DAGSVM method showed to be the fastest in the recognition phase but also produces the biggest error rate.

The third problem was recognition of handwritten letters from the Statlog database [12]. Table 4 presents the results of the experiment for this 26-class problem. Again the OvA method showed the lowest error rate but the longest training time. The OvO, DAGSVM and the BTS method achieved very similar error rates that were about 1.5% higher than the OvA method. The DAGSVM is again fastest in recognition being almost 10 times faster than OvA. The time needed for training of the 26 one-against-all SVMs was almost 7 times longer than the time for training the 325 one-against-one SVMs. The BTS method showed the lowest error rate of the methods that use one-against-one SVMs. The SVM-BDT method showed better recognition rate than the methods using one-against-one SVMs while being only slightly slower in recognition than DAGSVM and the fastest while training.

4 CONCLUSION

A novel architecture of Support Vector Machine classifiers utilizing binary decision tree (SVM-BDT) for solving multiclass problems was presented. The SVM-BDT architecture was designed to provide superior multi-class classification performance utilizing a decision tree architecture that requires much less computation for deciding a class for unknown sample. Clustering algorithm that utilizes distance measures at the kernel space is used to convert the multi-class problem into binary decision tree, in which the binary decisions are made by the SVMs. The results of the experiments show that the speed of training and testing are improved, while keeping comparable or offering better recognition rates than the other SVM multi-class methods. The experiments showed that this method becomes more favorable as the number of classes in the recognition problem increases.

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GENETSKI ALGORITEM IN METODA MONTE CARLO V PROGRAMU AUTODOCK

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Abstract: V farmacevtski industriji je hitrost ključnega pomena. Razvoja zdravil si danes ne moremo več predstavljati brez uporabe računalniških simulacij. Za vezavo ligandov na tarčne molekule se v množici programov uporablja tudi AutoDock. Na primeru vezave ligandov na receptorsko mesto toksina kolere smo primerjali dva algoritma optimizacije (genetski algoritem in metoda Monte Carlo). Zanimalo nas je predvsem, kateri algoritem je hitrejši in kateri da boljše rešitve.

1. UVOD

Kolera je bolezen, ki jo povzroča bakterija *Vibrio cholerae*, ki izloča toksin. Ta toksin lahko za človeka smrten. Toksin kolere spada v AB_5 družino holotoksinov, ki imajo značilno strukturo [1,2]. Ena katalitsko aktivna komponenta A je združena z netoksično komponento za vezanje receptorjev, ki nastopa v obliki pentamera B podenot. Le ta je odgovoren za vezavo toksina kolere na ganglozid GM1, ki se nahaja na celičnih membranah epitelnih celic v prebavnem traktu.. Ta vezava je ključnega pomena za delovanje toksina. Funkcija prepoznavanja in vezave se ohrani tudi, ko odstranimo A podenoto [3].

Vezavi sledi cepljenje verige A in redukcija disulfidne vezi, zaradi česar nastaneta dva fragmenta – A1 (23,5 kD) in A2 (5 kD). A1 fragment, ki ima funkcijo encima, potuje skozi membrano v citosol, kjer sproži proces črpanja Na^+ ionov iz celic. Elektrokemijsko neravnotežje se nato kompenzira s prehodom Cl^- ionov in molekul vode iz celice, kar je razlog za simptome kolere (velika izguba vode, kar lahko vodi do smrti zaradi dehidracije) [4,5].

Glede na mehanizem delovanja toksina kolere, so možni trije načini zasnove profilaktičnega zdravila:

- inhibicija delovanja katalitsko aktivne podenote A [6,7],
- preprečevanje nastanka kompleksa AB_5 [8],
- načrtovanje majhnih molekul, ki delujejo kot vabe za GM1 vezno mesto toksina in s tem preprečujejo vezavo toksina kolere na črevesno steno [9,10].

Za načrtovanje majhnih molekul, ki se vežejo na toksin in delujejo kot inhibitorji se uporabljajo metode molekulskega modeliranja. Te metode uporabljajo različne algoritme optimizacije, od katerih sta daleč najpogostejša genetski algoritem in metoda Monte Carlo. V svoji seminarski nalogi sem na podlagi virtualne knjižnice izbral dve molekuli, ki se vežeta na receptorsko mesto toksina kolere. Večja molekula se imenuje psGM1, manjša pa je molekula galaktoze. Inhibitorja smo vezali na receptorsko mesto toksina kolere, pri čemer smo enkrat za optimizacijo uporabili genetski algoritem, drugič pa metodo Monte Carlo. Oba načina optimizacije sta del programa AutoDock, katerega smo pri svojem delu uporabljali.

Sama struktura receptorja (toksin kolere) je znana že od prej in se med vezavo liganda ne spreminja. Slednjega lahko spravimo na receptorsko mesto s pomočjo spreminjanja položaja vrtenja vezi v samem ligandu. Spreminjanje položaja in vrtenje vezi pa ne poteka naključno, pač pa z algoritmi optimizacije, s katerimi poskušamo doseči globalni energetski minimum za kompleks receptor-ligand. Dosežen minimum nam pove kako uspešen je izbrani ligand pri vezavi na receptorsko mesto. Takšen način raziskav pripomore k nadaljnjemu razvoju bolj efektivnih in predvsem metabolno stabilnih inhibitorjev toksina kolere.

2. PROGRAM AUTODOCK

Program Autodock so razvili z namenom, da priskrbi avtomatiziran postopek za napovedovanje interakcij ligandov z biomakromolekulskimi tarčami. Motivacija za nastanek takšnega programa so bili problemi, ki spremljajo načrtovanje bioaktivnih učinkovin in težave na področju računalniškega načrtovanja zdravil. Strukture proteinov in nukleinskih kislin, ki jih dobimo z x-žarkovno kristalografijo, nam lahko služijo kot tarče za biološko aktivne agente pri nadzoru bolezni rastlin in živali ali pa pripomorejo h boljšemu razumevanju bioloških procesov. Natančno poznavanje interakcije takšnih agentov oz. molekul kandidatov je zelo pomembno za razvoj zdravil.

Vsak proces vezanja oz. združevanja mora uravnotežiti dve nasprotujoči si zahtevi:

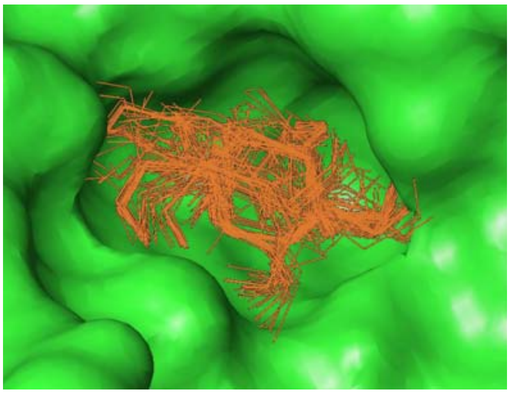
- biti mora robusten in točen,
- ne sme zahtevati preveč računske moči.

Idealen proces naj bi bil sposoben najti globalen minimum energije interakcije med substratom in ciljnim proteinom, tako da bi preiskal vse prostorske stopnje sistema. Takšen način pa bi, tudi na najmočnejših računalnikih, zahteval preveč časa, zato so v AutoDock vgrajene različne tehnike, ki poenostavijo proces vezanja. Eden izmed procesov, ki so ga razvili za AutoDock, uporablja metodo po Metropolisu, po kateri spreminja konformacije in s pomočjo po mreži razporejenih molekularnih privlačnostnih potencialov hitro oceni energijo. Metoda zahteva relativno malo vhodnih podatkov. Raziskovalec mora definirati volumen pravokotnika, ki oklepa protein, rotirajoče vezi substrata in poljubno oz. naključno začetno konfiguracijo. V novejših verzijah AutoDock-a pa je prisotna tudi nova tehnika iskanja globalnega minimuma, ki temelji na genetskem algoritmu [11].

3. VEZAVA LIGANDOV NA TOKSIN KOLERE

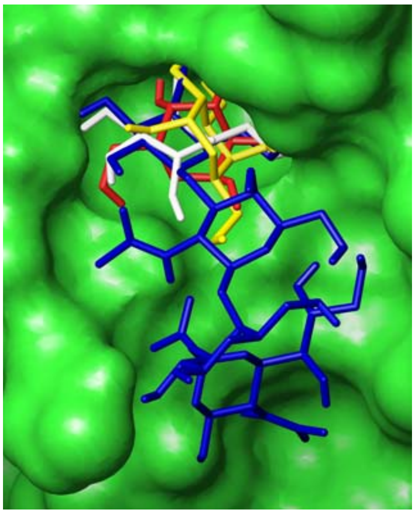
Receptorsko mesto toksina kolere lahko razdelimo na dva dela; nespremenljiv del in topilu izpostavljen del. Nespremenljiv del je kot ulit za molekulo galaktoze, ki mora biti zato tudi sestavni del vsakega liganda, ki ga želimo vezati na toksin kolere.

Najprej smo s pomočjo genetskega algoritma poskušal najti najbolj ugodno konformacijo kompleksa toksin-galaktoza. Izračunali smo cikle po 10, 50 in 100 neodvisnih genetskih algoritmov in preveril, kako so razvrščene rešitve. Če rešitve razporedimo po podobnosti, imamo pri ciklu 10-ih algoritmov pet skupin rešitev, pri ciklu 50-ih algoritmov 10 skupin rešitev, pri ciklu 100-ih algoritmov pa 13 skupin rešitev. V vsakem ciklu je vsaj 40 % vseh rešitev zasedlo energetsko najbolj ugodno konformacijo, 20 % vseh rešitev se je znašlo v drugi energetsko najbolj ugodni konformaciji, ostale rešitve pa so zasedle energetsko manj ugodne konformacije. Majhno število skupin podobnih rešitev in nenaključna porazdelitev rešitev (najboljša rešitev je močno priviligirana) kažeta na to, da je genetski algoritem ustezna izbira za iskanje energetsko najbolj ugodne konformacije kompleksa toksin-galaktoza. To se tudi lepo vidi na sliki 1, kjer so prikazane vse rešitve cikla 100-ih neodvisnih genetskih algoritmov. Večina teh rešitev zavzame enako ali vsaj zelo podobno konformacijo, tako da je kljub stotim orientacijam liganda na aktivnem mestu molekula galaktoze še vedno prepoznavna.



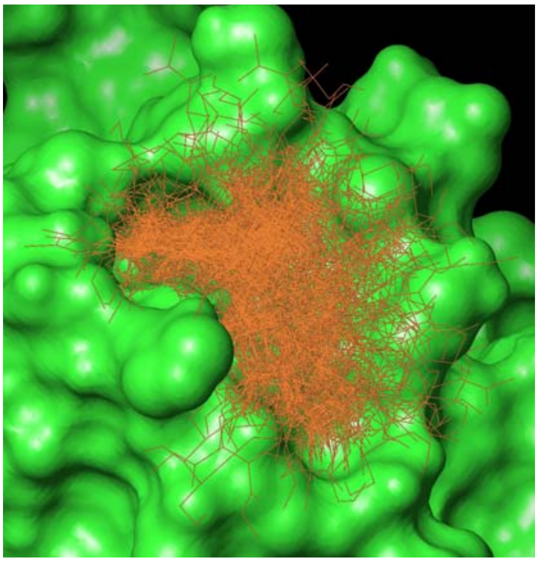
SLIKA 1: Prikaz konformacij galaktoze na receptorskem mestu toksina, ki jih dobimo s ciklom 100-ih neodvisnih genetskih algoritmov.

Slika 1 kaže na to, da dobimo s pomočjo genetskega algoritma precej podobne rešitve, kar pa še ne pomeni, da so te rešitve tudi prave. V ta namen moramo najboljše konformacije primerjati s strukturo kompleksa toksin-galaktoza, ki je bila določena kristalografsko. Slika 2 prikazuje kristalno strukturo kompleksa toksin (zelena barva)-ligand o-GM1 (modra barva), v primerjavi z energetsko najbolj ugodno (rdeča barva), položajno najbolj ugodno (bela barva) in energetsko najmanj ugodno (rumena barva) konformacijo molekule galaktoze. Tako kot v primeru vseh uspešnih ligandov, ki se vežejo na receptorsko mesto toksina, ima tudi o-GM1 molekulo galaktoze kot enega izmed sestavnih delov. o-GM1 se s tem galaktoznim repom veže v nespremenljiv del receptorskega mesta, ravno tako kot prosta galaktoza. Na sliki 2 lahko vidimo, da sodeč po izračunih genetskega algoritma, prosta galaktoza zavzame konformacijo, ki je podobna konformaciji galatoze, ki je sestavni del liganda o-GM1.



SLIKA 2: Na osnovi kristalografskih podatkov prikazano receptorsko mesto toksina kolere na katerega je vezan ligand o-GM1 (modra barva). Za primerjavo so tudi prikazane tri rešitve genetskega algoritma za vezavo galaktoze. Z rdečo barvo je označena energetsko najugodnejša konformacijo, bela barva označuje položajno najbolj ugodno, rumena pa energetsko najslabšo konformacijo.

Seveda nas je po začetnem uspehu zanimalo, kako bi genetski algoritem rešil problem vezave večjega liganda na receptorsko mesto. Ker poznamo kristalno strukturo kompleksa toksin : o-GM1, smo si za preučevani ligand izbrali omenjeno molekulo [12]. Za razliko od proste galaktoze, se večji ligandi vežejo tako v nespremenljiv del kot tudi topilu izpostavljen del receptorskega mesta. Posledica večje površine vezanja je več mogočih konformacij in daljši čas računanja. Zopet smo izračunali cikle po 10, 50 in 100 neodvisnih genetskih algoritmov in preveril, kako so razvrščene rešitve. Rešitve smo razporedili po podobnosti in dobili pri ciklu 10-ih algoritmov 6 skupin rešitev, pri ciklu 50-ih algoritmov 17 skupin rešitev, pri ciklu 100-ih algoritmov pa 47 skupin rešitev. Še vedno je v vsakem ciklu vsaj 40 % vseh rešitev zasedlo energetsko najbolj ugodno konformacijo, vendar pa je število rešitev v drugi energetsko najbolj ugodni konformaciji drastično padlo. Dobili smo več skupin z energetsko manj ugodnimi konformacijami, ki so vsebujejo le po eno rešitev in se medsebojno tudi precej razlikujejo. Veliko število med seboj različnih konformacij je lepo razvidno iz slike 3, kjer so prikazane vse rešitve cikla 100-ih neodvisnih genetskih algoritmov.



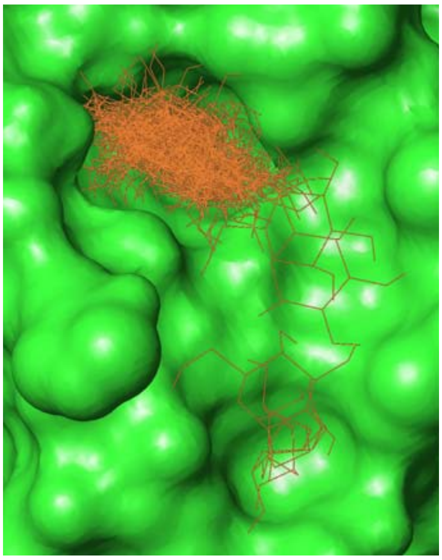
SLIKA 3: Prikaz konformacij molekule o-GM1 na receptorskem mestu toksina, ki jih dobimo s ciklom 100-ih neodvisnih genetskih algoritmov.

Če primerjamo kristalno strukturo kompleksa toksin-ligand o-GM1, z energetsko najbolj ugodno konformacijo molekule galaktoze vidimo, da je genetski algoritem dobro opravil nalogo iskanja optimalne konformacije, ki se je zelo približala eksperimentalni vrednosti.

Ko smo s pomočjo genetskega algoritma dobili najboljše konformacije kompleksov galaktoza – toksin in o-GM1 – toksin, smo za iskanje optimalnih vezav uporabili še metodo Monte Carlo. Najprej smo se pozabavali z vezavo galaktoze na receptorsko mesto toksina. Tokrat smo zračunali cikle po 10, 50 in 100 neodvisnih Monte Carlo algoritmov in preveril, kako so razvrščene rešitve. Vsaka rešitev je za izračun porabila nekoliko več časa kot v primeru uporabe genetskega algoritma. Kljub daljšemu času računanja pa je bila raznolikost rešitev zelo velika, same rešitve pa z energetskega stališča niso bile tako ugodne, kot pri računanju z genetskim algoritmom. Veliko število različnih rešitev je lepo razvidno na sliki 4, kjer za razliko od slike 1 molekule galaktoze sploh ne moremo več prepoznati.

Energetsko najugodnejša konformacija kot tudi najslabša rešitev sta precej različni od kristalografsko določene strukture kompleksa ligand – toksin kolere.

Ker je metoda Monte Carlo na naš problem delovala precej slabše od genetskega algoritma že pri majhni molekuli galaktoze, bi bilo vsakršno testiranje večjih ligand povsem nesmiselno, saj bi tam dobili še bolj heterogene rešitve. Računanja vezave molekule o-GM1 na receptorsko mesto s pomočjo metode Monte Carlo tako sploh nismo izvedli.



SLIKA 4: Prikaz konformacij molekule galaktoze na receptorskem mestu toksina, ki jih dobimo s ciklom 100-ih neodvisnih algoritmov Monte Carlo.

4. ZAKLJUČEK

Zaradi pomankanja časa in čedalje višjih stroškov razvoja se danes v farmacevtski industriji za načrtovanje majhnih molekul, ki se vežejo na tarčno molekulo (npr. protein) in delujejo kot inhibitorji, uporabljajo metode molekulskega modeliranja. Te metode uporabljajo različne algoritme optimizacije, od katerih sta daleč najpogostejša genetski algoritem in metoda Monte Carlo. Oba algoritma sta implementirana v programu AutoDock, s pomočjo katerega lahko napovedujemo interakcije ligandov z biomakromolekulskimi tarčami.

V tem delu smo s pomočjo virtualne knjižnice izbrali liganda galaktozo in o-GM1 za vezavo na toksin kolere. Da bi dobili informacije o jakosti vezave in konformaciji nastalih kompleksov, smo si za algoritem optimizacije izbrali tako genetski algoritem kot tudi metodo Monte Carlo. Genetski algoritem se pri vezavi galaktoze obnese zelo dobro, saj dobimo precej homogen sklop rešitev (slika 4), hkrati pa je »prava« rešitev (t.j. globalni minimum) dosežena že v eni izmed prvih petih simulacij. Če za simulacijo uporabimo metodo Monte Carlo, potrebujemo za rešitev nekoliko več časa, a je rezultat kljub temu precej slabši kot pri genetskem algoritmu. Rešitve so razpršene po širokem območju, nobena od njih pa tudi v primeru stotih zaporednih simulacij ni prišla blizu energetskim vrednostim kompleksa, dobljenim z uporabo genetskega algoritma. To še ne pomeni, da je genetski algoritem boljši od metode Monte Carlo, vendar prvi v preučevanem primeru potrebuje za boljšo rešitev precej manj časa. Boljše in bolj homogene rešitve bi lahko dobili tudi z metodo Monte Carlo, če bi spremenili parametre simulacije. Lahko bi na npr. povečali število dovoljenih zavrženih stanj ali pa število »runov«, vendar bi vse tovrstne rešitve le še povečale čas računanja, kar pa v današnjem, z denarjem in časom obsedenem svetu ne bi bilo smotrno.

Genetski algoritem se dobro odreže tudi pri vezavi večjega liganda (o-GM1) na toksin kolere. Najboljša rešitev se zelo približa kristalografski strukturi, rahlega odstopanja pa ne moremo pripisati optimizacijski metodi, temveč je najbrž posledica slabih in dobrih približkov, s katerimi poskuša program simulirati stanje v naravi. Računa z metodo Monte Carlo niti nismo opravili, saj se je že v primeru manjše molekule ta pokazala kot neprimerna za obravnavan primer.

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ADAPTIVITY – THE FUTURE OF EDUCATIONAL HYPERMEDIA SYSTEMS

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ABSTRACT

Educational hypermedia systems constitute an area where the implementation of adaptivity is becoming a topical issue of today. In the context of educational hypermedia adaptivity there constitutes a system ability to adapt itself to the actual student's knowledge, goals, needs, skills, individuality etc.

This paper summarizes some of the methodical approaches to the development of educational adaptive hypermedia systems. Further, this paper presents the solution of adaptive navigation support in the eLearning subsystem of University information system at MUAF in Brno.

1 INTRODUCTION

The basic principle of adaptive hypermedia systems (AHS) lies in respecting the difference of every user of the system. In consequence, the system adapts its presentation (content) or provides adaptive navigation which is based on actual knowledge, preferences, aims, skills, computer literacy of the user etc.

Today, adaptation mechanisms are most frequently used in the field of electronic education (eLearning) where it is necessary to adjust the content and navigation to the preliminary knowledge of the user, his/her study objectives and preferred learning style. Respecting the individuality of the student can significantly contribute to improving the quality and efficiency of the process of electronic education.

It is not the goal of adaptive educational systems to create an "artificial teacher". Though a personal approach of a teacher is irreplaceable, in cases of distance educational systems the adaptive technology constitutes a useful alternative to classical static systems. Some of the arguments supporting the use of adaptive technology point out that: [1]

- When there are many students in a group, the teacher cannot provide a systematic individual approach to all of them; he usually works with a student individually only when solving a specific problem with him/her. Using AHS can be an appropriate complement.
- An appropriate construction of educational AHS will lead to more effective absorption of information for a concrete user and to improvement of ergonomic quality of the system when compared to static hypermedia.
- At the same time, the aim and output of AHS can also be an adaptation of the technical aspect of the system (e.g. user interface, adaptation to users with a handicap).

2 METHODICAL APPROACHES

2.1 Structure of Educational AHS

The information structure of a typical educational AHS consists of two interrelated spaces: [2]

1. traditional hyperspace (a set of tutorial hypertext pages),
2. knowledge space (a set of concepts).

Considering this division the project of an educational AHS includes the following steps:

1. creating the structure of hypertext space,
2. creating the structure of knowledge space and
3. connecting the knowledge space with hyperspace.

Apart from constructing the structure of hypermedia system and creating tutorial materials the author has to design the structure of the knowledge space in the adaptive system as well. Further, he defines the relations between hyperspace consisting of tutorial materials and the knowledge space. Creating an educational AHS is significantly more demanding than creating a traditional educational system of the same extent. More demanding development of AHS is the price we pay for having adaptivity in the system.

2.2 AHAM Reference Model

One of the starting points for developing an educational AHS can be the AHAM reference model [3]. The model represents an abstraction of structure and functionality of adaptive hypermedia systems. This model was originally created in relation to the development of adaptive educational systems [4], however, its principles can be used in other fields as well. The model specifies the following basic items of AHS:

- *Domain model* consists of concepts and their mutual relations. A concept represents a comprehensive part of a presented area.
- *User model* describes which data about the user the system saves.
- *Adaptation model* includes rules that enable us to specify, how the state of the user model influences the presentation of information from the domain model.
- *Adaptation engine* accomplishes the actual adaptation according to rules of the adaptation model and it generates the final presentation.

2.3 Modelling the Student

The most significant feature of a user in educational hypermedia is the knowledge of the field that is being taught. The knowledge is a feature of a user that is under constant change. It can increase (by studying) or decrease (by forgetting) during the work in the system as well as between separate visits of the system. Knowledge based AHS have to recognize the changes of the state of knowledge and update the user model in a corresponding way.
There are publications that deal with the user modelling in detail [5, 6]. They state two basic techniques of a user modelling:
Stereotype User Modelling presents a simpler method which does not allow individual adjustment for every user. Users are classified into groups on the basis of a similarity with a certain stereotype and the system adapts itself to these groups.
Overlay Modelling presupposes a copy of the domain model for each user. The adaptive system gains and saves attributes related to the characteristics of a user for each concept of the domain model (e.g. number of visits of a certain concept, amount of time spent by studying the concept, level of understanding the concept). Evident requirements for the realization of an overlay model are balanced by the possibility of individual adaptation to each user. In the educational AHS the overlay model has been most frequently used for capturing the knowledge of a user.

2.4 Adaptation Techniques

In AHS we use a wide range of adaptation techniques whereas the efficiency of a particular adaptation technique depends on the context of its usage. In this field a certain terminology and taxonomy has already been established, a detailed description can be found in publications [5, 7]. Adaptation techniques can be divided into two main groups:

1. *Adaptive navigation support* (sometimes called *Link Level Adaptation*). Examples include direct guidance, adaptive link sorting, adaptive link annotation etc.
2. *Adaptive presentation* (sometimes called *Content Level Adaptation*). Examples include inserting/removing fragments, altering fragments, stretchtext etc.

3 ADAPTIVITY IN ELEARNING SUBSYSTEM UIS

The above stated methodical frame provides a basis for the below described solution of adaptivity [8] in eLearning subsystem of University information system (UIS) at MUAF in Brno. The adaptation process in the eLearning subsystem is schematically shown in the figure 1.

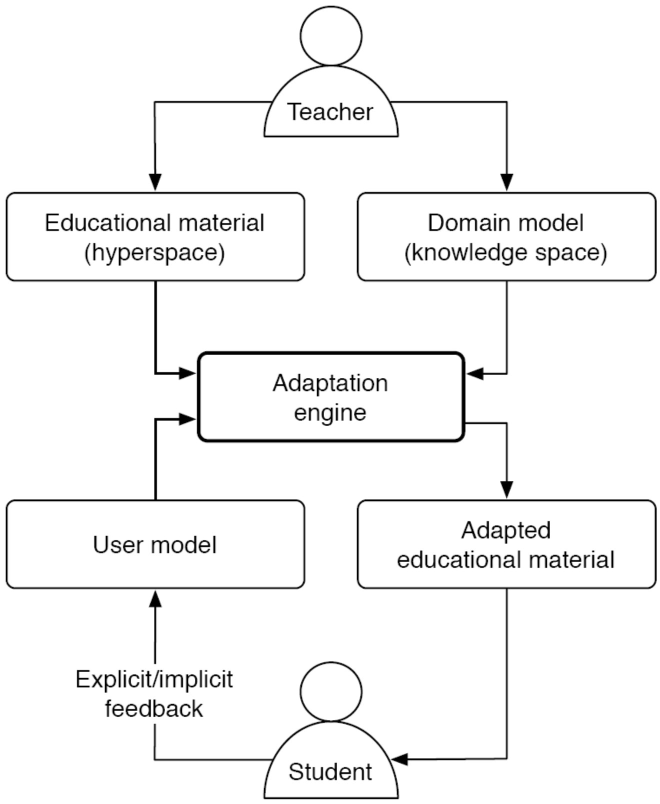

Figure 1: *The adaptation process in eLearning subsystem*

3.1 Project of Domain Model

The study materials in eLearning subsystem consists of study text and other items, e.g. tutor entries (definition, control question, advice of the tutor, etc.), notes, links to additional sources, multimedia objects. The study material is divided into various parts that are hierarchically ordered, while the complex structure is compatible with content packaging according to SCORM standard. Each part is saved in the database as a XHTML page.
Generally a domain model is formed by a set of concepts. In the suggested solution a concept corresponds to one part of the study material (XTML page) with an assigned stereotype. The stated stereotype has two roles. Firstly, it decides which level is the particular part appropriate for (e.g. beginner). At the same time it carries information on number of knowledge points which a student gets by studying the particular part.
The complex knowledge carried by the domain is crucial for the needs of the adaptation process. This is called *expert knowledge* in the terminology of AHS. It is the maximum knowledge that students can achieve by studying the whole

course. The value of expert knowledge can be deduced from the domain model by summing up knowledge points for all concepts of the model.

$$ek = \sum_{i=1}^{n} kp_i$$

ek ....expert knowledge of a domain
n.........number of concepts
kp_i ......knowledge points for i-th concept

3.2 Project of User Model

The characteristics, which had been chosen to be modelled by the system, was the knowledge of the user. The user model is initialized on the basis of a pre-test result of a student or by assigning the student to the lowest stereotype (if the pre-test is not defined). Next adaptation is accomplished only on the basis of an implicit feedback, i.e. by monitoring the work of a student in the system. The obtained information is saved in an overlay user model which is dynamically changing as the student passes through the study material.
For each visited concept of the domain model which corresponds to the actual stereotype of the student a value about the visit of the concept is saved in the overlay model. The relevant part is considered to be studied and mastered at the moment of the visit which is the easiest approach used in many existing AHS.
An important role during the adaptation process plays the complex actual knowledge of the student in relation to the expert knowledge. The student is assigned to the relevant stereotype on the basis of his/her total number of knowledge points. The complex knowledge of a student can be deduced as follows:

$$pk = pr \cdot ek / 100$$

pk.......preliminary knowledge of a student
pr ....result of the pre-test (in %)

$$ak = \sum_{i=0}^{v} kp_i$$

ak.......actual knowledge of a student
v.........number of visited concepts, where $v \le n$

$$ck = pk + ak$$

ck.......complex knowledge of a student

3.3 Result of Implemented Solution

The changes in the user model and the state of the domain model are reflected in the adaptive display of the menu in the course browser of eLearning subsystem. The links in the menu are annotated by the technique called *traffic light metaphor* [9] and different colours of the links. Further, a head of the course browser has been modified where in case of adaptive course students can see their level (stereotype) they currently belong to (see figure 2).

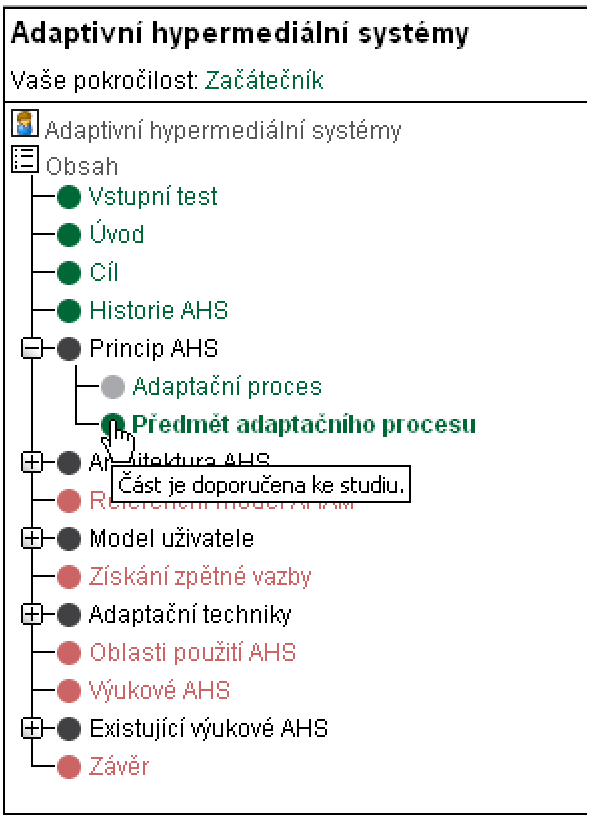

Figure 2: *The menu with adaptive annotation*

Different colouring distinguishes parts recommended for study and parts that are with respect to the knowledge of the student not recommended for study at the time. The graphic annotation also provides information whether a particular part has been already visited. Further, the semaphore icons are equipped with text annotations that specify their meaning.
The used method of annotation gives information to the student if it is useful to follow the link or not. If the student decides to follow the recommended part which corresponds to his/her stereotype, a record of his/her visit is saved into the user model. Students are allowed to visit also those parts that do not correspond to their actual knowledge and are marked as nor recommended. However, this visit is not saved in the user model. Thus the user is not limited in his/her choice of parts, but the value of his/her complex knowledge does not change by visiting the unrecommended

parts. The system provides guidance, but does not enforce a single reading sequence upon the learner.
As soon as the user visits all parts that are relevant to his/her actual stereotype, he moves into higher knowledge group. Those parts of the course which are assessed by the author as relevant for the higher stereotype are newly marked as recommended in the menu. So the student is gradually led through the tutorial materials and he is recommended to visit those parts of the course that correspond to his/her actual level of knowledge.

4 CONCLUSIONS

The aim of this paper was to provide a basic outline on the possibilities of using adaptivity in educational hypermedia systems. When deciding if to integrate adaptivity into educational systems a question arises, if the hyperspace of these systems is extensive enough to counterbalance the implementation costs with accelerated and more effective educational process.
In this paper a suggestion of adaptivity solution of eLearning subsystem UIS MUAF in Brno has been presented. It provides a basic solution of adaptivity with space for its further development (more sophisticated methods of estimating the student's knowledge, implementation of other adaptation techniques etc.). The solution has been implemented and is currently in the phase of testing and after adjusting details it will be set into operation.
It is assumed that integrating adaptivity into the eLearning subsystem, especially in cases of more complex study materials, will bring more effective education as the orientation of students in the study material will improve. It can optimise the way of a student through the materials and reduce time spent in the educational system on getting the same amount of knowledge. We will have to test in the future if this hypothesis is correct.
In conclusion, it is to be said that adaptivity is not a heal-all remedy and only the author of an eLearning course should decide if it is appropriate to use it in that particular case. The authors of adaptive courses have to face increased demands because apart from designing the actual tutorial materials they have to design and create the domain model as well. However, these demands are well compensated by making the education process more effective, if integration of adaptivity is relevant for the particular extent and type of educational materials.

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WIRELESS SENSOR NETWORKS IN EARLY FOREST FIRES DETECTION

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ABSTRACT

The main aim of this study is to define the possibilities of wireless sensor networks application in early forest fires detection. In fact, in the past few years the region of Balkan Peninsula including Macedonia were hit from huge forest fires resulted with destroying the flora and fauna in many National Parks, human life loss and large material loss. One of the reasons for this situation was the missing of on time information about locations, dimensions and environmental parameters in the fired areas. The concept of wireless sensor networks is fully applicable for this purpose. Networked nodes with sensing, processing and low-power wireless communication capabilities is an ideal solution for early detection of fire presence. The model is based on detection (sensing) of fire products: increased temperature, decreased humidity and CO (smoke) presence. Environmental monitoring is very essential part of our existence, as the world became dangerous place for living. The danger is very hard to predict but always the on time reaction can allay the consequences.

1 INTRODUCTION

In the past decade, we were witnesses of the rapid progress and development in electronics and communication technologies.

This progress was especially experienced in mobile and wireless communication and embedded systems. The recent advances in MEMS technology and modern types of sensors, introduce us in our everlasting dream – ubiquitous, pervasive computing.

Wireless local area networks (WLANS) are implemented almost everywhere, in our homes, workplaces, our cities and they are modern life reality. Also, the wireless personal area networks (WPANS), provide cable-less communication among devices such as personal computers, printers, PDA's etc.

One of the main reasons for recent progress in wireless communication was the extremely need for mobility. Today, we need freedom in our movements as we are conditional from different types of electronic devices which are tools for execution of daily working duties.

We can sure confirm those well known facts, but naturally one question is here present: What is the future? Where is the way of the next revolution in computing? The right answer of this question was given by the father of ubiquitous computing – Mark Weiser: "Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence". This citation make us to think in a way that next step in communication technology development will be focused in enabling communication and computational abilities to all types of devices. The right term for this performance is "Everything Connected".

Very interesting and challenging field of communication networks – Wireless Sensor Networks (WSN) is rapidly coming of age. The emergence of Wireless Sensor Networks has enabled new classes of application that benefit a large number of areas including environmental monitoring, geology, agriculture, health, retail, military home and emergency management. Wireless Sensor Network is an infrastructure consisted of sensing, measuring, computing and communication elements that give us ability to instrument, observe and finally, react to the events and phenomena in specified environments. The environment can be physical world, biological system or an information technology framework.

There are four basic components in a Wireless Sensor Network: set of distributed and localized sensors, wireless interconnecting network, central point of information clustering and set of computing resources to handle data correlation and mining and event trending. The main technology trend is integration of all this components in single box called mote. On the Figure 1. is illustrated the main architecture of the typical sensing node. This architecture can be expanded by adding additional elements including location finding systems (GPS modules), actuators etc.

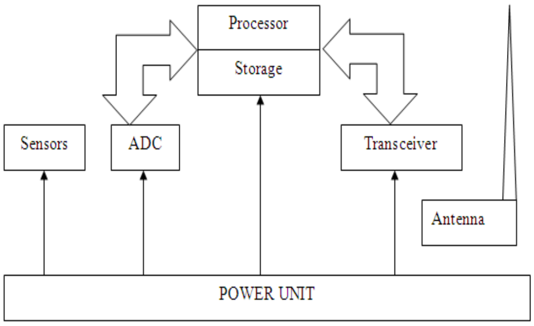

Figure 1: *Typical sensing node.*

The mote includes sensors which are capable of sensing many types of information from the environment including temperature, light, humidity, radiation, the presence of biological organisms, geological features, seismic vibrations etc. These environmental information give us the real picture what happens around us and Wireless Sensor Networks are the right platform to obtain them.

2 APPLICATION ANALYSES

Environmental monitoring is one of the crucial interests in many scientific, military and civil areas. The common for all is the need for on time and precise information about environmental parameters. In this text, we are focused on possibilities of Wireless Sensor Networks applications in environment protection, especially in fire protection of National Parks in Macedonia. The main reason to think in this way is the fact that our region - Balkan Peninsula including Macedonia is often hit by fires in summer period, resulting with large material and nature loss. By the analysis and information provided by the local fire stations in Macedonia, we conclude that the biggest reason for late fire station reaction was the missing of information about locations and intensity of the fire in fired places.

Wireless Sensor Networks are the cheapest and the most effective solution for preventing these types of disasters. One of the fundamental concepts of Wireless Sensor Networks is cost-effective implementation. In fact, all of these problems can be solved by using traditional sensors, wired systems or standard wireless protocols, but the solution will be extremely expensive. Wireless Sensor Networks design is based on using low-power and cheap elements, which can be deployed with high density over the area of interest. Some informal sources says that in Macedonia in the past years the material loss from fires was about 70-80 million Euros. This amount is more than enough to cover the main National Parks with multi-modal wireless sensing motes, which are capable to detect, localize and alarm presence of fire in critical areas. These motes are small-size and cost-effective. Current sensor systems based on Bluetooth technology cost about 10$, but Bluetooth is very limited as a transmission technology in terms of bandwidth and distance.

On Figure 2. is shown the miniature sensor mote – MacroMote, developed at UC-Berkeley (Courtesy of UC-Berkeley). The size of the mote is approximately size of one coin.

The first fundamental concept of Wireless Sensor Networks is the self-organization capability and system scalability. For Wireless Sensor Networks to become truly ubiquitous a number of challenges must be overcome [1]: limited functional capabilities, including problems of size, power factors, node costs, environmental factors, transmission channel factors, topology management complexity and node distribution, standards versus proprietary solutions, and scalability.

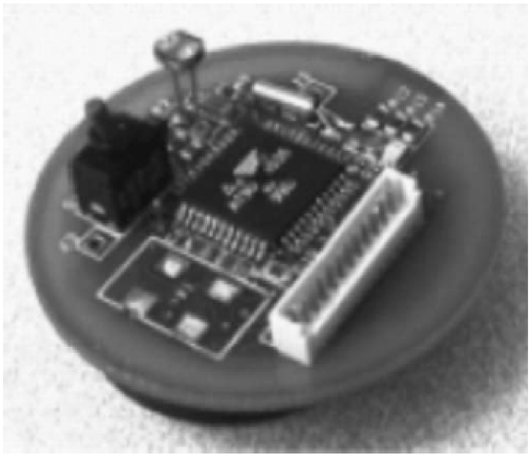

Figure 2: *Berkeley MacroMote*

All of these elements must be taken in advance before we start thinking about the system's design. When we think about high distributed and high dense implementation of Wireless Sensor Networks over a critical wooden forest, the first question is how many types of sensors we need for effective fire detection? This question has physical nature and it is strongly connected with the fire phenomena. There are few sensible products of the fire presence: smoke (CO), increased air and soil temperature, light, and decreased humidity.

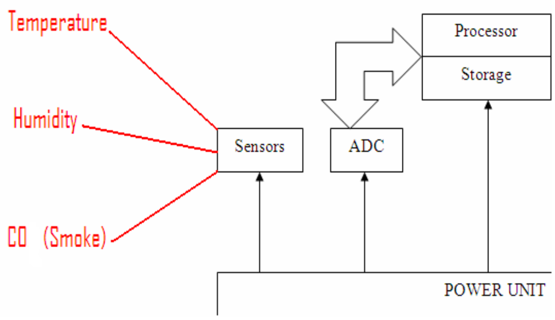

Figure 3: *Fire Detection Sensor node*

For high reliable and stable system all of these factors should be taken. The presence of all of these elements with defined values, which depends from environmental conditions, can be adequate reason to think about fire presence. Also the system can be extended with low-resolution imagers for taking the image from the critical area.

One of the main constraints about Wireless Sensors Networks is power consumption issue. The sensor node lifetime is in strong dependency with battery life. Distributed wireless sensor nodes have limited power sources based on AA alkaline cells or Li-AA cells. Replenishment of power source in many cases is almost impossible. The function of as sensor node in the observed sensor field is to detect defined events, perform local data processing and then transmit raw or processed data. Therefore power consumption issue can be allocated in three functional domains: sensing, communication and data processing each of which requires optimization.

Deploying and managing high number of nodes, in example for fire detection purposes 100-200 nodes/km^2, requires special techniques. Beside that many wireless protocols are designed to have ad hoc capabilities, they are not suitable for using in the field of Wireless Sensor Networks. As we said in above text, Bluetooth technology is very limited for using as transmission technology in bandwidth and distance boundaries. Sensor nodes based on Bluetooth are still expensive if we assume that we design high distributed and high dense network.

The IEEE 802.15.4 standard has been adopted by the ZigBee Alliance for wireless personal area network technology. The alliance is association of hundreds of members around the world, working together to enable a reliable and cost-effective networking of wireless devices for monitoring and control, based on an open global standard. There are three categories of logical devices in the ZigBee standard: Network Coordinator (FFD – Full Function Device), Router (FFD) and End Device (RFD - Reduced Function Device). The network coordinator is responsible for network parameters and configuration, router for linking the different components, and the end device contains just enough functionality to communicate with its parent node: router or coordinator. In the fire detection WSN application one of the most important issue is the network topology. Based on the logical devices defined in ZigBee protocol, the network topology can be organized in one of three possible topologies: star, mesh (peer-to-peer), and cluster three. On Figure 3. these types of topologies are illustrated.

The star network topology is organized with single coordinator and support up to 65.536 devices. This topology is useful when the wireless sensor network is distributed in small distance area. In the case of fire detection application this topology will be not applicable because we expect to cover bigger wooden forest area. For this purpose the ideal will be mesh or cluster-tree topology. The mesh configuration implemented in the fire detection system will allow path formations from any source device to any destination device.

In example if the area of interest is about 10 km^2, we expect implementation of thousands sensor nodes. One of the main principles in this design is to realize capabilities for communication among all of the nodes in the network.

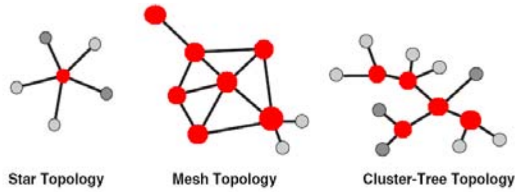

Figure 4: *ZigBee Network Topologies*

The main interests are physical parameters: temperature, smoke presence (CO), humidity and light intensity, or more precisely changes in their values. All of the sensors nodes (end RFD devices) should alarm the parent FFD device (router or coordinator) about significant changes in the values of parameters. The algorithm for making decision for fire presence alarming, is based on the predict that if a sensor node registered rapid changing or increasing temperature and CO presence, and light, but decreasing humidity the panic procedure should be activated. The panic procedure should request parameter comparing among the sensor nodes. FFD devices in this situation are collectors of data about parameter's conditions in the end devices that they cover. Also additional devices equipped with low-resolution cameras needs to be activated to get real-time images of the critical area. Special software applications are needed for processing the data and final decision making. Thru the ZigBee gateways information can be send to the fire station servers where fire alarm will be realized. The system in the fire station will provide information to fire station staff about location and intensity of the fire. Localization can be realized by GPS systems integration in the sensor nodes. Sure this will increase the power consumption, but GPS system can be implemented in few sensor nodes that we will equip with additional power sources and alternative - renewable power sources. Then with implementation of localizing algorithms the localization can be achieved.

Wireless Sensor Networks in the area of environmental monitoring today are unique solution which provides cheap implementation and scalability. Self-organization capability of the Wireless Sensor Networks is one of the crucial techniques which promising explosive development and innovations in the new network technologies. Expanding the network with new motes (nodes) is allowed by not changing the network topology and system's architecture.

3 CONCLUSION

Wireless sensor networks as one of the top emerging technologies, are original solution for fires detection and prevention issues. The detection of the fire in the earliest stage can be done only with highly integrated and high dense network topologies and multimodal sensor nodes, which is one of the main aspects of wireless sensor networks philosophy. The financial analyses for damages in

Macedonian forest fires in past few years say that application and integration of wireless sensor network for this purpose is acceptable.

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MODELING OF GENE REGULATORY NETWORKS BY BOOLEAN NETWORKS

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ABSTRACT

In this article, we present the importance of interpretation of fundamental cellular mechanisms related to organism's genome. To obtain a comprehensive notion about interaction among genes, gene regulatory networks (GRNs) are used. As input data for inferring GRNs, gene microarray expression data and ChIP-chip data are used. One of the models of GRNs is the model based on Boolean network which is described in this paper. We implemented and visualized a Boolean network over yeast gene expression time-series data. Also, we calculated the numbers of state-transitions of each Boolean network node over all time points.

***Keywords*: gene regulatory networks, gene expression, Boolean networks**

1. INTRODUCTION

The cell functions and development are regulated by complex networks of genes, proteins and other components by means of their mutual interactions. These networks are called gene regulatory networks (GRNs).
The gene regulatory networks are used to produce a clear and comprehensible notion for cell regulation, to reveal the fundamental gene regulatory mechanisms, to determine the reasons for many diseases and to find out the interactions between drugs and their targets in the cells.
Modeling of the gene regulatory networks represents one of the most powerful techniques to describe the fundamental cellular mechanisms and correlated intracellular and intercellular processes. The aim of many researches which include the experimental and simulating techniques is by studying the gene regulatory networks to reveal therapeutic and prognostic relevant knowledge about many diseases.
The introduction of experimental technologies such as microarrays and chromatin immunoprecipitation ChIP-chip, has provided a large number of available datasets related to gene expression and transcription factors (TFs). These datasets are basis for further analysis to reveal the key gene regulation mechanisms.
In this article we modeled a gene regulatory network by a Boolean network. The obtained GRN is based on real time-series yeast gene expression data, which is early preprocessed. Also, we calculated the number of state-transitions of each gene/node over all discrete time steps and the attractor length.
This article is organized as follows. In the second section we present the backgrounds of gene regulatory networks. The section 3 is devoted to Boolean networks, their attributes and the dynamics. The consequent section is devoted to the obtained results and visualized Boolean network. The concluding remarks are given in the last section.

2. THE BACKGROUNDS OF GENE REGULATORY NETWORKS

The living cells during their life span carry out many different tasks controlled by cell genome which is encoded in the DeoxyriboNucleic Acid (DNA) molecule. The necessity of generating, analyzing and integrating complex and large scale data led to development of whole genome experimental techniques such as microarray technology [5]. Microarray experiments which for the first time were carried out in the mid 1990s provide large-scale gene expression data sets. These data sets are basis for further computational analyses and can be utilized for revealing intrinsic knowledge about cell processes on molecular and genomic level.
The genes are transcribed into messenger RiboNucleic Acid (mRNA), and then in the process of translation proteins are synthesized. The indirect interaction is obtained by the expression of appropriate mRNA and the protein products, which are obtained in the process of translation. The synthesized proteins which activate or inhibit the transcription of the other genes are called transcription factors (TFs). The molecules that are substrates or products of these reactions can activate or inhibit proteins that control processes of transcription or translation. The gene regulation

controls biochemical reactions indirectly in cells when performs a control of gene expression [3]. Gene regulatory networks are the common mechanism to study these complex and intrinsic influences between network's components. Transcription factors are important components in gene regulatory networks. The gene expression in one organism is regulated by action of multiple transcription factors which can disable, enable or inhibit gene expression. They are able to bind to specific sites on nearby DNA and to influence the process of transcription.

To achieve the more precise GRNs, the time-series gene expression data obtained by microarray technology, are used. However, the microarray technology does not provide data related to the protein-protein interactions, metabolic changes and post-translation effects.

Beside microarray technology, in the first years of this century, a new chromatin immunoprecipitation (ChIP-chip) technique was developed. This technique is used to study the protein-genome interactions and thus, to obtain more accurate and reliable GRNs. ChIP-chip provides an insight into interaction between transcription factors and promoter region of the gene when it is combined with microarray analysis [1] [6].

Theoretical studying of gene regulatory networks was appeared in the 1960s. But the missing of relevant experimental data was a barrier until the last years of the previous century when the microarray technology has appeared. The achieved experimental gene expression data requested development of new computational techniques to analyze the data and to infer very important information from the expression data. Because the experimental techniques can not measure the mutual dependencies between all genes from one genome simultaneously, to determine the mutual gene interactions, computational techniques are used for reconstruction of the GRNs.

The reconstruction of the GRNs provides an understanding about cell regulation, discovering of the basic gene regulatory pathways. The aim of the reconstruction of GRNs is to obtain networks from given datasets that the most precisely can infer conclusions about regulatory signals. The reconstruction of GRNs is a difficult problem because of the huge number of possible network structures and the requirement to find a network structure which is the most consistent with given dataset. The quality and the dimensionality of gene expression data have a big influence on the reconstruction process. For representation of gene regulatory networks, more models are used, such as Boolean networks, Bayesian networks, dynamic Bayesian networks, state space model, linear and nonlinear differential and difference equations model, information theory approach model, fuzzy logic model and others models.

Microarray data are very important to infer gene regulatory networks. But, the noise and the small number of samples affect largely in the accuracy of GRNs. It is required to preprocess the microarray data by handling the present noise, normalization, logarithmic transformation, dealing with outliers, filtering and rescaling. Clustering of gene expression profiles from the entire organism's genome provides an initial step to analyze the gene expression data. Clustering discovers the group of genes – clusters consisted of coexpressed and coregulated genes which are likely involved in mutual cellular processes and functions.

3. BOOLEAN NETWORKS MODEL

One of the simplest models of GRNs is the model based on **Boolean networks (BNs)** which consist of a set of nodes and edges. The genes correspond to the binary-state nodes in a Boolean network and the wires between nodes correspond to interactions between genes. In the Boolean network known as Kauffman's network, the gene expression levels are represented by two states: over- (state 1) and under-expression (state 0) [8]. The states are obtained by discretization of gene expression levels. Such discretization leads to a big information loss because the real gene expression data change continuously in time.

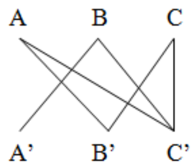
By using of mathematical formalism, a Boolean network $G(V,F)$ is defined as a set of nodes $V=\{x_1,x_2,...,x_n\}$ and a set of Boolean functions $F=\{f_1,f_2,...,f_n\}$, where a Boolean function is $f_i(f_1,f_2,...,f_n)$ for $i=\{1,2,...,n\}$ [2] [10], where n is the number of nodes and k indegree - input nodes per genes. Each node is a binary variable 1 or 0 and its value at time t+1 is determined by the values of some other genes at time t (Eq. 1):

$$x_i(t+1)=f_i\left(x_{j1(i)}(t),x_{j2(i)}(t),...,x_{jk(i)}(t)\right) \qquad (1)$$

The wiring diagram (Fig. 1 a) provides information about gene connections, but it is not sufficiently to infer the right logical dependences between nodes. Also, the gene interactions can be described by Boolean rules, which are presented on Fig. 1 b). Alternatively, the Boolean networks can be defined by a complete state transition table presented on Fig. 1 c).

One of the worst sites of the Boolean networks is super-exponentially growth. Let n denotes the number of nodes and k – number of inputs per gene, then the number of all possible networks is given by Eq. 2.

$$\left(2^{2^k}\frac{n!}{(n-k)!}\right)^n \qquad (2)$$



a)

A'=B

B'=A or C

C'=(A and B) or (B and C) or (A and C)

b)

inputs			outputs		
A	B	C	A'	B'	C'
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	1	1	1
1	0	0	0	1	0
1	0	1	0	1	1
1	1	0	1	1	1
1	1	1	1	1	1

c)

Figure 1: *A Boolean network with 6 nodes and 6 wires presented by a) a wiring diagram, b) Boolean rules and c) a state transition table.*

Several extended models based on Boolean networks are proposed. Liang et *al*. introduced REVerse Engineering Algorithm (REVEAL) which automatically constructs a large-scale Boolean network from gene expression data [4]. The algorithm extracts network structures with minimal number of wires by using systematic mutual information analysis of state transition tables. This model uses information theory approach to find out how the genes are connected in the networks and then their interactions and functions. The REVEAL can be applied to multi-valued discretized gene expression data. Unfortunately, the multi-value states lead to huge number of possible state transitions. The number of potential networks is higher than the number calculated by Eq. 2 because of the multi-level discretization. The authors have shown that REVEAL has better performances in the cases where the network has low number of input edges per gene *k*.

The models based on Boolean networks largely simplify the structure and the dynamics of the gene regulation. In Boolean network, there is a finite number of possible states (2^n), certain states will be repeated infinitely often if the network enters to transition into them. Such states are called attractors and states that lead into attractors make up their basins of attraction [2]. The attractors are cyclical and might consist of more than one state. The Boolean networks are deterministic, that means the state space is finite and that the networks eventually reach a steady state or a state cycle - dynamic attractor [7]. These networks obtain only quantitative measure for gene regulation mechanisms. These are the main reasons why Boolean networks can lead to radically different and not appropriate behavior, which does not correspond to real genetic systems and to given datasets.

Another proposed model is a probabilistic Boolean network that can be considered as a model consisted of many Boolean networks that work simultaneously, but all of them share the information about whole system states [2]. If one of the networks transits into next state, remaining networks are synchronized.

4. RESULTS

To obtain an implementation of Boolean gene regulatory network we use RBN Toolbox [9]. As input dataset we use gene expression profiles from yeast genome which contain expression data of 6400 genes measured over 7 time points. This dataset is quite large and contain information about genes which do not show significant changes during the experiment and some of data values are noisy. Therefore we perform filtering of genes by removing those genes which contain outliers and missing values. Also we remove the gene expression data with variance in the lowest 10% and those genes that have very low absolutely expression data – lower than 2.

Then we carry out *k*-means clustering over so reduced dataset and achieve 15 clusters. We select the representative cluster with 21 genes and discretize their expression profiles. To obtain and visualize a Boolean gene regulatory network over selected cluster, we choose the Classical Random Boolean Networks CRBN, where at each discrete time point all genes/nodes in the network are updated synchronously [9]. For indegree *k*=2 – number of inputs per gene, the obtained Boolean network is presented in the Fig. 2.

Additionally, we present the state-transitions of each Boolean network nodes over 7 time points. Their numbers is graphically shown in the Fig. 3. Also we calculate and attractor length – in our case it is 0, that means there is no attractor among transition states.

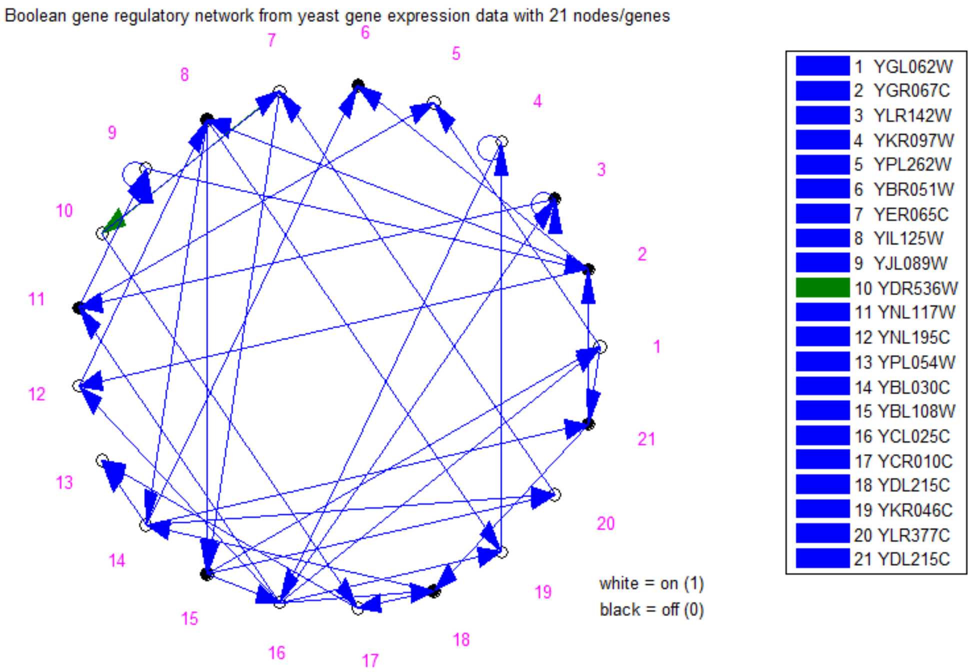


Figure 2: *A random BN obtained from yeast gene expression data. The genes are represented by small circle dyed depending on their state. The nodes lie on an circle and the arrows illustrate gene interaction directions. The green arrow (between gene 7 and gene 10) shows interaction in both directions. The circles around nodes 3, 4 and 9 show their self-regulation. The legend contains the gene's names and their respective numbers of BN nodes.*

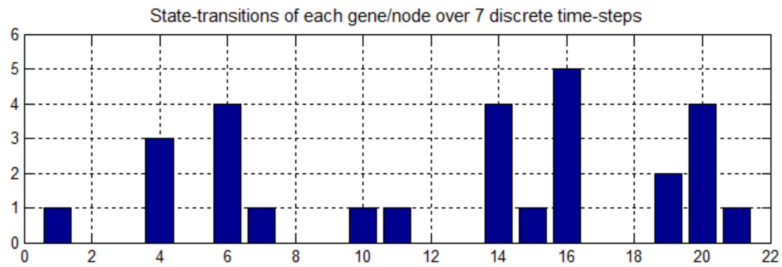


Figure 3: *The gene/node 16 has the largest number of state-transitions, unlike nodes 2, 3, 8, 912, 13, 17 and 18 which have not any state transition at all.*

5. CONCLUSION

The variety of interactions among components in the gene regulatory networks is base to further studying the life processes in the all life organisms. The Boolean networks provide a good beginning point into GRNs modeling and understanding of gene interactions.

The available genomic and proteomic datasets in the post genomic era are fundamental for further gene regulation studying, promising research area for computer scientists and biologists. The detailed understanding of mutual gene interactions is very important for pharmacogenomics in the direction of new technology application and new techniques for drug discovery.

The future improved models should be able to uncover and integrate GRNs from many gene expression datasets, time-series data and other heterogeneous data related to the components which are involved in gene regulations. Also those models will be able to incorporate the prior knowledge derived from existing research publications, microarray and ChIP-chip datasets and to explore the unobserved experimental cases and to predict the system functioning.

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ROBOTS' MOTIVATIONS FOR LEARNING AND SELF-DEVELOPMENT

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ABSTRACT

After a half-century of continued research, the artificial intelligence is still far from developing any type of general purpose intelligent systems. But there are a lot of successful experiments that gave hope and that should be the basic issue for developing such system.
In this article we will see robots' motions, especially curiosity drive, as investigatory, manipulatory, as exploratory; arguments about achievements of intrinsic motivation system as the basic issue for robots learning.
The main idea of integrating such motions, as curiosity, in artificial intelligence is to recreate the world of a human infant, create an entity with a sense of being, with a notion for exploring its environment, to build a robot which can learn and develop.
Key words - **curiosity, intrinsic motivation, intrinsic development, self-motivating.**

1 INTRODUCTION

It is valuable for a robot to know its current position and orientation with respect to its map of the environment. This allows it to plan actions and predict their results using its map; this allows it to learn how to use vision as a sensory modality. Important is when a robot is put in a complex, continuous, dynamic environment to be able to figure out by itself without prior knowledge which situations in this environment have a complexity which is suited for efficient learning at a given moment of its development.
Curiosity is the drive that pushes individuals (in our case robot) towards learning and self-development. This is why curiosity is often referred as a drive that generates positive emotions in the robot or as some kind of emotion. But sometimes, it is also referred as task-independent or task non-specific. During the years of research, curiosity is usually related to notions like: novelty, anticipation, surprise, exploratory behavior, interest, play.

2 LATEST ACHIEVEMENTS IN INTEGRATING MOTIVATIONS IN ARTIFICIAL INTELLIGENCE

In this part we are going to discuss about implementation of a habit system that automatically executes actions based on internal and external context (Hsiao K., Roy D., 2005, A habit system for an interactive robot). A robot system explained in this study is with both actions: habitual (actions based on concept) and intentional (actions performed in explicit service of a goal).
Internal context of this system is a set of factors such as maintaining the mental model and external context includes factors coming from the environment, such as robots' motor heat levels, proximity to surfaces and utterances from humans. So, the habits in this system include taking actions to reduce motor heat, avoid collisions with surfaces and interact coherently with humans.
Ripley is a robot arm designed for human interaction with seven degrees of freedom, starting with five series-elastic actuators and ending with two standard motors for rotating and opening the gripper claw. Ripley has also a visual input, provided through mounted cameras.
The robot operates in tabletop domain executing actions such as viewing, grasping and lifting objects. Usual actions that Ripley does are picking objects, replace them and gave to human, gauge the weight of objects.
The ability to interact with the environment is facilitated by its object-tracking mental-model, implemented as an internal three-dimensional simulation of the robot's environment. The result is a representation of objects in the robot's environment, along with the representation of the position of the human partner and the robot itself. Ripley deals with verbal interactions by parsing the speech, finding word referents within its current mental model. Its vocabulary includes names for properties (blue, heavy), spatial relations (on the left, close to), verbs (pick up, put down, hand me) and set of sentences templates for requesting clarifications ("Do you mean this one?"). If the robot determines that the situation is clear, there is a single course of action to take, it does it - take the action or respond. If no unique referent is provided the robot responds with question to resolve the ambiguity.
In this habit system curiosity refers to a drive that causes the robot to look around at various areas of the table and its surrounding environment. Having an up-to-date mental model is an anticipatory action that enables the robot to respond more quickly to requests from the human partner. If we compare this curiosity motivation with animal's drive to stay aware of its immediate environment, periods of exploratory learning would be analogous to an animal

playfully trying previously untested actions, or to learn more about relatively unfamiliar objects. Another Ripley's behavior is spoken interaction. But, this interaction system is not very robust to interruption, so this allows all interaction-related actions to be completed before returning control.
What is accomplished by implementing such habit system is creating an interactive robot capable of semi-autonomously assisting humans in various tasks. Creating an conversational assistive robot capable of learning about its environment and interspersing its own physical and mental needs with the desires of the interacting humans.

The method proposed in study "Active lexicon acquisition based on curiosity" (Ogino M., Kikuchi M., Asada M., 2006) is based on the estimation of the co-occurrence probabilities between the words uttered by a caregiver and the visual features that a robot observes. This is a lexical acquisition model which makes use of curiosity to associate visual features of observed object with labels that is uttered by a caregiver. In this model the curiosity is based on the evaluated saliency and it affects to the selection of objects to be attended and changes the learning rate for lexical acquisition.
The system learns lexicons on shapes and colors of an observed object through communication with a caregiver. The robot selects one salient object; it acquires the visual features on shapes and colors through visual sensors and utters labels from its own knowledge. At the same time caregiver teaches a label that corresponds to the visual feature of the object that is unknown to the robot. So, curiosity that the robot feels has effects on the selection of the object to be attended. It consist two kinds of saliency: the habituation – low saliency for the visual features that is always observed and high for features that is observed for the first time; and the knowledge-driven, characterized by acquired knowledge – high saliency for the visual features that is not associated with any other label that is already learned.
The goal of this simulation experiment is that the learning model with curiosity acquires the given labels much faster and it shows very good performance in the environment in which the number of exposed objects gradually increases. (It is important that the agent cannot associate the visual feature with the word uttered by the caregiver without understanding which feature the uttered word is intended and this is solved by associating the uttered label with the unlearned feature based on curiosity.) More important is that in this method the robot and the caregiver have joint attention. This experiment is the beginning of investigations in this area. It gave basics for developing this method to a real robot and combines other constraints such as grammar information.

According to Oureyer P.-Y., Kaplan F in paper "Intelligent adaptive curiosity: a source of self-development", 2004 "Intelligent adaptive curiosity is a drive which pushes the robot towards situations in which it maximizes its learning process".
Seeing curiosity as a mechanism of self-development while the complexity of its activity autonomously increases is very important. In such environment the robot can focus on situations which are nor too predictable, nor too unpredictable. Curiosity is one of the drives that pushes robots in such situations.
Important is that when a robot is put in a complex, continuous, dynamic environment it will be able to figure out by itself without prior knowledge which situations in this environment have a complexity which is suited for efficient learning at a given moment of its development.
The simple algorithm is: at each time step the robot chooses the action for which the predicted learning progress is maximal. So viewing the learning progress as an internal reward, leads to a classical problem of reinforcement learning. The idea of the improved algorithm is that instead of comparing the mean error in prediction between situations which are successive in time, to compare the mean error in prediction between situations which are similar.
The machine for prediction of the robot is composed by a set of experts which are specialized in particular zones of the sensory-motor space, and each expert possesses a set of training examples, and each training example is possessed by only one expert. This set of examples is used to make predictions. Important is that at the beginning there is only one expert, and as new examples are added the expert should be split into two experts depending on some criterion. But there is another criterion which decides how the set of examples is split in two parts which will be inherited by the new expert (finding a dimension to cut). The experiment of this algorithm shows a crucial result from the developmental robotics point of view. It allows a robot to autonomously scale its behavior so that it explores sensory-motor situations of increasing complexity and avoids being trapped exploring situations in which there is nothing to learn. The robot focuses first systematically on one kind of situations and then focuses systemically on another kind of situations.
The goal of the paper "Intelligent adaptive curiosity: a source of self-development" (Oureyer P.-Y., Kaplan F., 2004) is to present a mechanism which enables a robot to autonomously develop in a process that is called self-development. IAC (Intelligent adaptive curiosity) algorithm allows a robot to autonomously scale the complexity of its learning situations by successively and actively focusing its activity on problems of progressively increasing difficulty. This is the first method which allows a developmental robot to go throw all steps autonomously and without prior knowledge.
In another paper of Oudeyer and Kaplan (Discovering communications, 2006) they use intelligent adaptive curiosity system as a cognitive architecture of the robot for development of communications skills. This system maximized only the expected reward, so problems related

to delayed rewards are avoid, what makes possible using simple prediction system that later can be used in a straightforward action selection loop.
The explained experiment is called “Playground Experiment”. This involves a physical developmental robot capable of moving arms, neck, cheeks and producing sounds, which is installed into a play mat with various toys as well as with pre-programmed “adult” robot which can respond vocally to the developing robot in certain conditions.
What is shown is that more complex linguistic communication shares the same kind of special dynamics that distinguishes it from interaction with simple objects. Learning to predict the effects of the vocal outputs is different from predicting the effects of the motor commands directed towards non-communicating objects. Communication situations are characterized by such kinds of different learning dynamics. This doesn’t mean that they are more difficult to learn then how to interact with these objects.
In this system crucial difference is that the cognitive machinery as well as the motivation system is not specific to communication. Using complex reinforcement machinery brings biases which are specific to a particular method. While using such a method with intrinsic motivation system will be useful for the future research.
In the paper of Stojanov and Kulakov (On curiosity in intelligent Robotic Systems, 2006) they describe their understanding of curiosity based on thinking that it is better “a system to do something, rather than nothing”. So they think is good for the agent, if there is no specific goal, via the introduction of curiosity the agent to get rewards whenever it steps into the unknown, which would hopefully improve its world model and its performance on subsequent tasks. The model of the agent that they describe has a collection of inborn schemas that are self-motivated to get executed. So, the process is guided by the primitive internal value systems based on the satisfaction on agent’s drives, and one of them is curiosity. There are four critical mechanisms that guide agent’s development: *Abstraction mechanism* – which enables the agent to deal with more and more complex situations with the same or less cognitive effort; *Thinking and planning mechanism* – which hypothetically combines various previous experiences into new knowledge; *mechanism that provides emergence of more complex inner value and motivational systems* according to which new experiences are judged, foreseen and executed; *socialization mechanism* that enables the agent to interpret in a special way inputs coming from other intelligent agents. In this model agent’s interaction with the environment is represented by a graph with nodes and links (knowledge graph).
In their opinion curiosity is part of the motivational system and it can only partially influence the decision for taking actions, or may provoke internal interest for thinking about certain parts of agent’s environmental knowledge (represent by a knowledge graph). So, curiosity would only maximize the learning curve of an agent equipped with a mechanism for reinforcement learning.
In context of curiosity and understanding they are distinguishing two kinds of feeling of understanding in their agent architecture: feeling of understanding for the working memory and feeling of understanding for the whole agent’s environmental knowledge. In a particular situation, average confidence (of conceptual node within a distance of few links in knowledge graph) is used to judge the situation at hand. If the confidence is high enough, situation (represented in the working memory) seems to be well understood. If it is low the situation is perplexing. The feeling of understanding for the whole agent’s environmental knowledge is calculated as an average of confidence of all schemas in the graph. So, curiosity drive in this architecture is defined as proportional function of the both feelings of understanding. The purpose is to create a tendency to raise the confidence of the agents’ knowledge, because if the agent is generally perplexed it is hardly possible that it would learn something new. Only when the agent is confident enough in its current active knowledge, it is willing to continue to explore new situations and learn new things. But the agent can understand something if it can find connection of new experience with something, or some experience, that it already understood. In the term of the architecture (the writers explain), the percept will be understood if a connection can be found between current percept and some percept that are part of some already understood schema. So, the transfer of knowledge occurs when a good analogy-mapping has been made. New schemas are constructed between nodes of the knowledge graph, and the interconnectivity is increased.
The most important characteristic of intelligence in explained architecture is expectations. Whenever the expectations are met, the agent does not have to bother what it will do next. The problem for the agent appears when it is surprised (by the detected mismatch between the expected and real percepts) and it has to figure out the solution for the situation. So, the curiosity drive has a function to increase the unexpectancy and uncertainty by adding new nodes in the knowledge graph (meaning something new to be learn) through imagination or thinking, or made by analogy-making.
The purpose of the paper (On curiosity in intelligent Robotic Systems, 2006) is about curiosity not to be treated as simple driving forces which pushes agent to do something but as an elaborated mechanism which is inseparable from the internal knowledge representation and as guide for the process of thinking and imagination.

3 CONCLUSION

The goal of this article is to overview different approaches in the study of motions of robots’ self-development, related to some notions like curiosity, as an emotion and understanding it in its functional context, distinguishing two aspects: external (emotional expression for communication and social coordination) and internal (emotion for organization of behavior – selection, attention and learning) aspect as well as seeing curiosity like necessary drive to act upon and interact with the environment.

The curiosity is drive that pushes individuals towards learning and self-development. This is why scientists see curiosity as field for developmental robotics.

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CREATING INTELLIGENT MARKETS FOR SMEs USING THE SNAP-DRIFT ALGORITHM: A HIGHER EDUCATION COLLEGE PERSPECTIVE

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ABSTRACT

The further and higher educational college (HEC) markets within the United Kingdom are considered to be dwindling. This has made it extremely difficult for private colleges to attract students as well as to provide a medium for alternate education within Britain. We present our research findings having conducted an extensive case study of a private college providing higher educational services within greater London. The research also provides a platform for determining the merits of using artificial neural networks within this sub area of education provision. In order to demonstrate a case for the integration of neural systems in this type of market we explicitly consider the snap-drift algorithm for determining likely benefits for creating intelligent markets in private colleges of higher education.

1 INTRODUCTION

Education considered the cornerstone of society has been dwindling within the United Kingdom for the last five years. The exact reasons are unclear; however, it has been argued in the past that fewer students are now willing to embark on academic pursuit in Britain due to the respective constraints such as immigration and a lack of readily available job prospects during the years of study. This has been made more evident, as more post 1992 universities are devoted towards creating academic agreements with established colleges. Most evident are Holborn and St.Patricks colleges. Also, it has been made apparent that more overseas students (i.e. those not directly associated with the European Union) are more inclined to enrol with a private college because fees are somewhat cheaper as opposed to direct university enrolment.

2 HEC CHALLENGES

As the student numbers continue to dwindle, there is a designated need for deploying technology. Therefore HEC's must be able to attract students and identify there specific needs in regards to training. This we believe is difficult as now such institutions must also amass the ability to maintain student levels for ensuring that students remain at their respective institutions for pursuing accredited university courses. For these institutions to survive they must be operated as any other business. Hence, for our research purposes we denoted our case under examination as a small firm. Chiefly because we have found that our case study as well as the competition falls into the European Union classification of small and medium enterprises (SMEs). All of which, indicates that the case in question would also need to satisfy their respective customers (in this case students) whilst operating with a limited employee infrastructure.

3 CREATING INTELLIGENT MARKETS

Small firms have essentially adopted two levels of marketing that there larger counter-parts have proven to be useful in there respective functional areas. These two levels of marketing are strategic and operational types of marketing.

3.1 Strategic Marketing and HEC's

For HEC's to initiate marketing they must be concerned with the strategic type of marketing. Therefore being better able to assess how one firm competes against another firm in a predefined market place. Strategic marketing in HEC's would have to be undertaken in order to ensure that a firm is fully equipped to capitalise on potential threats associated with existing firms, operating in the same market or firms in alternate markets that possess the capability to become a competitor at a later date.

Each of the four stages of strategic marketing should be followed explicitly. These four stages are planning; information gathering; decision-making and implementation. At the planning stage the firm is more concerned with the determination of clear set of goals (or objectives) and a feasible mission statement. Hence, management must be able to demonstrate where they are expected to be in a fixed number of years in the future.

Information gathering must focus on the firm's external environment. As a result, management should focus on ensuring that an organisation is open in ensuring that they are responsive to the needs of their customers. This may include the family and friends of employees working in that firm, as this is the only way to determine how market changes will affect a firm. Essentially, communicating with the outside world will determine when and what changes are required for ensuring that the right products and services are being provided.

The type of information gathered will determine what type of decisions is to be made and as such this will establish the type of marketing strategy to deploy. For example, if the external environment suggests that customers require more child friendly products, then this may lead to a new product being created that attempts to capture a child focused market. If all decisions have been made then a strategy has been created. For such a strategy to prove beneficial to any firm it has to be executed at the right time. Therefore, the implementation time will determine the success of that marketing strategy.

3.2 Operational Marketing

This type of marketing consists of the 4 Ps associated in marketing normally referred to as the marketing mix. They are product, price, place and promotion [1]. Product refers to the item that is being marketed whereas price is the numerical value associated with the product being sold to a customer. Place refers to the location where a product is being sold whilst promotion is purely dependent on how the marketer attempts to communicate the existence of a product. Promotion normally takes the form of an advertisement via radio, television, print advertising or Internet advertisements.

4 SMEs AND MARKET SEGMENTATION

A market segment occurs when an existing market is divided into subsets. These subsets behave similarly to each other, making segments in similar categories more likely to respond to similar marketing models [2]. Each market could be categorised as either top-up or bottom-up approach. Top-up occurs when a marketer divides the entire population in a certain locale into segments. Bottom-up is more concerned with a single customer. Thus, a profile is created based on what products and or services that a single customer is interested in.

5 THE UNSUPERVISED SNAP-DRIFT NEURAL NETWORK (USDNN)

This type of network is closely based on both adaptive resonance theory and learning vector quantisation. It was created as a potential solution for the limitations found in using adaptive resonance theory especially in non-stationary environments [3]. It has the advantage of interpreting data under analysis irrespective of the type of network performance that the network is currently associated with [4]. Therefore, it can toggle between both types of performance giving either a snap effect when network performance is poor or a drift effect when network performance is good [5]. For a more in depth explanation of Figure one below see [3-5].

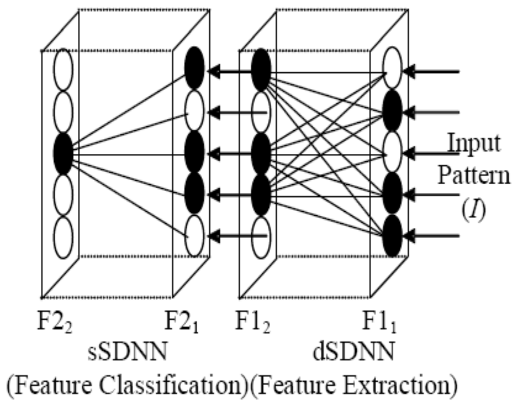

Figure 1: USDNN architecture.

6 METHODOLOGY

In order to determine the likelihood of our chosen case being successful in its predefined market a short proforma consisting of eight categories was used for collecting student characteristics. Each of the eight categories is course type; course name, course length, country of origin, cost of course, start year, gender and age.

Our chosen HEC provided us with a sample size of 216 from a total of 453 enrolled students (approximately 48%)

6.1 Data Pre-processing

Each variable was either data scaled or data normalised in order to ensure that the likelihood of key similarities between variables could be optimised. We found that all variables were needed for data analysis to be effectively meaningful.

6.2 Results

The snap-drift neural network was fed with student response inputs. All of which were used as independent variables for this network. This lead to seven distinctive classes being form within the data collected. Our classes were created as a result of using an unsupervised snap-drift neural network. This meant that our dataset did not have to be split into training, testing and validation types of data. However, optimal network performance was achieved by determining the point at which our network no longer needed to perform self-learning. In this case we achieved this at five hundred epochs. At this stage we could see that our data classification did not change beyond this point.

6.3 Brief Explanation of classes

Seven classes have been formed within our data under examination. Each member of each class is regarded has having similar characteristics to that of its member. Therefore, members of one class cannot belong to another class.

Class one currently consists of only students deemed as international students for fee purposes studying professional courses such as the British Computer Society (BCS) professional diploma and the Institute for Management of Information Systems (IMIS) Higher Diploma. Each member of this group are undertaking one year course primarily of African and Caribbean origin.

Class two hosts members pursuing hybrid courses (i.e a combination of business and computing modules) at the degree and professional course level such as the Association for Business Executives (ABE) courses.

Class three consists of students mostly of Caribbean and South American origins. The majority of its members are female and specifically paying lesser fees as opposed to class one that consisted of mostly male students but also undertaking yearly courses.

Classes four consists of postgraduate business students of African and Asian origins. In this classes the category of fee payment is extremely higher than most of the other groups. Fees are attributed to the type of degree as opposed to country of origin.

Class five consists of students participating on English for speakers of other languages (ESOL). This group had members mostly from Eastern Europe and Asia.

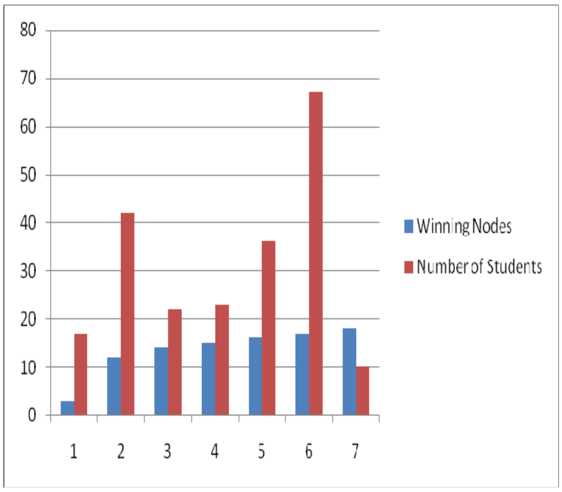

Figure 2: indicates the nodes to number of students ratio

The largest distribution of students currently occupy **class six** (denoted as winning node six in fig.2 above) . Class six consists of sixty seven members of which sixty two (62%) of its members are currently pursuing computing courses equivalent to the UK's higher national diploma standard (i.e second year degree level). This class also indicates that more than ninety percent (90%) of its members are nationals of the continent of Africa.

Our smallest class, dentoed as **class seven** in fig.2 only hosts ten members. All male, possessing an average age of twenty six. Each member of this group are currently pursuing a business type of degree course. It essentially consists of final year (3rd students) making up sixty percent (60%) of this group undergraduate degree and postgraduate degree course students accounting for forty percent (40%).

7 CONCLUSIONS

Our research though preliminary indicates that small colleges can compete efficiently if provided with the intelligent tools for ensuring market sustenance. At this early stage we were able to determine the largest international student percentiles which seem to indicate a market trend across all HEC's within the United Kingdom. Understanding the factors associated with those students opting for these HEC's will determine the right kind of partnerships that should exist for universities generally.

The HEC under examination provides clues for determining how to market academic products to international students. In particular, when using the snap-drift, we have found that students from the continent of Africa provide the largest proportion of students wanting to pursue academic study in

Britain. However, most of these students are drawn to a HEC specifically because of the cheaper fees on offer irrespective of course type. Therefore, by determining the amount of such students successfully completing HEC courses it would better aid universities in attracting such students to continue on degree validated courses at these institutions.

Using the snap-drift algorithm we believe that a case for creating an intelligent marketing model does exist. As for HEC's to withstand competition they must now be able to not only attract students but be able to change as existing markets change. A model of this type would proven instrumental in determining types of courses most suitable for current or emerging student markets.

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Zbornik 11. mednarodne multikonference
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Proceedings of the 11th International Multiconference
INFORMATION SOCIETY – IS 2008

Vzgoja in izobraževanje v informacijski družbi

Education in Information Society

Uredili / Edited by

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http://lopes1.fov.uni-mb.si

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Ljubljana, Slovenia

PREDGOVOR

Čeprav živimo v informacijski družbi in zaradi tega močno narašča pomen poklicev in znanj, povezanih z računalništvom ter z informacijskimi in komunikacijskimi tehnologijami, se soočamo tudi z vrsto težav, saj nekateri procesi v družbi temu razvoju ne sledijo dovolj hitro. Celo nasprotno, soočamo se s pojavi, zaradi katerih lahko pričakujemo v prihodnosti še večji razkorak, če ne bo prišlo do pravočasnega in odločnega ukrepanja. Na to jasno opozarja deklaracija mednarodnega strokovnega združenja IFIP (International Federation for Information Processing), sprejeta letos septembra na svetovnem kongresu IFIP v Milanu, ki opozarja na veliko upadanje števila diplomantov računalništva in na premajhno število dijakov, ki v srednji šoli izberejo pouk računalniških predmetov na višji stopnji zahtevnosti. Problem že občutijo zaposlovalci v industriji na področju informacijskih in komunikacijskih tehnologij, seveda pa ni in ne bo brez posledic tudi za šole. Ne gre za manjša trenutna nihanja, pač pa za opažanja, ki kažejo na dolgoročne trende. Teh pa ni možno obrniti čez noč, saj vemo, da se cikli v izobraževanju merijo v letih in včasih celo v generacijah.

Omenjena deklaracija predlaga nekaj ukrepov, potrebnih za preseganje problemov, ki jih prinaša upad zanimanja za računalniške in sorodne študije. Med drugim naj bi zanimanje dodatno spodbujale tudi državne institucije, ki se morajo polno zavedati stanja in ukrepati z mehanizmi, kot je npr. štipendiranje in spodbujanje investicij v izobraževanje za IKT. Razvijati je potrebno učne programe, ki dajo čim boljša znanja IKT tudi drugim, neračunalniškim in netehniškim profilom. Predvsem pa se nam zdi pomemben zadnji izmed predlaganih ukrepov, to je zagotovitev finančnih in drugih pogojev, ki bi pritegnili visoko usposobljene in »navdihujoče« diplomante računalništva, da bi se odločali za delo učitelja.

Tudi naše in vaše izkušnje, ki si jih izmenjavamo na vsakoletnih konferencah o vzgoji in izobraževanju v informacijski družbi (letošnja je že 11.), vztrajno postavljajo v ospredje sporočilo, da sam razvoj tehnologij ne bo prinesel napredka, saj so njegovo osrednje gibalo ljudje, ki ga ustvarjajo s svojim vsakodnevnim delom, in ljudje, ki njihove rezultate vztrajno prenašajo v prakso. Tako ene kot druge pa na njihovo poslanstvo pripravljamo učitelji. Učni materiali in pripomočki so seveda izjemno pomembni, a ne čudi, da je ena od najelitnejših ameriških univerz na začudena vprašanja ob sprostitvi dostopa do njihovih e-vsebin prepričljivo odvrnila, da se zaradi tega ne boji kakršnekoli škode, saj so njihova glavna prednost še vedno ljudje. Če tudi nekdo absolvira vse e-vsebine, si s tem še ne pridobi izobrazbe dotične univerze. Pozdravljamo nove možnosti, ki jih prinaša razvoj e-učenja in drugih dopolnitev ter izboljšav učnega procesa, ki jih prinašajo IKT. Hkrati pa ne pozabimo, da neposredni stik z učiteljem, ki ne posreduje le svojega znanja, pač pa tudi navdihuje in iz učencev v kar največji meri izvablja njihove potenciale, da se (tudi ob dostopu do IKT) razvijajo in se učijo učiti, ostaja nepogrešljiv.

Vladislav Rajkovič, Tanja Urbančič, Mojca Bernik

PREFACE

Occurrence of information society has contributed to the increasing importance of professions related to computing as well as information and communication technologies (ICT). On the other hand, we are now facing new problems since some of the processes in the society cannot keep up with the pace. Moreover, if we do not act with determination and in a timely manner, we can expect the gap to widen even further. A clear warning in this respect has been issued by the International Federation for Information Processing (IFIP) in a declaration passed this September at a world IFIP congress held in Milan. The warnings refer to a big decrease of computing graduates and small numbers of high school students who choose to take computing courses at a higher level. The adverse effects have already been recognized by the employers in the ICT industries and schools. These observed changes cannot be discarded as small temporary fluctuations for they indicate long-term trends. We know, however, that it is impossible to reverse these trends overnight since cycles in education are measured in years, sometimes in generations.

Declaration mentioned above proposes several measures required to overcome problems brought about by a decline in interest for computing and related studies. Governmental institutions need to be aware of the situation and act for example by providing scholarships and incentives for investments in education in ICT. Developed should be curricula for ICT that would best suit professionals from fields different than computing and science. The measure we find to be essential is to ensure financial and other conditions necessary in order to attract highly trained and inspiring computing graduates to choose a teaching career.

It is also our and your experience that we exchange at annual conferences on education in the information society (this year's being already 11th) that persistently report on how the development of technologies alone will not bring progress. The momentum is namely caused by people via their daily work as well as by people who keep transferring the findings into practice. However, teachers are the ones who prepare them for their missions. Educational materials and supplies are of course extremely important. Still, it is hardly surprising how one of the top Universities from the USA responded to the bewildered questions regarding the free access they offer to their e-content. They believe people are their main asset and do not expect to suffer any loses due to this decision. Even if a person does become fully acquainted with the complete e-content, they do not automatically achieve the level of education of the institution in question. We welcome new opportunities arising from the development of e-learning and other improvements of the learning process attributed to ICT. At the same time we should not forget that direct contact with the teacher remains indispensable. Not only does a teacher possess knowledge but also inspires students and unlocks their potentials to develop and learn to learn, also due to ICT.

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U – učenje, potencialna revolucija učenja

U-Learning, Potential Revolution in Learning Process

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Povzetek

Sodobni čas nam ponuja nešteto variacij na temo e- (e-izobraževanje, e-družba, e-banka…). Tudi EU se z Lizbonsko strategijo opredeljuje glede vizije svoje prihodnosti, ko želimo do konca l. 2010 postati na znanju temelječa gospodarska velesila. Zastavljeni cilj bomo dosegli s primerno IKT in organiziranostjo pri pripravi in posredovanju znanj. Z uporabo IKT se izognemo izolaciji študentov, ki študirajo na daljavo in omogočamo vzpostavitev povezav med njimi samimi in tutorji. E-izobraževanje omogoči praktično neomejen dostop do virov informacij, študij pa postaja interaktiven. Tehniški izziv e-izobraževanja je vezan na posredovanje oblikovane vsebine uporabniku, ki poteka preko neskončne palete najrazličnejših komunikatorjev. Potreba po intenzivnem razvoju se kaže na tehniškem in pedagoškem področju. Vse bolj prednjači uporaba mobilnih naprav, ki so stalno prisotne pri uporabnikih in jim ponujajo prave informacije ob pravem času in to na najbolj ustrezen način. Okolje m-učenja lahko močno razširi uporabnost e-učenja. Naslednja logična točka razvoja nas torej čaka v vseprisotnem u-učenju, ki je sinteza e- in m-učenja. U-učenje, uporabnikom omogoča posredovanje znanj kadarkoli, kjerkoli in kakorkoli – potencialna revolucija učenja, mar ne?

Ključne besede: e-učenje, m-učenje, u-učenje

Abstract

Many e- variations (e-learning, e-society, e-bank, …) are continuously emerging in modern time. EU visions its future on knowledge based economy by the end of year 2010 as stated in Lisobon strategy. This goal can be achieved by means of appropriate ICT (information communication technology) and organized knowledge presentation. Using ICT prevents distance learning students from being isolated and enables communication between students and professors. Almost unlimited access to information is enabled by use of ICT making study more interactive. Suitable passing of designed content to user presents a technical challenge of e-learning. This passing of information takes place over many different communication channels. Intensive development is needed in technical and pedagogical area. Use of mobile devices which are constantly present by user is growing rapidly. These devices offer users correct information at the right time and in most suitable form. M-learning environment may greatly widen use of e-learning. Next logical development step is everywhere present u-learning which is a combination of e- and m-learning. U-learning enables people to use the knowledge anytime, anywhere and in any possible way – potential learning revolution isn't it.

Keywords: e-learning, m-learning, u-learning.

Učenje na daljavo v procesu izobraževanja s področja zoperstavljanja terorizmu

Distance Learning in to Processes of Education Relating Area of Counter Terrorism"

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Povzetek

Nove asimetrične grožnje vplivajo tudi na razvijanja novih pristopov izobraževanja v okviru procesa zoperstavljanja terorizmu. S spoznanjem, da je človek in njegova sposobnost načrtovanja in prilagajanja spremembam v okolju ključni dejavnik uspeha organizacije, postaja ustrezno izobražen in usposobljen človek najpomembnejši vir učinkovitega procesa zoperstavljanja terorizmu. Korenite spremembe v svetovnem varnostnem okolju in napredek v razvoju informacijske tehnologije in komunikacij s povečanjem znanja, je skupaj z uveljavljanjem kriterijev globalnega trga eden izmed najpomembnejših dejavnikov, ki oblikujejo sodobno družbo, družbo znanja in novih sodobnih tehnologij. Nacionalnovarnostni subjekti se morajo zavedati, da izobrazba njihovih pripadnikov ena izmed pomembnejših dejavnikov za uspeh organizacije. Vsekakor je jasno, da ni enotnega konsenza kako izobraževati bodoče strokovnjake na področju zoperstavljanja terorizmu, obstaja kar nekaj alternativnih idej in poti. Možnost izražanja kritičnega mišljenja na področju proučevanja terorizma predstavlja prvi nujni predpogoj za uspešnost razvoja tega raziskovalnega področja. Znanje in sposobnosti pripadnikov takih organizacij, so postale eden od poglavitnih dejavnikov za njeno učinkovitost v procesu zoperstavljanja terorizmu. Zato je bistveno, da se te organizacije zavedajo dejstva, da je potrebno zagotavljati nenehno vlaganje v izboljšanje znanja in sposobnosti njenih pripadnikov. Aplikacije novih modelov izobraževanja med katere sodi tudi izobraževanje na daljavo, je lahko učinkovita pot za doseganje želenih ciljev.

Ključne besede: zoperstavljanje terorizmu, izobraževanje na daljavo, informacijsko komunikacijska tehnologija

Abstract

New asymmetric threats influence on development of new education approaches in to framework of process countering terrorism. Finding that human and his ability for planning and adapting to changes in environment is key factor of success organization. Appropriate educated and trained human is the most important source of efficient process of countering terrorism. Radical changes in to world security environment and progress in to development of informational and communicational technology with enlargement of knowledge is together with enforcement criterion of global market one of the most important factors which shaping modern society, society of knowledge and new modern technological. National security subjects have to realize that education theirs members is one of the most important factors for success of organization. It is obviously that in to this environment doesn't exist united consensus about how educate future counter terrorism experts, but already exist some alternative ideas and ways to do it. Chances for expressing critical thinking on area of research phenomenon of terrorism is one of the basic condition for efficient further development of this research area.

Knowledge and abilities of members of this organization are become one of the critical factors for their efficiency in to process of countering terrorism. For these reasons is very important that organizations are aware of facts that it is important to constantly invest in to improvement of knowledge and abilities of their members. Application of new models educations among which we can also put distance learning, could be efficient way for achievements of planning goals.

Keywords: countering terrorism, distance learning, information and communication technology.

Uporaba računalnikov v dijaških domovih Severno Primorske regije

The Use of the Computers in the Boarding Schools in the Region of North Primorska

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Povzetek

Računalniki tudi v dijaških domovih predstavljajo vse pomembnejši element za uspešno in kakovostno osebno in strokovno delo dijakov, ki bivajo v dijaškem domu. Pričujoči strokovni članek predstavlja vlogo računalnikov in kapacitete računalnikov v dijaških domovih severno primorske regije, obenem pa tudi možnosti, kako jih dijaki lahko koristijo. Ob koncu pa avtorica navaja priložnosti, kako bi računalnike lahko še bolj izkoristili za vzgojno-izobraževalno delo dijakov.

Ključne besede: vzgojitelj, računalnik, dijaški dom

Abstract

Computers in boarding schools as well as anywhere else represent a more and more important element for a successful and quality personal and professional work of the pupils who stay in the boarding school. The present article deals with the use of the computers and its capacity in the region of the North-Primorska, at the same time there are also listed the possibilities how to use the computer. At the end the author tells how the computers could be used even better in the educational institutions for the better work of the pupils.

Keywords: educator, computer, boarding school.

Ali lahko interesne dejavnosti računalništva izboljšajo stanje informacijske pismenosti v slovenskem šolstvu

Can Computingcomputer science Extra-curricular Activities Improve Condition of Information literacy in Slovenian Education System

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Povzetek

Prispevek predstavlja delni prikaz rezultatov raziskave »Stanje in trendi uporabe računalnikov v slovenskih osnovnih in srednjih šolah«, ki jo avtor izvaja vsaki dve leti za potrebe Ministrstva za šolstvo in šport ter projekta »Informatizacija SLO šolstva«. Predstavljen je del rezultatov didaktične problematike pouka Informatike s poudarkom na izvajanju interesnih dejavnosti računalništva v slovenskih šolah.

Ključne besede: Izobraževalni sistem, računalnik v izobraževanju, didaktična problematika, raziskava, računalniško – informacijsko opismenjevanje, srednja šola, interesne dejavnosti - krožki.

Abstract

The following article analyses some of results of investigation "Present State and Trends of Using Computers in Slovenia Primary and Secondary Schools". This work author elaborates every two years for Ministry of education and sport and national project "Informatization of Slovenian Educational System". Article analyzes some didactic criteria of teaching computer science and first of all performing computer science extra-curricular activitiesračunalništva v srednjih šolah in Slovenian education system.

Keywords: educational system, computer in education, didactic problems, research, computer - informatics literacy, secondary school, extra-curricular activities.

Izgorelost kot poklicna bolezen

Burnout Sindrom as Professional Disease

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Povzetek

Izgorelost -in še posebno poklicna izgorelost- prizadene vse več ljudi. Nastane zaradi bremen, s katerimi se spopadamo v življenju in/ali na delu. Izgorelost (ang. burnout) je bolezen tistega, ki se dolgo in vztrajno bori, ki se bori dlje in navadno bolje kakor drugi, za neko idejo, za nek način dela in življenja, za neke odnose. Je bolezen tistega, ki spozna, da ni v recipročnih odnosih v delovnem in/ali zasebnem svetu. Če takšna borba traja dolgo, se lahko prelomi v izgorelost, kar škodi psihološkemu in fizičnemu zdravju osebe, pa tudi njenemu socialnemu in družinskemu okolju.

Ključne besede: stres, izgorelost, sindrom adrenalne izgorelosti, poklicne bolezni

Abstract

The number of people affected by burnout has been rapidly growing. Burnout is due to various stressors experienced in life and at work. Burnout is a disease suffered by those who struggle- more intensively and longer than the majority- for an idea, a way of working or living, for relationships. It is a disease affecting those who have not been experiencing reciprocity in their relationships, be at work or in private life. When this struggle goes on for a long time, it can easily end up in burnout, this being noxious to ones psychological and physical health as well as his or her social and family environment.

Keywords: sress, burnout, adrenal burnout sindrom, professional diseases.

Delovanje nizkofrekvenčnih elektromagnetnih polj na zdravje

Health Effects of Exposure to Extremely Low Frequency Electric and Magnetic Fields

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Povzetek

Svetovna zdravstvena organizacija (SZO) je konec lanskega leta objavila izsledke raziskave o vplivih nizkofrekvenčnih elektromagnetnih polj (NFEMP) na človekovo zdravje. V drugem poglavju so predstavljeni povzetki raziskave in napotki za prihodnje raziskave po posameznih raziskovanih področjih ter splošni zaključki raziskave.

Ključne besede: nizkofrekvenčna elektromagnetna polja, Svetovna zdravstvena organizacija, mobilni telefoni

Abstract

The World Health Organizations Environmental Health Criteria 238 monograph addresses the possible health effects of exposure to extremely low frequency electric and magnetic fields. Second chapter summarizes the research main conclusions and recommendations from each section as well as the overall conclusions of the health risk assessment process.

Keywords: extremely low frequency fields, World Health Organization, mobile phones.

Delo ob računalniku povzroča kronična poklicna obolenja na kosteh in mišicah

Work Next to Computer Is Causing Chronic Professional Illnesses on Bones and Muscules

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Povzetek

Kostno-mišična obolenja predstavljajo pretežen delež poklicnih bolezni. Najpogostejše so težave s hrbtenico in zgornjimi ekstremitetami, kar je posledica nepravilne, prisiljene drže pri delu ali pa nepravilnega dvigovanja bremen. Za pisarniške delavce je značilna poklicna poškodba ukleščenost osrednjega živca v zapestju in poškodbe ledvenih vretenc zaradi stalne neprimerne drže. Z ustreznimi prilagoditvami delovnega mesta in večjo aktivnostjo med delom lahko signifikantno znižamo število obolelih.

Ključne besede: poklicne bolezni, bolezni kosti in mišic, računalnik, prilagoditev delovnega mesta.

Abstract

The bone-muscular diseases represent the major part of professional illnesses. Among these spine and upper extremities difficulties are most common. They are caused by anomalous and forced pose during the working process and by inappropriate load liftting. Captured median nerve in carpal tunnel and lumbal vertebras injuries are the most significant injuries for office workers caused by anomalous hands and body pose. The number of the diseased could be significantly reduced by suitable adjustment of the working place convenient and increased activity during the working process.

Keywords: professional illnesses, bone-muscular diseases, computer, working place adjustment.

Uporaba pametnih mobilnih telefonov v izobraževanju

Use of Smart Mobile Phone in Education

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Povzetek

Prišlo je do zlivanja medmrežja in mobilnih omrežj, tako je vedno in povsod mobilno dostopen internet. Uporaba mobilnih telefonov se je izjemno razširila med uporabniki. Dostopne cene in množica kvalitetnih storitev so ugodno vplivale na njihovo uporabo. Tudi otrokom je dosegljiv svet navidezne resničnosti, kot mobilna storitev. V osnovnih in srednjih šolah pogosto starši in učitelji prepovedujejo uporabo mobilnih telefonov zaradi motenja pedagoškega procesa in zlorabe zasebnosti. Napredne mobilne tehnologije so izključene iz pedagoškega procesa, ker so nas nepripravljene presenetile. Za izboljšanje izobraževalnih procesov z primerno metodo lahko uporabimo pametne mobilne telefone.

Ključne besede: Vzgoja, izobraževanje, mobilni telefoni, motnje pedagoškega procesa, zloraba zasebnosti, pametni mobilni telefoni

Abstract

With convergence of internet and mobile networks the world wide web is easy to acces almost everywhere. The us of mobile phones has spread extensively among the phone users. Accesible prices and a handful of quality services have influenced the users very positively. The imaginary reality is also accasable for the children, as mobile service. Parents and teachers have prohibited the use of mobile phones in many primary and secondary schools due to the disturbance of pedagogical proces and privacy abuse. High mobile technology is excluded from the pedagogical proces, because it caught us unprepared. For improvement of educational proceses we cane use mobile smart phones as an appropriat method.

Keywords: Upbringing, education, mobile phone, disturbance of pedagogical proceses, abuse of privacy, mobile smart phone.

Do dodatnih znanj z izobraževalnimi portali

Gaining Additional Knowledge by E-learning Portals

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Povzetek

Spletni izobraževalni portali so sodoben način izobraževanja na daljavo. Zelo primerni so za izobraževanje mladih, ki odraščajo ob računalniku in svetovnem spletu. Z njihovo pomočjo lahko na njim zanimiv način pridobijo dodatna znanja na določenih področjih. V prispevku ugotavljam, da dijaki, ki jih poučujem, malo uporabljajo izobraževalne portale iz dveh razlogov: ker jih je malo in ker nimajo vsebin, ki si jih želijo. Dijaki si želijo izobraževalni portal s celotno srednješolsko snovjo, ki bi bila predstavljena na zanimiv način skupaj z nalogami za preverjanje znanja in rešitvami le teh, kar bi jim omogočilo samostojno, zanimivo in hitrejše učenje. Izbrane izobraževalne portale so ocenili večinoma zelo dobro.

Ključne besede: izobraževalni portal, e-izobraževanje, izobraževanje na daljavo

Abstract

E-learning portals are a modern way of distance learning. They are very appropriate for education of young people, who have been growing up with computers and World Wide Web. This article ascertains that my pupils don't use e-learning portals often and there are two main reasons for this fact: there are only few of e-learning portals available and in many cases the topics they are looking for are not present. The pupils wish for such an e-learning portal that contains the complete school material, presented in an interesting way together with tests for verifying their knowledge as well as with solutions, which would enable them to learn independently and in less time. Selected e-learning portals have been evaluated very good in most cases.

Keywords: e-learning portal, e-learning, distance learning.

Varovanje osebnih podatkov v vzgojno – izobraževalnih ustanovah

Protecting Personal Information in Educational Institutions

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Povzetek

V različnih vzgojno – izobraževalnih ustanovah (vrtci, šole, dijaški domovi,…) se vsak dan znova srečujemo s tematiko varovanja osebnih podatkov. Ocene in bolezni učencev, podatki o starših, videonadzor,… to je le nekaj konkretnih primerov, v katerim smo zavezani spoštovati Zakon o varstvu osebnih podatkov (v nadaljevanju: ZVOP-1). Z omenjenim člankom želim približati omenjeno tematiko pedagoškim delavcem in jim tako pomagati, da bi znali v praksi pravilno postopati v skladu z določili ZVOP-1.

Ključne besede: osebni podatek, varovanje, vzgojno-izobraževalna ustanova, Zakon o varstvu osebnih podatkov

Abstract

We meet the problem of protecting personal information in different educational institutions (nurseries, schools, hostels for students …) every day. Students' marks, illnesses, information about parents, video supervision … are only a few examples where the law about protecting personal information (ZVOP-1) must be respected. In this article I would like to put the themes near to the pedagogues and thus help them to act correctly in everyday practice.

Keywords: personal information, protecting, educational institution, law about protecting personal information.

Uspešna vpeljava e-izobraževanja v poslovno okolje

Implementing e-learning in an Organisation

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Povzetek

V večini slovenskih podjetij in drugih organizacijah imajo tako zaposleni kot vodstvo le malo ali celo nobenega znanja niti izkušenj z e-izobraževanjem. Vpeljava e-izobraževanja v takšno organizacijo predstavlja velik izziv, ki ga pogosto spremljajo dvomi in strah pred neznanim. Zato je potrebno projekt uvedbe pazljivo načrtovati in izvajati, da bi dosegli zastavljene cilje in vzpostavili naklonjenost vseh zaposlenih do te vrste izobraževanja. Ker je osnovni cilj e-izobraževanja na delovnem mestu dobro usposobiti udeležene zaposlene, se je smiselno osredotočiti na zadovoljstvo udeležencev in učne rezultate. To pa lahko dosežemo z ustrezno rabo spletnih 2.0 tehnologij, uporabno učno platformo in sodobnimi didaktičnimi pristopi v e-izobraževanju, ki postavljajo udeleženca v središče učnega procesa. Pomembno vlogo za učinkovit e-tečaj imajo dobro usposobljeni mentorji. V članku predstavljamo model vpeljave e-izobraževanja v organizacijo ter njegovo implementacijo v Carinski upravi RS.

Ključne besede: e-izobraževanje, usposabljanje na delovnem mestu, usposabljanje mentorjev

Abstract

Establishing e-learning in an organization represents a challenge, especially if most members do not have much knowledge about e-learning. The project should be carefully planned and run in order to create a positive attitude towards e-learning. As the objective of e-learning in the workplace is qualifying employees, focus should be made on the learners' satisfaction and learning results. These can be achieved with appropriate use of web 2.0 technologies, usable e-learning system and constructivist approaches in e-learning, where efficient e-course and well-skilled mentors have an important role. This article describes the model of introducing e-learning in an organization, and its realization in The Customs Administration of the Republic of Slovenia.

Keywords: e-learning, learning at work post, mentors' training.

E-gradiva za slovenščino v 8. razredu

Online Learning Resources for Slovene Language in the 8th Grade

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Povzetek

Prispevek predstavlja pedagoška in didaktična izhodišča priprave e-gradiv za pouk slovenščine v 8. razredu ter prikazuje raznovrstnost in širino izdelanih e-gradiv. Pripravljeno osnovnošolsko e-gradivo obsega 90 odstotkov z učnim načrtom za slovenščino predvidenih ur v 8. razredu. Pri nastajanju sva avtorici upoštevali lastnosti računalniškega medija in izkoristili njegove prednosti za obogatitev šolske obravnave. Pri snovanju naju je vodila želja, da bi spodbujali k akcijskemu učenju, omogočali čim večjo interaktivnost in raznovrstnost nalog. Nastale vsebine zajemajo vse stopnje učnega procesa – od motivacije, prek obravnave do novih nalog – ter vse štiri z učnim načrtom predvidene sporazumevalne dejavnosti (branje, poslušanje/gledanje, govorjenje, pisanje) in raznovrstne metode ter oblike dela pri pouku. Pozorni sva bili tudi na interakcijo, tako je gradivo v celoti narejeno dialoško, spodbuja pa tudi interakcijo med učenci, medpredmetne povezave in želi krepiti procese samoizobraževanja in vseživljenjskega učenja.

Ključne besede: obravnava umetnostnih in neumetnostnih besedil pri pouku slovenščine, slovenščina, e-gradiva, sodelovalno učenje

Abstract

This article represents pedagogical and didactical framework for online learning resources for Slovene language in the 8th grade in all their diversity. Authors prepared 90 per cent of all the lessons, planned for the 8th grade. In order to enrich the whole learning process computer and all its advantages have been used. All the prepared online learning resources try to stimulate active learning, interactivity and diversity of exercises. Within the content authors tried to embrace all the stages of learning process (from motivation to new exercises), all four communication activities (reading, hearing/watching, talking and writing), and various working methods, expected in the national curricular document for Slovene language. Special focus was pointed at the interaction between the pupil and the content; dialogical method stimulates interaction among pupils and strengthens extracurricular connections and processes of lifelong learning.

Keywords: fiction and non-fiction text, Slovenian language, online learning resources, cooperative learning.

Model samovrednotenja učiteljev

Teachers' Self-evaluation Model

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Povzetek

Članek zajema opis izdelanega modela za samovrednotenje učiteljev, ki bo pripomogel h kvalitetnejši izvedbi izobraževalnega procesa, saj se bodo učitelji na osnovi modela lahko samovrednotili in izboljšali kritične točke svojega poučevanja. Izdelana sta dva modela, in sicer v enem nastopajo kot varianta učitelji in dijaki, v drugem pa poleg učiteljev in dijakov tudi posamezni učitelji. Ta modela sta samo primer za model samovrednotenja učiteljev, kajti možno je izdelati model po želji učitelja. Učitelj si lahko sam izbere želena vprašanja in na osnovi analiz vprašanj se lahko na njegovo željo izdela model za samovrednotenje učiteljev, ki je prilagojen izbranim vprašanjem. Na osnovi analize vprašalnikov so bili strukturirani kriteriji, ovrednoteni, določene so beli zaloge vrednosti in funkcijske koristnosti, opisane variante ter analizirane. V opisani analizi je bil uporabljen računalniški program Dexi in računalniški program Merlin.

Ključne besede: vzgoja, izobraževanje, učitelji, samovrednotenje, kakovost

Abstract

The article describes the model for teacher selfevaluation, which will contribute or enable a better execution of the education process. According to the model, the teachers will be able to self-evaluate and improve critical aspects or parts of their teaching. I have made two models. In one of the two models there are teachers and pupils appearring as variants, and in the other one there occurs an individual teacher besedes teachers and pupils.The two models are just an example of the teacher self-evaluation model as it is possible to make a model according to the needs of a teacher. The teacher himself or herself can choose the questions he or she wants, and on the basis of question analyses he or she can make his or her own model for the self-evaluation. According to the analysis of the questionnaires I have constructed the criteria, evaluated them, determined the values and functional usefulnesses, described the variants, evaluated the variants, analysed them. In the described analysis there have been used two computer programmes Dexi and Merlin.

Keywords: upbringing, education, teachers, self-evaluation, quality.

Model za pomoč pri ocenjevanju ključnih kompetenc v postopku izbora kandidata za vpis na akademijo za ples

Model for Evaluation of Competences in Selection Procedure on Academy of Dance

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Povzetek

Na podlagi modela kriterijev izbire plesnega profila ter s pomočjo računalniškega programa za večparametrsko odločanje DEXi smo zgradili računalniško podprt sistem, kot orodje pri ugotavljanju razvojnega potenciala bodočega plesnega kadra. Takšen sistem nam lahko pomaga pri odločanju o najbolj primernih kandidatih za zasedbo razpisanih mest pri vpisu na Akademijo za ples, pri določanju ciljev razvoja študijskega programa in planiranju osebnega razvoja in izobraževanja ključnih plesnih kadrov.

Ključne besede: Plesni kader, model ustreznih kriterijev, ugotavljanje primernih kandidatov, kriteriji, merske lestvice, Dexi

Abstract

Based upon criterions of dance profile and software for multi-attribute decision making support DEXi we structured a computer's supported system that can help us to identify future potencional dance cadres. That system can help us in recruitment process when we want to detect the best candidate for entry on Academy of dance, in developing goals of study programme, structuring of personal development plans and education programmes in dance cadres.

Keywords: dance cadres, model of suitable criteria, finding out appropriate candidates, criteria, scale, Dexi.

Projektno delo preko svetovnega spleta – nova izkušnja za šolo, učitelje in učence

Project Work on Internet – New Experience for School, Teachers and Pupils

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Povzetek

Projektno delo v šolah ni nekaj novega, nove so predvsem vsebine in pristopi k projektnemu delu. Sodelovanje šole v mednarodnih projektih je primer, kako je mogoče uporabiti sodobno informacijsko komunikacijsko tehnologijo za posodobitev in popestritev pouka. Vključevanje v mednarodne projekte pa pomeni tudi nove izkušnje za šolo, učitelje in učence. V prispevku bom predstavila primer praktičnega vključevanja v mednarodni projekt s področja naravoslovja.

Ključne besede: projektno delo, informacijsko komunikacijska tehnologija, fizika, aktivne metode učenja

Abstract

Project work is not new in schools but there are new contents and accesses to it. Cooperation of school in international projects is an example of how to use modern informational communication technology to modernize and variegate lessons. Incorporation in international projects also means new experiences for school, teachers and pupils. In the article I will introduce an example of practical incorporation in international project in the field of natural sciences.

Keywords: project work, information communication technology, physics, active learning methods.

Ocena projektne naloge pri predmetu družba

Project Evaluation at School Subject Sociology

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Povzetek

V seminarski nalogi smo predstavile postopek preverjanja in ocenjevanja projektne naloge pri predmetu družba. Predmet družba je eden izmed rednih premetov v 5. razredu osnovne šole z devetletnim programom. Poleg standardnega ocenjevanja (kontrolnih nalog in ustnega spraševanja) se učitelji poslužujejo tudi ocenjevanja, ki spodbuja učenčevo kreativnost. Tako pouk poteka v obliki projektnega učnega dela. Končni izdelek učenca je projektna naloga, ki jo učitelj oceni po izbranih kriterijih. V prvem delu je opredeljen problem, odločitvena skupina in metode dela. Za odločitveno skupino smo si izbrale učence 5. razreda Osnovne šole Orehek Kranj. V drugem delu pa je opisan pomen opisnih kriterijev pri spremljanju napredka učencev, ter njihov pomen pri preverjanju in ocenjevanju projektne naloge. V nadaljevanju je predstavljen način kako in kaj oceniti pri projektni nalogi. S pomočjo računalniškega programa Dexi je, ob upoštevanju kriterijev, predstavljen odločitveni model, katerega končni rezultat pa je ocena projektne naloge.

Ključne besede: preverjanje, ocenjevanje, Dexi, projektna naloga, kriteriji za preverjanje znanja

Abstract

Our research assignment presents procedure at pre-test checking of pupil's knowledge and the project evaluation at school subject Sociology. Sociology is one of the compulsory subjects in 5th grade nine year elementary school. Teachers examine pupil's knowledge with standard grading (examination papers and oral exams) and with grading which encourage pupil's creativity. School lessons are based on project work. Final pupil's product is a research project, which is assessed based on selected criterions. Our research paper first defines the decision problem, decision formed group and work methods. In our case decision formed group are 5th grade pupils from Elementary school Orehek Kranj. Second part describes the meaning of selected criterions in pupil's progress and the meaning of the same criterions at the final pupil's project evaluation. Research paper also presents the method of pupil's knowledge assessment based on project work. Computer software Dexi presents the decision model, the criterions and the final result which is the evaluation of the project work.

Keywords: Pre-test checking of pupil's knowledge, grading, Dexi, project work, knowledge evaluation and assessment.

Implementacija odločitvenega modela za izbiro izbirnega predmeta v devetletki

Implementation of a Decision Making Model for the Choice of Optional Subjects in Nine-Year Elementary School

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Povzetek

Sprejemanje odločitev je vsakodnevno dejanje. Vse večji pomen pa se daje kvalitetnim odločitvam. Kljub tehtnemu premisleku so odločitve lahko slabe ali celo napačne, zato je pomembno, da si pri pomembnejših odločitvah pomagamo z informacijsko podporo. Tako so učenci v tretji triadi osnovnošolskega programa postavljeni pred odločitev o izbiri izbirnega predmeta za naslednje šolsko leto. Glede na širok repertoar izbirnih predmetov je odločitev zahtevna, saj je v osnovnem naboru 86 izbirnih predmetov, ki se skrčijo glede na interes in usposobljenost kadra na posamezni šoli. Za lažjo in kvalitetnejšo odločitev smo izdelali večparametrski hierarhičen odločitveni model za pomoč pri svetovanju o izbiri izbirnega predmeta. Model je zasnovan na osnovi odločitvenih pravil, dobljenih z rudarjenjem podatkov in ekspertnim znanjem. Model je izdelan v DEXI-ju in predstavlja kvalitetno podporo pri odločanju o izbiri izbirnega predmeta. Pripomore h kakovosti in objektivnosti izbire izbirnega predmeta in tako zagotavlja, da učenci res izberejo predmet, ki pokriva njihovo t.i. močno stran izobraževanja. Model je uporaben za svetovalno službo na osnovnih šolah, prav tako tudi za učence in starše. Podane so smerni oz. možnosti implementacije izdelanega modela v vse slovenske šole.

Ključne besede: osnovna šola, izbirni predmeti, odločanje, odločitveni model, ekspertni sistem, DEXI, strojno učenje, rudarjenje podatkov

Abstract

Reaching a decision is a daily act. However, more and more importance is given to making wise decisions. In spite of serious reflection decisions can be bad or even wrong; therefore it is important that with crucial decisions we make use of information support. Thus pupils in the third triad of the primary school programme need to reach a decision and choose optional subjects for the following school year. A rich repertoire of optional subjects makes this decision difficult. There are 86 optional subjects in the basic range, which is reduced in accordance with the interests and qualification of the teaching staff at a particular school. To be able to reach an easier and wiser decision, a multi-parameter hierarchical decision-making model has been created to provide help in counselling about the choice of an optional subject. The model is designed on the basis of decision-making principles acquired by data mining and expert knowledge. It is created in DEXI and it provides quality support in reaching decisions about the choice of optional subjects. It contributes to quality and objectivity of the choice and it ensures that pupils really select subjects which cover their so-called stronger sides in education. This model is useful for counseling service at primary school as well as pupils and their parents.

Keywords: primary school, optional subjects, decision-making, decision-making model, expert system, DEXI, machine learning, data mining.

Učitelji in uporaba e-pošte

Teachers and Use of E-Mail

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Povzetek

Ljudje elektronsko pošto uporabljamo za različne namene. Tako kot v normalnem okolju pri vsakdanjem komuniciranju z ljudmi, je potrebno tudi na internetu upoštevati poleg pravnih zakonov, ki predpisujejo, kaj je dovoljeno in kaj ne, določena pravila obnašanja in nepisane norme, če želimo, da bo komunikacija z ostalimi uporabniki potekala normalno in na spodobnem nivoju. Zasebnost je ustavna pravica posameznika in to naj ostane, dokler ne vpliva na delovne rezultate ter doseganje ciljev. Moralno obvezo do delodajalca in delavcev bi moral imeti vsakdo izmed nas, čeprav vemo, da vedno ni tako. Delodajalci morajo vedeti, kaj počnejo njihovi zaposleni. Zahtevani cilji naj bodo jasno postavljeni. Poznati morajo njihove motive za delo, njihove ambicije in usposobljenosti. Tako bodo dosegli mnogo več kot z nadzorom in z zapovedmi, kaj smejo in česa ne. Razmišljajo naj o tem, kaj naj počnejo, da bodo ljudje učinkoviti in uspešni.

Ključne besede: Elektronska pošta, delovno mesto, nadzor, uspešnost, zasebnost

Abstract

People use e-mail for various reasons. While communicating both in everyday life as well as via internet certain rules and laws should be followed. These rules and laws determine the established patterns of behavior and some written rules of what is allowed or not allowed in terms of successful and appropriate communication. Privacy is a constitutional right of every individual as long as it doesn't influence work results and achieving goals. Everyone should have a moral obligation to the employer and to his colleagues to do his work properly. The employers should know what their employees are doing. They need to know what their motives for work, ambitions and qualifications are. The tasks and goals should be clearly defined. This is the way that more can be achieved than by constant supervision and rules and commands of what the must or mustn't do. The employers are supposed to create new methods enabling their employees to be efficient and successful.

Keywords: E-mail, work place, supervision, efficiency, privacy.

Delo z računalnikom kot vzrok za stres

Working with Computer as a Stress Factor

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Povzetek

Na poti v elektronsko revolucijo je veliko ljudi obsedelo za pisalnimi mizami in računalniki. Marsikdaj je bilo prihranjeno veliko dragocenega časa. Kljub skokovitemu napredku na posameznih področjih, pa je razvoj prinesel določene težave in slabe strani. Več urno mirovanje brez prekinitev pogosto povzroča glavobol, razdražljivost, živčnost, napetost, utrujenost, bolečine ter različne poškodbe. Sodobni čas le malokdaj dopušča trenutke za sprostitev. Nenehno prinaša nove obremenitve in pritiske, ki v nas povzročajo stres. Ta ni vedno negativen, kakšen je, je odvisno od posameznika, ki je pod stresom. Pri vsakem pa je nekje meja, kjer se "dober" stres prevesi v negativnega. Na delovnem mestu se moramo truditi, da zaradi pretirane vestnosti ne postanemo žrtev stresa. Večkrat si vzemimo minuto ali dve časa. Počivajmo ter sprostimo svoje telo. Ne mislimo na nobeno stvar (meditirajmo/sanjarimo). Če imamo možnost, izkoristimo svoj odmor za kratek , umirjen in sproščujoč sprehod, brez večjih fizičnih naporov.

Ključne besede: Elektronska revolucija, stres, stres in delovno mesto

Abstract

On our way to electronic revolution lots of people have reduced their active lives to sitting at their desks and computers. Thus lots of precious time has been saved. Despite the lively progress in some areas, the fast development has brought about some difficulties and disadvantages. Being stationary for more headache, anxiety, nervousness, tension, exhaustion, pains and various medical problems. The moderen times rarely leave time for relaxation. New responsbilties, duties and pressures keep coming into people's lives, and they all cause stress. However, stress is not always negative, its kind depends on the individual himself. But ther is olways a border, wher 'good stress' transforms into the negative stress. At our work enviroment we should be aware that being too meticulous and fussy abaut detais might turn us into victims of stress. Every day we should take a minute or two of our time to rest and relax. We should empty our minde, stop thinking about anything (meditate/day-dream) If we have the possibility, we should spend our break for calm and and relaxing walk, without greater physical efforts.

Keywords: Eletronic /virtual revolution, stress, work enviroment.

Moj prvi film (delamo z WMM)

My First Movie (working with WMM)

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Povzetek

Na naši šoli že nekaj let načrtujemo in izvajamo delo z nadarjenimi učenci. Ponudimo jim številne dejavnosti, v katere se potem vključujejo po lastni izbiri. Ena izmed dejavnosti so tudi računalniške vsebine. Letos smo se skupaj z nadarjenimi učenci odločili, da bomo spoznali program Windows Movie Maker - WMM in vse pomembne dogodke, ki smo jih na šoli sproti zabeležili z digitalnim fotoaparatom, zmontirali ter ponudili na ogled v obliki filma. Učenci se sami odločijo, na katero temo bodo posneli film. Pri delu s tem programom učenci:

- širijo in poglabljajo temeljno računalniško znanje,
- razvijajo ustvarjalnost,
- uporabljajo sodelovalne oblike učenja,
- lahko svobodno izbirajo med raznovrstnimi ponudbami ,
- naučijo se pravilno uporabljati in kombinirati različne multimedijske naprave (računalnik, digitalni fotoaparat, skener, LCD projektor).

Recept za delo s programom WMM: Sestavine: priljubljene slike, zabavni video in avdio posnetki, nekaj ur časa in vedoželjni učenci. Dodamo: domišljijo, ščepec humorja, originalnost, ustvarjalnost, individualnost. Potrebujemo še: operacijski sistem Windows XP ali Windows Vista (naša posoda), kjer fotografije, videoposnetke in glasbo zmontiramo. Na koncu projekt posnamemo (spečemo) kot film. Še toplega objavimo na šolski spletni strani, ob raznih prireditvah ponudimo učencem, staršem in drugim obiskovalcem šole. Udeleženci delavnice se bodo naučili izdelati svoj film v programu WMM (z napisi, odjavnimi špicami, animacijami …) iz lastnih slik, video posnetkov in zvočnih posnetkov. Pridobili bodo izkušnje za posredovanje znanja učencem.

Ključne besede: Snemanje, fotografija, film, videoposnetek, zvočni posnetek, efekt, učinek, naslov, video, avdio.

Abstract

We have worked with talented pupils on many different fields of interests. They are choosing from a wide selection of presented possibilities. One of the most popular is the computer workshop. This year pupils will be learning about Windows Movie Maker - WMM. With digital camera we shoot pictures about every important events in our school. With the Movie maker we capture those photos and make nice and funny movies. They:

- wide and deep the basic computer knowlege,
- Develope creativity,
- Engage in learning,
- have free choices,

- learn how to use a range of multimedia devices (computer, scanner, digital camera, projector).

Recipe for working with WMM: Ingredients: favoured photos, fun video footage, a few hours of free time and eager students. Add: imagination, a pincg of humor, creativity, individuality. We also need: OS Windows XP or Vista, where we put things together. At the end: we save the project as a movie. We past it on the school web site. And then theyshow the movies to the students, parents and other school visitors on special ocasions. The participants of this workshop will learn how to make their own movie with WMM (with subtitles, titles, credites, animatons …) and they will provide skills wich will help them educate pupils how to use this programme.

Keywords: Movie Maker, movie, sound, capture, media, effect, transitions, titles, video, audio.

Evolucijsko reševanje šolskih urniških problemov v osnovni in srednji šoli

The Evolutionary Way of Solving the Scheduling Problems in Primary and Secondary Schools

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Povzetek

iUrnik – je programski robot kateremu posredujemo minimalne potrebne vhodne podatke. Okoli 30 uteži določa kriterijsko funkcijo za praktično uporaben urnik in vse potrebne relacije med učenci, učitelji, prostori/učili in predmetnikom. Na računalniku simulirana evolucija urnikov producira z zadanimi nastavitvami vedno bolj in bolj skladne urnike. Inteligentni urnik je izdelalo podjetje Algit (ALGoritemske Informacijske Tehnologije), to je podjetje za algoritemske optimizacije različnih problemov. Samo navidez enostavnega problema, kot je šolski urnik, človek ne more več dobro rešiti brez zelo močnega programa, zato je tu iUrnik, kjer glavno vlogo odigra evolucijski algoritem.

Ključne besede: urnik, učenec, učitelj, program, predmetnik, sistemizacija, robot

Abstract

iUrnik – is a software robot, to which we provide the minimal data of initial conditions. About 30 ponders which represents the fitnes function and also every relevant detail about the school - students, teachers, classrooms… A simulated digital evolution provides increasingly better school schedules. The Inteligent sholl scheduling program has been produced by Algit d.o.o (ALGoritemske Informacijske Tehnologije). We optimize algorithmic solutions. School schedules are classical example of such a NP problem, where even humans are quite lost. Therefore, we have iUrnik which evolves the schedule digitally with incredible success.

Keywords: Scheduler, teacher, student, group, penalties, input, robot.

Ključ do zabavnega fitnesa je video vadba

The Key to Fun Fitness Is Exergaming

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Povzetek

Video vadba je sodelovanje v tehnološko aktivirani fizični aktivnosti, ki upošteva uporabnika v akciji ali igri. V obliki zabave (ang. game play) ustvari izkušnjo v virtualni realnosti, ki zahteva od udeležencev, da uporabljajo svoje telo v aktivnosti igre. Za pravo virtualno izkušnjo si uporabnik nadene 'magični pas', ki ga postavi v središče video igre in ko se hitro premika in visoko skače, prestreza žoge, da ne padejo na tla ter s tem pridobiva pozitivne točke. Tako vadba hitreje mine, zaznan napor pa je minimalen. Danes so na tržišču številni sistemi video vadbe in pripadajoči izdelki. Video vadba se lahko uporablja v profesionalnem športu, v zabavni rekreaciji, pri uvajanju novih športnih disciplin in za organizacijo pravih internetnih tekmovanj. Mogoče jih bodo sčasoma uvedli celo v šolie v učni proces.

Ključne besede: šport, športna vzgoja, fizična aktivnost, video vadba, računalniki, video igre, virtualna izkušnja.

Abstract

Exergaming is participating in technology-driven physical activities which involve the user in action or role play in the form of the computer game. It creates a virtual reality experience requiring members to use their body to participate in the computer gaming activity. For real virtual experience the user put on the »magic belt« which will put him in the centre of the video game. The user will score points if he moves fast and jumps high enough to catch the ball before it falls down. The time doing of this practice passes away much faster and the effort invested in it is minimal. These days many systems of exergaming and the belonging products are accessible on the market. Exergaming can be used in professional sport, as a fun in fitness, for introduction new type of sport or for internet competitions. They might be gradually introduced into educational process in Slovene schools, too.

Keywords: sport, gym class, physical activities, exergaming, computers, video games, motivation, virtual experience.

Navajanje študentov zdravstvene nege k uporabi informacij, dostopnih prek svetovnega spleta

Making Students of Nursig Used to Application of the Information Accessible through the Internet

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Povzetek

Uvod: Uporaba sodobne komunikacijsko-informacijske tehnologije za iskanje aktualnih strokovnih in znanstvenih informacij, ni več stvar izbire, ampak nujnost za vse, ki želijo biti strokovnjaki, kar velja tudi za področje zdravstvene nege. Študentje kot bodoči strokovnjaki, jo morajo že v času šolanja spoznati in pričeti uporabljati. Problem: Navkljub možnostim je uporaba teh virov podatkov v zvezi konkretnimi strokovnimi problemi ter vprašanji premajhna. Prikaz primera: Študenti zdravstvene nege Visoke šole za zdravstvo v Ljubljani morajo v tretjem letniku med drugim opraviti tudi seminar s področja Zdravstvene nege internističnega bolnika. Izbrati si morajo problem iz realnega sveta zdravstvene nege, nato pa najti ustrezne deskriptorje ter izvesti iskanja v podatkovnih zbirkah Medline, Scinahl ter Chochrane ter si ogledati relevantna spletna mesta. Naročiti se morajo tudi na Jupsline ter Medscape. Najti morajo tri pomembne članke na izbrano temo, jih povzeti in na podlagi novih znanj podati ustrezne zaključke. Sklep: Zasnovo in izvedbo takšnih seminarjev je potrebno iz leta v leto spreminjati glede na aktualne informacijske vire in dostope do njih in glede na že razvite spretnosti študentov.

Ključne besede: Zdravstvena nega, študenti, informacije, internet.

Abstract

Purpose: The use of modern communication technology for seeking topical professional and scientific information is no longer a matter of choice, but is truly a need for anyone who wants to become a professional, which is applicable to nursing as well. Students, as future experts, should become familiar with the technology and start using it already during their education. Problem: In spite of the opportunities, usage of the sources of all the relevant data treating specific professional problems reachable through the Internet, is unsufficient. Example: Students of the third year of Nursing at the College of Health studies, Ljubljana have to, among other duties, take a special course in the field of Nursing. The students have to choose a problem from the field of real life in Nursing. They have to find relevant descriptors. The information are to be found in the Medline, Cinahl and Chochraine databases, relevant web sites are to be visited and sign up registration at the Jupsline and Medscape Nursing are to be done. From these sources three relevant articles are to be chosen and summarized, and based on the new knowledge, conclusions are to be drawn. Conclusion: Based on the currently accessible sources and the average students' computer literacy, planning and realization of such courses need to be changed year by year.

Keywords: nursing, students, information, Internet.

Uporaba informacijsko komunikacijske tehnologije pri pouku biologije in naravoslovja

The Use of Information Communication Technology at Biology and Natural Science Lessons

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Povzetek

Uporaba informacijsko komunikacijske tehnologije učitelju razširja možnosti poučevanja, učencem pa predstavlja privlačnejšo možnost učenja. Njena prednost je povezovanje različnih področij z računalništvom oziroma informatiko. Učenci na ta način poleg pridobivanja znanja iz določenega predmeta izboljšujejo tudi svojo računalniško pismenost. Ena izmed sodobnih oblik podajanja informacij so elektronske prosojnice. Z vzpodbudo učencev, da predstavijo svoje seminarske naloge v takšni obliki, jih hkrati naučimo tudi uporabe programa Power Point. Tudi svetovni splet v zadnjem času predstavlja pomemben vir podatkov za učenje. Pomembno je, da v kopici podatkov učenci znajo najti tiste, ki jih potrebujejo za reševanje svojih nalog in upoštevajo tudi verodostojnost vira. S tem pa se možnosti uporabe računalnika v pedagoškem procesu še ne končajo. Dober način za razbijanje monotonosti pri konvencionalnem učenju so računalniški programi, ki poleg inovativne predstavitve snovi omogočajo tudi preverjanje znanja. Računalnik pa omogoča tudi nadgradnjo klasičnega mikroskopiranja, saj z uporabo posebnega mikroskopa s kamero slike lahko prikazujemo na projekcijskem platnu.

Ključne besede: informacijsko komunikacijska tehnologija, računalniška pismenost, elektronske prosojnice, spletne strani, računalniški programi, mikroskop s kamero.

Abstract

The use of information communication technology extends the teaching possibilities for the teacher and represents more attractive way of learning for pupils. Its advantage is the ability to connect various fields with computer and information science. It enables the pupils to gain knowledge in certain subject and improve their computer literacy at the same time. One of modern ways of handing the information are electronic transparencies. As pupils present their projects this way they also learn how to use Power Point. The World Wide Web is lately also an important data source. It is important that pupils know how to find relevant data in the stack of information and be careful about its credibility. The list of possibilities of using computer in pedagogic process is herewith not finished. A good way for decreasing monotony of conventional learning are computer programs which enable an innovative mode of teaching as well as testing of pupils' proficiency. The computer also makes possible to upgrade of conventional microscopy as one can connect it to a microscope with camera and thus to present the picture on the projection screen.

Keywords: information communication technology, computer literacy, electronic transparencies, web pages, computer programs, microscope with camera.

UNITE – Primer dobre prakse e-izobraževanja

UNITE – The Case of Good Practise of eLearning

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Povzetek

Prispevek predstavi projekt UNITE kot primer dobre prakse e-izobraževanja in m-izobraževanja. V projekt se je kot del mreže šol vključila tudi Gimnazija in srednja ekonomska šola Trbovlje. Učitelji so v sodelovanju z nacionalnimi partnerji kreirali in pripravili vsebino ter implementirali pedagoške scenarije s pomočjo spletne aplikacije UNITE in mobilnih aparatov. Pedagoški scenariji so bili pripravljeni za različna področja kurikuluma, implementiral pa se je scenarij, vezan na informatiko, geografijo in zgodovino.

Ključne besede: IKT, e-izobraževanje, m-izobraževanje

Abstract

The paper aims to present the UNITE eLearning and mLearning good practise that have been implemented in Gymnasium and economic secondary school Trbovlje as a part of the Network of Schools. UNITE school teachers in cooperation with local partners designed, prepared the content and implemented the pedagogical scenarios with help of UNITE platform and mobile devices. Pedagogical scenarios were created for different area of curriculum, in Slovenia was implemented the scenario regarding the informatics, geography and history.

Keywords: ICT, eLearning, mLearning.

Obremenitev in motivacija študentov pri spletno podprtem izobraževanju: Priporočila na podlagi primerjave istočasnih kombiniranih izvedb predmeta „Multimediji” na različnih šolah

Student Workload and Motivation in Web-Supported Education: Recommendations Based on a Comparison of Three Simultaneous Blended Deliveries of the Course „Multimedia” at Different Schools

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Povzetek

Prispevek predstavlja in preizprašuje problematiko obremenitve študenta in z njo povezane učne motivacije, še posebej v kontekstu najnovejših, t. i. Bolonjskih prenov študijskih programov. Pri tem se posebej osredotoča na spletno podprto, kombinirano izobraževanje. Skozi primerjavo treh istočasnih kombiniranih izvedb predmeta „Multimediji” na treh različnih slovenskih višjih strokovnih šolah, ter opis izbranih dobrih praks, so podana priporočila za prihodnostno naravnano, aktivno rabo novih IKT v izobraževanju – od kurikularno-razvojnih vidikov, preko kombiniranih oblik procesov ocenjevanja in zagotavljanja kakovosti, do didaktičnih metod, npr. rabe forumov, wiki-jev, online gradiv in virov (tudi multimedijskih) ter drugih e-izobraževalnih oblik. Z vidika zmanjševanja obremenitve tako učitelja kot študentov ter hkratnega povečevanja učnega učinka oziroma zviševanja učne motivacije so tako podani prvi obrisi interaktivnega razbremenitvenega modela kombiniranega izobraževanja.

Ključne besede: obremenitev, dejanska, motivacija, učni učinek, e-izbraževanje, kombinirano, praksa

Abstract

The article presents and questions the issue of student workload and learning motivation, especially in the context of recent so called Bologna curriculum renewals. Therein it focusses especially on the web-supported, i. e. blended form of learning. Through a comparison of three simultaneous blended deliveries of the course „Multimedia” at three different higher vocational schools in Slovenia, and with description of selected good-practice examples, recommendations are given for a future-oriented, active use of new ICT in education – from curriculum-development thorugh blended forms of assessment and quality assurance, to didactical methods, e. g. use of forums, wikis, online materials and resources (also multimedia), and other forms of e-learning. From the perspective of decreasing the workload for both teacher and student as well as simultaneously increasing the learning effectiveness and motivation, the article originally attempts at sketching an interactive model for decreasing workload through blended learning.

Keywords: workload, actual, motivation, learning effectiveness, e-learning, blended, practice.

Mehatronizacija procesov kot nova smer nadgradnje informatike

Mechatronisation as new direction of informatics development

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Povzetek

Novejša veda mehatronika se je že pojavila v šolah od univerzitetnega do poklicnega nivoja. Tako pri študentih kot tudi pri sodelavcih v podjetjih nastajajo različne predstave o tem, kaj je mehatronika, kje je področje dela za strokovnjake mehatronike. Podane so osnovne definicije in sheme mehatronskih sistemov na treh osnovnih nivojih: od tehnoloških do strojnih in proizvodnih mehatronskih sistemov. Mehatronika izhaja zgodovinsko iz mehanskih procesov, se nadgrajuje z elektromagnetnimi in zaokrožuje z informacijsko komunikacijskimi procesi. Predhodnica mehatronike je avtomatizacija procesov, ki pa se nadaljuje z mehatronizacijo ročno in osebno upravljanih procesov na podlagi elektronsko izmerjenih podatkov iz nadzornih sistemov. Zgrajen je tudi mehatronski didaktični sistem za nadzor mehatronskih sistemov na vseh treh nivojih. Nadzorni sistemi pri avtomatskih procesih nadgrajujejo avtomatizacijo na eno ali več stopenj višjo raven, pri ročno ali osebno upravljanih procesih pa generirajo nove do tedaj nevidne slike procesov, ki uporabnika navadijo razmišljanja z več novimi dimenzijami in s tem povzročajo razvoj procesov z višjo dodano vrednostjo in tudi vse ostalo, kar tako osebje dela, je na višjem nivoju, kot prej.

Ključne besede: Mehatronika, informatika, tehnološki, strojni, proizvodni, sistem, proces, dejavnik, avtomatizacija, nadzorni sistem

Abstract

The new schools of mechatronics from university degree to manual professions arises in Slovenia last few years. The students and their co-workers in the companies have very different imagination about mechatronics as science and also as working field of mechatronic workers. Some basic definitions and schemas of on three levels from technological, to mechanical and manufacturing mechatronics systems are described. From the historical point of view teh mechatronics began with mechanical processes upgrading with electromagnetics and rounded up to information and communication processes. Preliminary the automation of processes was growth in new direction with mechatronisation of manual and personal process control on base of electronically measured data of monitoring systems. The new didactic system for three level mechatronics monitoring systems was built. The monitoring systems upgrades the automatisation level of automatic processes. They also generate new pictures of unvisible manual and personal controlled processes which make user thinking in more dimensions as before and enable the development of new processes with higher added value. Everithing, what is done is better than before.

Keywords: mechatronics, informatics, technological, mechanical, manufacturing, system, process, factor, automatization, monitoring.

Slovenščina na splošni maturi 2008 in 2009 ob podpori IKT v panožnem centru za smučarske skoke in nordijsko kombinacijo

ICT Support for Slovene Language in the General Matura 2008 and 2009 in Ski Jumping and Nordic Combination Centre

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Povzetek

Avtorica v članku pripoveduje, na kakšen način si pomagamo z IKT pri slovenščini pri pripravi na splošno maturo v Panožnem centru za smučarske skoke in nordijsko kombinacijo. Dijaki športniki so zelo veliko odsotni od pouka, zato jim je IKT v veliko pomoč pri pripravi na maturo. Dela, ki jih morajo dijaki prebrati za splošno maturo 2008 in 2009 - J. B. P. Molière, Tartuffe; Ivan Cankar, Kralj na Betajnovi; Friedrich Dürrenmat, Fiziki; Matjaž Zupančič, Vladimir (matura 2008); Jane Austen, Prevzetnost in pristranost; Andrej Hieng, Čudežni Feliks (matura 2009) – smo spoznavali s pomočjo medmrežja. Dijaki so si pošiljali internetne vire za seminarske naloge, po dva dijaka sta si dopisovala po e-pošti in se učila pisati besedilne vrste. Naredili so razčlembe neumetnostnega besedila in imeli PowerPoint predstavitve. V šolskem letu 2008/2009 bomo dosedanje delo nadgradili s spletno učilnico Ekonomc http://239.gvs.arnes.si/ucilnica-ekonomc.

Ključne besede: dijaki športniki, slovenščina na splošni maturi 2008 in 2009, medmrežje, e-pošta, e-izobraževanje, IKT

Abstract

The author is pointing out how we can employ IC technology when preparing students for the general Matura in Slovene of Ski jumping and Nordic combination Centre. IC technology is very helpful for the students athletes, who are absent from their lessons. The literary works, prescribed for the general Matura 2008 and 2009 - J. B. P. Molière, Tartuffe; Ivan Cankar, Kralj na Betajnovi; Friedrich Dürrenmat, Fiziki; Matjaž Zupančič, Vladimir (Matura 2008); Jane Austen, Prevzetnost in pristranost; Andrej Hieng, Čudežni Feliks (Matura 2009) – have been approached by the help of the internet. The students sent each other internet sources for their seminar papers. Students work together in pairs exchanging e-mails and learning writing texts. Students had analysed the non-fiction texts and made PowerPoint presentations. In the school year of 2008/2009 we will continue our lessons with the web work classroom Ekonomc http://239.gvs.arnes.si/ucilnica-ekonomc.

Keywords: students athletes, the general Matura 2008 and 2009 in Slovene, internet, e-mail, e-education, IC technology.

E-izobraževanje med pedagoško-didaktično teorijo in prakso
E-education between Pedagogical and Didactic Theory&Practice

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Povzetek

Pred šolo so nove zahteve, da postane bolj učinkovita in s tem več prispeva k ekonomskemu uspehu družbe. Hkrati pa šola dobiva ponudbo, naj svoje naloge opravlja z naprednejšo tehnologijo. Informacijska tehnologija v zmogljivostih močno presega dosedanjo učno tehnologijo. Z internetom, ustvarja elektronsko vzporednico klasični šoli in klasičnemu učenju. Obstajajo, žal šele posamezni dokazi, da lahko s podporo IT, to je z e-izobraževanjem izrazito izboljšamo učenje in tudi šolo v celoti. Verjamemo lahko, da ni poti nazaj in da ne gre za modno muho. Vendar pa ne vemo natanko, kdo naj se tega loti in kako ter za koliko. Zadržanost pedagogov, pomanjkanje empiričnega raziskovanja in krati nastajanje trga proizvodov za e-izobraževanje brez ocene kakovosti, temu razvoju ni v prid. Prodor e-produkcije brez oči, ušes in mnenj pedagogov, ki morajo razen za prakso poskrbeti tudi za napredek lastne teorije, lahko dosedanjim izobraževalnim dosežkom škodujejo. Didaktika lahko po analogiji marsikaj izvede in ovrednoti tudi v spletnem okolju, razen tega pa vzpostavi ustrezne mehanizme za vrednotenje elektronskih in virtualnih elementov izobraževanja. Predvsem spodbudi k iskanju prave poti in uravnavi vijugavih poti do kakovosti e-izobraževanju in boljšega znanja je namenjen ta prispevek.

Ključne besede: didaktika, e-izobraževanje, informatizacija, IT, informacijska tehnologija, multimedija, interaktivnost, kakovost znanja

Abstract

In last years the scool is under the preasure to become more effective and to contribute to economic prosperity of society. In the same time there are new opportunities on education tehnology market. The information tehnology much more surpasses traditional learning tehnology. With internet we have paralel way for traditional school and traditional learning. We have some research results confirming thesis that IT may improve the school and the learning process generally. But it is the thrue, that we have no back way and that the e-learning is not only a caprice. But the true is, that there many unanswered questions. Whose problem is the e-education? How to solve them and how much will it cost? Hindrances of pedagogists, deficiency of research results and growing market of unverified e-education products are not good for development in this field. E-education without pedagogists eyes, ears in without their knowledge, may do a harm to such projects and to level of the knowledge. Especially because they must fundamentally contribute to the pedagogical theory. We may with didakticts by analogy realise and evaluate the learning process in web-environment, separately carry out special instruments for electronic and virtual components of education. The hearth of this article is how to stimulate the right way and how to straighten the curved ways to better education and to quality of knowledge.

Keywords: Didactics, e-education, informatization, IT, information tehnology, multimedia, interactivity, knowledge quality.

E-gradivo ter spletno učno okolje v luči motivacije in druženja

E-material and learning web-environment in the field of motivation and social inclusion

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Povzetek

Motivacija se tudi med učenjem na spletu ne poraja samodejno, zato moramo pogoje zanjo vzpostaviti, kar je še posebej pomembno, ker med učenjem ni pomočnika, ki bi jo obujal. V tesni povezavi z motivacijo je tudi vzpostavljanje socialnih interakcij, saj je so, če so primerne vzpodbudne za učenje. Motivacijo lahko vzpostavljamo tako z gradivom kot s spodbudami, ki prihajajo iz spletnega učnega okolja. Možnosti za druženje pa ustvarjamo predvsem v okolju. V sestavku opisujemo nekatere možnosti motiviranja in nekatere možnosti za vzpostavljanju socialnih stikov. Omejujemo se na tiste, ki so značilni za e-okolje, manj nas zanimajo tiste, ki jih po analogiji prenašamo iz klasičnega okolja. Opominjamo, da ima učenec pravico biti sam in se odločiti, kaj bo pokazal učitelju in sošolcem. Opominjam tudi na moč pohvale, vzpodbudne in optimistične komunikacije. Sinergija vseh dejavnikov, ki jih ustvarjajo motivacija in socialni odnosi pa se zlivajo v učno klimo. Ugodna učna klima dobro deluje na kakovost učenja, ugodna refleksija učencev, pa prispeva k dobri oceni kakovosti pouka.

Ključne besede: Motivacija, druženje, socialne interakcije, e-gradivo, spletno učno okolje, učna klima

Abstract

Motivation during e-learning on web is not rising avtomaticaly. That is the reason for necessity to restore the stimulative circumstances. There is no assistant during learning, which may awake or activate the student. Close to motivation is social inclusion, which stimulates the learning if it is good and pleasant. We have much opportunities to grow up learning motivation with e-material and e-environment. But the possibility of keeping company with others is especially in learning environment. In this article some possibilities and tehnics of social inclusion are presented. In the focus are the circumstances which are tipical for e-environment and less the stimulations transmited from traditional classroom. We must remind that the student has a right to be alone if he wants to, and to decide what may be showen to others. We remind the force of praise and the potency of optimistic and stimulative communication. The sinergy of all factors created with motivation and social realtions is learning climate or learning chemistry. Stimulative learning climate suppprts the quality of learning. In good climate students reflexion, when evaluates the learning process, is positive.

Keywords: motivation, sociability, social interactions, e-material, web-based learning environment, learning climate.

Dinamične spletne strani kot pripomoček pri poučevanju otrok in mladostnikov s posebnimi potrebami

Dynamic Web Pages as a Tool for Teaching Students with Special Needs

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Povzetek

Članek obravnava problematiko uporabe računalnika in interneta kot pripomoček pri poučevanju otrok in mladostnikov s posebnimi potrebami - natančneje s primanjkljaji na področjih učenja ter otroci s čustvenimi in vedenjskimi motnjami. Še nedavno je pomanjkanje informacijske tehnologije in neustrezno znanje strokovnih delavcev iz tega področja predstavljalo največjo oviro pri uporabi računalnika in interneta pri pouku, dandanes pa se bolj soočamo s težavami ustreznih vsebin za čimbolj učinkovito in smiselno uporabo informacijske tehnologije. Kot delna rešitev je predstavljena spletna stran za potrebe predmeta računalništvo in poslovna informatika, ki vsebuje slikovne, animacijske in multimedijske vsebine. Te dinamične spletne strani omogočajo lažje sledenje pouka, samostojnost pri učenju ter takojšnjo povratno informacijo.

Ključne besede: Računalnik pri pouku, dinamična spletna stran, multimedijske vsebine, otroci in mladostniki s posebnimi potrebami

Abstract

The article deals with problems of application of computer and Internet as a tool for teaching students with special needs - more precisely with learning problems and children with emotional and behavioral disorders. Still, not long ago the lack of information technology and unsuitable knowledge of professional workers from this field presented largestobstacle in using computers and Internet in classes. Nowadays we are confronted with problems of appropriate contents for more efficient and reasonable use of information technology. A web page, which contains image, animation and multimedia contents is introduced as a partial solution for subject Computing and business information science. These dynamic web pages provide easy instructions, autonomy at learning and immediate feedback.

Keywords: computer in class, dynamic web page, multimedia content, children and adolescents with special needs.

Izbira učbenika za 6. Razred devetletke pri predmetu matematika

Selecting a Course Book for Teaching Maths in the 6th Grade of Primary School

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Povzetek

Učitelji se pri svojem delu srečujejo z mnogimi odločitvami, ena takšnih je tudi izbira učbenika, ki ga bodo uporabljali pri pouku. Odločitev je običajno sprejeta v okviru aktiva učiteljev, kar pa zahteva veliko sodelovanja, komunikacije, izražanja mnenj in nenazadnje prilagajanja. Za kakovostno odločanje bi predstavljen model lahko bil učiteljem v pomoč pri izbiri, saj omogoča večjo preglednost, hitrejšo obdelavo podatkov in zmanjšuje pristranskost.

Ključne besede: Učbenik, odločitveni model, kriteriji, Dexi

Abstract

Teachers have to take many decisions in their work; one of them is which school book to choose for teaching. The decision is usually made by a team of teachers, and this demands good team work, communication, expressing of opinions and finally a lot of flexibility. The introduced model can be useful for effective decision making, since it offers a clear overview, faster data handling and reduces subjectiveness.

Keywords: School book, decision model, criterions, Dexi.

Učinkovitost oddaljenih laboratorijev za poučevanje na področju tehnike

Remote Laboratories Effectiveness for Education in Technical Sciences

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Povzetek

Sodobni izobraževalni procesi prinašajo s seboj nove izzive za integracijo informacijske in komunikacijske tehnologije v učne procese. Zaradi zahtev in potreb industrije po hitrejšem in učinkovitejšem pridobivanju praktičnih izkušenj se iščejo nove rešitve za izvajanje vaj, ki bi pritegnile in motivirale študente za dodatno pridobivanje znanja. Ena od rešitev so oddaljeni laboratoriji, ki nudijo izvajanje laboratorijskih eksperimentov v živo na izobraževalni instituciji, kar zmanjša potrebnost neposredne fizične prisotnosti študentov in povečuje možnosti za izboljšanje znanja študentov za reševanje določenih tehniških problemov. V članku je predstavljen primer uspešne izvedbe oddaljenega laboratorija za področje tehnike skupaj s tečajem, ki deluje v okolju Moodle. Posebej je izpostavljen tudi postopek prijavljanja na izvajanje oddaljenih eksperimentov ter sama izvedba vaje skupaj z opisom grafičnega uporabniškega vmesnika. Izvedena je bila evaluacija s priznano metodo SUMI za ocenjevanje uporabniške prijaznosti sistema. Poleg tega se je ugotavljal tudi odziv študentov na delo z oddaljenim laboratorijem. Rezultati raziskav so pokazali, da je v delu predstavljen oddaljeni laboratorij ustrezno uporabniško prijazen in s strani študentov in učiteljev sprejet kot primerna in zanimiva dopolnitev klasičnih laboratorijskih vaj.

Ključne besede: oddaljeni laboratorij, mehatronika, ocenjevanje uporabniške prijaznosti.

Abstract

Modern educational methods bring many new challenges including the integration of information and communication technology into the education process. Industry requests and needs faster and more efficient acquisition of practical skills which can be achieved by introduction of experimental exercises that attract and motivate students. Therefore new approaches and solutions for execution of practical exercises are being continually sought. One of the possible solutions are remote laboratories which offer possibility to execute real remote laboratory experiments in the educational institutions' laboratories and therefore enhance the students' knowledge and capability for dealing with some technical problems without the need for their physical presence in the laboratory. In the paper the example of successful implementation of remote laboratory and experimental remote course developed in Moodle environment is presented. Special attention is given to description of booking process for remote experiments, execution of remote experiment and applied user interface. Evaluation of interface usability from the point of view of end user was carried trough with acknowledged and proven SUMI method. Additionally another questionnaire was executed in order to investigate students' opinion about working in the remote laboratory. Results show that here presented remote laboratory is user friendly and accepted by both teachers and students as suitable and interesting supplement to the conventional laboratory exercises.

Keywords: remote laboratory, mechatronics, usability evaluation.

Uporaba video analize pri učenju plavalne tehnike delfin

Video Analysis in Learning Process of Butterfly Swimming

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Povzetek

Plavalni šport je v 80-ih letih prejšnjega stoletja doživel pomemben preobrat. Tekmovalci si ne pomagajo več predvsem z močjo, ampak so razvili nove tehnike, ki dajejo poudarek učinkovitosti plavanja. Ena pomembnejših sprememb je povečan poudarek na valovanju telesa med plavanjem. Ustrezno valovanje telesa je postalo nepogrešljivo pri obratih in to v vseh tehnikah plavanja. Plavalna tehnika delfin slovi kot najtežja in se je mnogi tekmovalci izogibajo. V raziskavi smo proučili možnosti uporabe video kamere, kot inštrumenta za pospešitev učenja te zahtevne plavalne tehnike. Proučevali smo časovne in tehnične posebnosti plavalčevega stila. Cilj raziskave je bil ugotoviti stopnjo znanja, ki jo v delfinovem slogu lahko usvoji rekreativni plavalec v okviru enoletnega učenja. Rezultati dokazujejo, da je plavalec uspel odpraviti 8 od 11 odkritih napak v tehniki. Preostale napake nakazujejo pomanjkanje gibljivosti in moči. Kljub primerni tehniki se plavalec ni uspel približati časom veteranskega nivoja. Menimo, da z usmerjeno, informacijsko podprto enoletno vadbo dolgih let treningov ni mogoče nadomestiti.

Ključne besede: plavanje, delfinova tehnika, video-analiza, valovanje

Abstract

In the 80's, important breakthroughs were made in the swimming sport. Since then, competitors don't rely solely on physical power, but stick to newer techniques, which emphasize efficient swimming. Among the most noticeable changes in modern swimming is the increased use of the body wave motion, called undulation. It has become indispensable for fast turning and originates from the butterfly stroke. Butterfly is often referred to as the hardest of all swim styles and avoided by competitors. In this study, the possibilities of a quicker learning by means of video camera use were examined. The goal of our research was to estimate the level which could be achieved by a recreational swimmer within a year of practice. The results show 8 out of 11 detected technique flaws successfully eliminated by our swimmer. The remaining flaws suggest a lack of flexibility and power. Althogh the swimmer has achieved proper form, masters level was not within reach. We deduce that long years in the swimming pool cannot be substituted by short-term methodical learning.

Keywords: swimming, butterfly stroke, video analysis, undulation.

Razvoj IKT kompetenc in šolski informacijski sistem

The Developement of ICT Competences and the School Information System

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Povzetek

V prispevku je predstavljena vzpostavitev in uporaba šolskega informacijskega sistema kot primer dobre prakse pri informatizaciji procesov v sodobni šoli. Prikazano je, kako za vodenje in organizacijo dela na šoli uporabiti šolski informacijski sistem in s tem razvijati IKT kompetence vseh zaposlenih. Avtorica kot pomočnica ravnateljice in članica tima za informatizacijo opisuje specifične organizacijske probleme, ki jih je tim za informatizacijo analiziral in s pomočjo IT poiskal rešitve zanje.

Ključne besede: Informacijski sistem, organizacija dela na šoli, IKT kompetence

Abstract

In this contribution the establishement and usage of the school information system is described and it is a good example of the informatisation of processes in a contemporary school. It is described and presented how we can use the school's information system at our school for the guidance and organisation of work and through this we can develope and improve the ICT competences of all the emloyees. As the assistant of the headmistress and team member for the informatisation, the author describes the specific organization problems, which the team has analized, and with the help pf IT, has found a solution for this problems.

Keywords: Information system, organization of work at school, ICT competences.

Odločitveni model za izbiro vzgojitelja v dijaškem domu

Decision Support System to Choose Educator in a Boarding School

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Povzetek

Človek se vsak dan sooča z različnimi odločitvami, ki jih je potrebno sprejeti. Te odločitve so včasih čisto preprostega tipa in do njih ni težko priti, včasih pa so težavne, saj so odvisne od veliko kriterijev. Pri težkih odločitvah nam lahko pomagajo odločitveni modeli, katere lahko dokaj preprosto izdelamo s pomočjo nekaterih, za ta namen specializiranih, računalniških programov. Pomembno je poudariti, da rešitev, oziroma najboljša odločitev, do katere smo prišli s pomočjo programov za podporo pri odločanju, ni vedno najboljša. Na njeno oceno vpliva veliko kriterijev, ki pa so bili izbrani z naše strani in obstaja velika verjetnost, da smo katerega preslabo ocenili, katerega od tistih nepomembnih dodali, in katerega od zelo pomembnih izpustili. V tem prispevku bom ocenjevala izbiro najustreznejšega kandidata za vzgojitelja v dijaškem domu s pomočjo odločitvenega modela Dex-i.

Ključne besede: odločanje, sistemi za podporo odločanju, Dex-i, vzgojitelj

Abstract

People need to make crucial decisions on a daily basis. Those decisions are sometimes easy to make, and sometimes they are a lot harder to make, because of their complexity and they depend on many criteria. When making hard and complex decisions we could use the help of decision support systems. It is important to stress out that the decisions, which is based on decision support system is not always the best decision to make. There are many effects on its result, which where chosen by us and there is relatively high possibility of bad criteria. Some of important criteria's could be left out or the role some unimportant is too high. In this work we will try to decide which educator is the best in a boarding school with decision support system Dex-i.

Keywords: decision making, decision support systems, Dex-i, educator.

Izobraževanje danes za poklice prihodnosti: Izzivi informacijske družbe

Educating Today for Professions of Tomorrow: Challenges of Information Society

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Abstract

When planning educational programmes, choosing the field of studies or planning professional career, it is of utmost importance to take into account not only personal interests and capabilities, but also trends of global industry. It is also necessary to recognise the directions set by the international community (civil organizations, professional associations, environmental organizations and politics). Some professions were very important and progressive at certain time in the past, but have died out due to technical development. On the other hand, some of them, although being very traditional, remain among most important ones for centuries. In the paper we identify several factors influencing the emerging and disappearing professions and discuss them in the context of sustainable development and information society.

Keywords: human resources, professions, sustainable development, information society, knowledge management.

Izobraževalni model v skladu z Lizbonsko strategijo v javni upravi

Lisbon Strategy Education Model for Public Administration

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Povzetek

Povzetek obravnava področje vseživljenjskega izobraževanja odraslih, ki je s tako imenovano Lizbonsko strategijo v letu 2000 končno pridobilo ustrezno mesto v izobraževalnem sistemu. Z raziskavo o vključenosti v vseživljenjsko izobraževanje smo želeli pridobiti informacije o motivaciji, o ovirah in potrebah, ki spremljajo odrasle zaposlene pri vključevanju v izobraževanje. Ugotovili smo, da se zaposleni manj vključujejo v formalno izobraževanje zaradi finančnih razlogov, prevelike zaposlenosti in obremenjenosti s službenimi in družinskimi obveznostmi. Se pa pogosteje vključujejo v krajše oblike neformalnega izobraževanja in usposabljanja, ki ga v večini financira delodajalec in poteka v okviru delovnega časa. Zaposleni največkrat čutijo potrebe po izobraževanju na strokovnem področju, tujih jezikih in informacijski tehnologiji. Z oblikovanjem modela želimo omogočiti zaposlenim pridobitev osnovnih veščin, ki jih je Lizbonska strategija označila kot ključne v gospodarstvu, ki temelji na znanju.

Ključne besede: vseživljenjsko učenje, lizbonska strategija, zaposleni, izobraževalni model

Abstract

The abstract highlights adult lifelong learning, which now finally attained the appropriate place in the educational system, thanks to Lisbon 2000 strategy. In the research on adult education we wanted to acquire information on employee needs, obstacles and motivation that accompany them while enrolling in training. It has been ascertained that employees do not comprehend formal education due to financial reasons, their workload and family matters. On the other hand they do attend shorter educational programs of informal education and further training. These methods of learning are often financed and supported by employers and are carried out during their working hours. In majority of cases employees usually have needs for professional training according to their field of expertise, foreign languages and current IT. By forming such an educational model, we strive to enable employees to gain basic skills. These have been recognised as key points in developing economy by Lisbon strategy and model’s fundamental grounds stand on knowledge.

Keywords: lifelong learning, Lisbon strategy, employed, educational model.

Digitalna kompetenca in njeno izgrajevanje: prenova predmeta Informatika v programu gimnazija

Digital Competence and its Building: Renovation of the Subject Informatic in Grammar School

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Povzetek

S prenovo srednjega izobraževanja so bile tudi v slovensko preduniverzitetno izobraževanje uvedene kompetence. V prispevku je prikazano zgodovinsko ozadje kompetenc in njihovega vpeljevanja v izobraževalni sistem Združenih držav Amerike in Evrope. Ker opredelitev kompetenc v slovenski strokovni javnosti ni povsem enotna, je v nadaljevanju izpostavljena operativna opredelitev, ki je bila uporabljena pri prenovi predmeta Informatika v gimnazijskem programu in kako je zamišljeno njeno izgrajevanje, vrednotenje ter ocenjevanje.

Ključne besede: kompetence, trendi v izobraževanju, informatika, gimnazija.

Abstract

The renovation of the grammar school curriculum has also introduced the competences into the pre-university level of the common educational system. The article comprises the historical background of the competences and their introduction into the educational system in the USA and Europe. Since the definition of the competences has still not been equally presented in Slovenian professional sphere, the following operative definition provides a basis, comprehended within the renovation of the subject Informatic in the grammar school curriculum and consequently its building and evaluation.

Keywords: Competence, education trends, informatics, grammar school.

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Izkopavanje znanja in podatkovna skladišča

Data Mining and Data Warehouses

Uredila / Edited by

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PREDGOVOR

Tehnologije, ki se ukvarjajo s podatki so v zadnjem desetletju (devetdeseta leta) močno napredovale. Iz prve faze, kjer je šlo predvsem zato kako podatke shraniti in kako do njih učinkovito dostopati, se je razvila industrija za izdelavo orodij za delo s podatkovnimi bazami, prišlo je do standardizacije procesov, povpraševalnih jezikov itd. Ko shranjevanje podatkov ni bil več poseben problem se je pojavila potreba po bolj urejenih podatkovnih bazah, ki bi služile ne le transakcijskem procesiranju ampak tudi bolj analitskim pogledom v podatke – pojavilo se je skladiščenje podatkov (data warehousing), ki postaja vse bolj standarden del informacijskih sistemov v podjetjih. Paradigma OLAP (On-Line-Analytical-Processing) zahteva od uporabnika, da še vedno sam postavlja sistemu vprašanja in dobiva nanje odgovore in na vizualen način preverja in išče izstopajoče situacije. Ker seveda to vedno ni mogoče, se je pojavila potreba po avtomatski analizi teh podatkov oz. z drugimi besedami to, da tehnologija sama pove, kaj bi utegnilo biti zanimivo za človeka – to prinašajo tehnike izkopavanja znanja (data mining), ki iz podatkov, ki ze nekje obstajajo, skušajo pridobiti novo znanje, ki uporabniku ponudi novo razumevanje svojih lastnih procesov.

Slovenska KDD konferenca ponuja nekaj predstavitev, ki se ukvarjajo z modernejšimi pogledi na delo s podatki – predvsem poslovno analitske poglede: pristope, orodja, probleme in rešitve.

PREFACE

Data handling technologies have significantly progressed in the 90's. The first phases mainly dealing with storing and efficiently accessing the data, resulted in the development of industry delivering tools for handling large databases, standardization of related processes, queering languages, etc. When the data storage was not a primary problem any more the need for improving the database organization resulted in the databases supporting not only transactions but also analytical views of the data. At this point data warehousing with OLAP (On-Line-Analytical-Processing) entered as a usual part of a company information system. The OLAP paradigme stil requires from the user to set well defined questions which is not always easy and possible. This led to the development of Data Mining offering automatic data analysis trying to obtain some new information from the existing data and enabling the user some new insights in the data. The Slovenian KDD conference covers a broad area including Statistical Data Analysis, Data/Text and Web Mining, Semantic Web, Link Detection and Link Analysis, Data Warehouses.

Urednika / Editors and Program Chairs

- Marko Grobelnik
- Dunja Mladenič

A FUNCTIONAL PROGRAMMING APPROACH TO DISTANCE-BASED MACHINE LEARNING

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ABSTRACT

Distance-based algorithms for both clustering and prediction are popular within the machine learning community. These algorithms typically deal with attribute-value (single-table) data. The distance functions used are typically hard-coded.

We are concerned here with generic distance-based learning algorithms that work on arbitrary types of structured data. In our approach, distance functions are not hard-coded, but are rather first-class citizens that can be stored, retrieved and manipulated. In particular, we can assemble, on-the-fly, distance functions for complex structured data types from pre-existing components.

To implement the proposed approach, we use the strongly typed functional language Haskell. Haskell allows us to explicitly manipulate distance functions. We have produced a SW library/application with structured data types and distance functions and used it to evaluate the potential of Haskell as a basis for future work in the field of distance-based machine learning.

1. General Framework for Data Mining

A general framework for data mining should elegantly handle different types of data, different data mining tasks, and different types of patterns/models. Dzeroski (2007) proposes such a framework, which explicitly considers different types of structured data and so-called generic learning algorithms that work on arbitrary types of structured data. The basic components of different types of such algorithms (such as distance or kernel-based ones) are discussed. Taking the inductive database (Imielinski and Mannila 1996) philosophy that proposes that patterns/models are first-class citizens that can be stored and manipulated, Dzeroski proposes to store and manipulate basic components of data mining algorithms, such as distance functions.

Structured data

Complex data types are built from simpler types by using type constructors. To be more precise, we start with primitive data types, such as Boolean, Discrete(S) and Real. These serve as the basic building blocks for structured data types, composed by using type constructors. A minimal set of type constructors might be Set() , Tuple() and Sequence(): These take as arguments a data type: Set(T) is the type of sets of elements of type T.

Generic distance-based machine learning algorithms

Distance-based algorithms are popular within the machine learning community. They can be used for both clustering and prediction. Examples of such algorithms are hierarchical agglomerative clustering (HAC) and the (k)nearest neighbor algorithm (kNN) for prediction.

The above mentioned algorithms (HAC and kNN) are generic in the sense that they can work for arbitrary types of data, be it attribute-value (tuples of primitive data types) or structured data. We only need a distance function to be provided on the underlying data type. The distance function and the underlying data type are then parameters to the generic algorithm.

A distance function on type T is a function from pairs of objects of the type T to the set of non-negative reals $d :: T \times T \to R^{0+}$. The three important properties this function has to satisfy are:

1) $d(x,y) \geq 0$
2) $d(x,y)=0$ iff $x=y$
3) $d(x,y)=d(y,x)$

A distance functions that besides these three satisfies the triangle property

4) $d(x,z) \leq d(x,y)+d(y,z)$

is called a metric.

In this work, we propose to use generic distance-based learning algorithms (GDBLA). These would be used in conjunction with a number of data types and corresponding distance functions from the domain of use, which can be passed as parameters to the GDBLAs. We propose to explicitly store and manipulate data types and distance functions for these. In particular, we propose to assemble distance functions for complex structured data types from pre-existing components.

2. Functional programming in Haskell

Since we are interested in storing, retrieving and manipulating distance functions, we consider the use of functional programming, i.e., Haskell (Thompson 1999).

Basics

There are a many features of functional programming and especially the language chosen (Haskell) that help users create succinct and easily understandable code. The code (as stated by people without extensive programming experience), is easily understandable, or at least the concepts, since they resemble the mathematical ones, are easy to grasp. Another desirable property of Haskell is its expressiveness, which allows the programmer/user to spend more time on thinking and reasoning about the application domain in question, rather than trying to conform to the language's style of programming.

The key feature of functional programming languages, including Haskell, is the way of using functions and function compositions. Functions are first-class citizens and as such can be manipulated, passed as parameters, used as return values. Such functions are called higher-order functions.

In the context of our work, higher-order functions are clearly needed. We want to assemble a distance function for a complex data type (output), using distance functions on component simpler types (input). Here, functions are clearly present both as input and as output, and a higher-order function is needed to perform the assembly.

Haskell uses pure functions and nothing else. This means that a Haskell function resembles a mathematical function in the way that for every execution the same result is returned, that is no side-effects are allowed. The interpreters can (because of this lack of side-effects) more efficiently reorder executions. Moreover, some functional languages, such as Haskell, have adopted a lazy evaluation strategy, which supports infinite data structures and which can avoid unnecessary evaluations. This is desirable, since the user can define, for example, a sequence of infinite length and not worry about evaluation of unnecessary elements of the sequence, until they are needed in the program.

Strong Typing

Haskell is strongly typed. This means, e.g., that you can’t freely use an Int instead of a Float, but rather have to explicitly convert the Int to a Float. Strong typing helps to find many programming errors. In particular, when combined with static typing, many programming errors can be caught before the program is run.

The type system of Haskell is polymorphic, allowing values of different data types to be handled using a uniform interface. A function that can be applied to values of different types is known as a polymorphic function. An example of a polymorphic data type is List (with elements of arbitrary type).

In our work, we make use of Haskell’s fine grained set of types, both in terms of strong typing and polymorphism. These are very powerful features of Haskell. Types are automatically inferred wherever possible, which can help avoiding mistakes in code, and can help inferring the most general type for some polymorphic function.

3. The anatomy of distances for structured data

Distances on primitive data types

The currently considered list of primitive data types is Boolean, Discrete(S), and Real. We use the delta distance function on the first two, and absolute difference for Real. Delta yields zero given two identical inputs, one otherwise.

Distances on complex/structured types

Structured/complex data types are obtained through the (recursive) application of type constructors to simpler/primitive data types, with primitive types as base cases. The type constructors used here are Set() , Tuple() and Sequence(). Given distances on simpler (primitive) data types, we can compose distances for more complex structured types.

Distances on complex objects can be calculated through recursively inspecting the structure of the type. For this, we need (a) a function to generate pairs of objects of the simpler constitutive types, (b) distance functions on (objects of) the simpler types and (c) an aggregation function that we apply to the distance values obtained by applying (b) to the pairs produced by (a) to obtain a single (non-negative real) value of the distance between the complex objects.

In essence, the tree structure of the complex data type is inspected and for that type tree the following holds:

- every internal node represents a type constructor
- every leaf node is a primitive data type

Every internal node of this tree gets a pairing function and an aggregation function attached to it and every leaf node gets a distance function. The way of applying these functions to get a distance value (non-negative real) as a result is discussed next through an example.

For instance, given the Set(Char) type, and a distance function d() over the simple type Char, the distance of two sets of this type could be calculated as follows. If A and B are sets of this type, $A=\{a_i \mid i=1..n\}$ and $B=\{b_j \mid j=1..m\}$, a choice can be made whether $AxB=\{(a_i,b_j)|i=1..n,j=1..m\}$ or just a subset thereof will be taken into account when determining the distance between the sets.

A function of the form

```
p :: [T]->[T]->[(T,T)]
```

can be used to determine the so-called important pairs of elements of the two complex objects, which will have the distance function d() applied to them. The function with this signature will be called a pairing function.

The second choice to be made is about the function that takes the computed distances between the pairs and produces a non-negative real, which is to be the distance between sets A and B. So, an additional function, called the aggregation function is to be defined, with the signature

agg :: [Float] -> Float

The third and last choice to make concerning the distance calculation on this complex type is which distance measure on our simple type Char to use. If we consider Char as a discrete type, the delta() function is the obvious choice. If we consider Char as an ordinal type (which we haven't discussed here), an absolute difference function which compares the two Chars after converting them to numbers (according to some character conversion table) may be used.

Pairing functions

The pairing functions are of more importance to the complex types using the Set() and Sequence() constructors. For the Tuple() constructor, given that it's heterogeneous, the pairing functions given below are most often in use.

```
p2 (Tuple2 a1 b1, Tuple2 a2 b2) =
[(a1,a2),(b1,b2)]

p3 (Tuple3 a1 b1 c1, Tuple3 a2 b2 c2) =
[(a1,a2),(b1,b2),(c1,c2)]

p4 (Tuple4 a1 b1 c1 d1, Tuple4 a2 b2 c2
d2) = [(a1,a2),(b1,b2),(c1,c2),(d1,d2)]
```

In the case of the Set(T) type constructor, a number of pairing functions can be used (Kalousis et al. 2006):

- all-to-all - every element from the first set is paired with every element from the second one
- minimum distance - an element from one set is paired with the closest element of the other set
- surjection pairing - considering all the surjections that map the larger set to the smaller, the "minimal" (with the distance Δ on T) such surjection is used
  $$d_S(S_1, S_2) = \min_{\eta} \sum_{(e_1,e_2)\in\eta} \Delta(e_1, e_2)$$
- linking - a mapping of one set to the other, all elements of each set participate in at least one pair
- matching - each element of the two sets associated with at most one element of the other set

Aggregation functions

An aggregation function has the signature:

```
type Agg = [Float] -> Float
```

Examples of functions that can be used are:

- square-root of the sum of squares (Euclidian distance)
  `sqrt (sum [x*x|x<-xl])`
- plain sum
  `sum [x|x<-xl]`
- minimum (or maximum)
- median

The first three functions give equal weight to all the distances that they aggregate, while the last three only take into account one (or sometimes two, in the case of median) values. All of the above are special cases of the so-called ordered weighted aggregation functions (OWA, Yager and Kacprzyk 1997), which first sort the values to be aggregated, then apply a set of weights before aggregating. Assuming the list is sorted in ascending order, minimum gives a weight of one to the first element, maximum to the last, and median to the middle element (or weights of ½ to the two middle elements if the number of elements is even).

Haskell makes available an interesting and powerful feature when implementing the above. If the following piece of Haskell code is explored, taking into account the definition of the Agg type signature:

```
wSum:: [Float] -> Agg
wSum weights elems =
sum [a*b | (a,b) <- zip weights elems ]
```

it can be concluded that this aggregation function, weighted sum aggregation, has an additional parameter - an array of real values, that is weights. Haskell in this case allows the user to evaluate and use throughout the code the construct `wSum weights`, which is a specific aggregation function obtained through partial evaluation of the `wSum` function: the evaluation is partial as not all parameters are provided, in particular the values to be aggregated. For this function definition to work properly it is required that the list `weights` is at least as long as the list `elems`.

4. A small database of distance function components

Populating the individual aspects

We have implemented a small database DDTD (database of data types and distances) where the definitions of data types and their corresponding distance functions are stored. We start with the primitive data types mentioned above and the basic distance functions on these. We also store additional distance functions on the primitive data types, as well as aggregation and pairing functions.

We have also implemented a generic version of the kNN algorithm, for demonstration purposes as well as for testing the Haskell implementation of the concepts discussed above (structured data and distances thereon). Datasets conforming to type definitions stored in the DDTD can be loaded from a database or from an XML file. This allows us to experiment with machine learning algorithms that work with structured data.

The process of populating DDTD with data type definitions, distance definitions, additional aggregation or pairing functions can be carried out either from the command line, or from a graphical interface (currently supporting a subset of the actions listed below). We can

- create definitions of new data types (composing complex data types out of simpler ones)
- create a definition of a distance over some data type (either using built-in functions or additional custom aggregation, pairing and distance functions)
- add a new distance function on a primitive type
- add a new aggregation function
- add a new pairing function

The data types can be described using XML or Haskell code. The additional functions have to be in Haskell syntax. The reason behind using the Haskell syntax is that it provides extensive support for mathematical functions (mostly defined in its Prelude), as well as support for processing lists, which can be easily learned, grasped and reused.

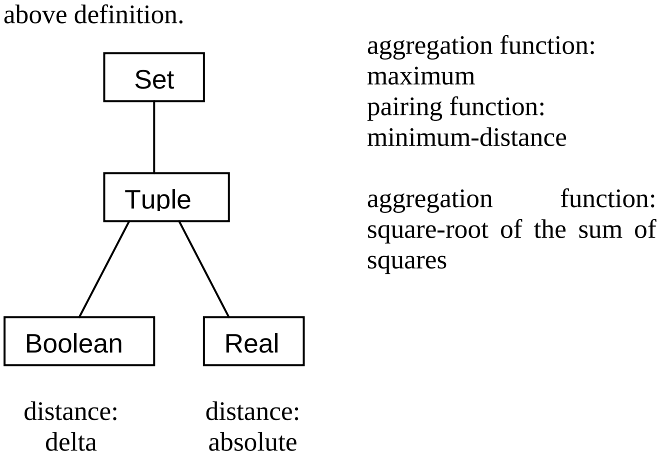
For every function to be added into the system, its signature (expected input data) has to be defined first, since some functions could use additional parameters (as was the case with the `wSum` aggregation function described in section 3 of this text). The definitions of the new functions have to be first checked for errors and then, if they produce the expected results, will be imported into the database, for further use. The possibility for additional functions and custom data types greatly increases the potential for use of DDTD.

DDTD usage scenario

Let us take for example the data type

```
t :: Set (Tuple2 Bool Float)
```

Note that this is the true Haskell definition of the type: Here we use Tuple2 instead of Tuple, as Tuple is really a class of type constructors of varying arity (Tuple1, Tuple2, …), rather than a type constructor. Two type constructors are used (Set and Tuple) and two primitive types (Bool and Real) in the above definition.



Picture 1. A custom data type with a distance defined for it

Using DDTD this custom data type is first declared. Then using a plain XML editor, the dataset that is to consist of this kind of objects is defined or imported from a database (another possibility could be to load it directly from a file). Once we have defined a data type, we can define a distance function on this data type (covered in the next section): As soon as this is done, distances on selected pairs of objects are calculated, for the purpose of checking if the results are as expected (in terms of types). Finally, a machine learning algorithm (like the implementation of k-NN mentioned above) can be invoked on the dataset.

Custom creating distance functions

For the data type in our example, a distance function could be defined in the following way (see Figure 1):

- For the Set type constructor, the aggregation function maximum and the pairing function minimum-distance are used
- For the Tuple type constructor, the aggregation function square-root of the sum of squares and the default pairing function are used
- For the Bool primitive type the distance-delta is used
- For the Real primitive type the distance-absolute is used

This distance function definition is converted into an appropriate XML code and stored in database, for later use.

If the functions supported by DDTD by default are not suitable for our complex distance definition, additional functions can be added. For instance, if an additional aggregation function is needed, for, say the median of a list of real values, the following should be carried out. Since the new function is going to be an aggregation function, the signature for aggregation function should be:

```
type Agg = [Float] -> Float
```

Finally, the body of the function should be written:

```
median xl = s!!(length `div` 2)
      where s = Data.List.sort xl
```

This definition will be checked for errors and then imported into the database and can later be used accordingly.

5. Conclusions and related work

We have been here concerned with distance-based machine learning, and in particular in such approaches that can handle arbitrary types of structured data. We have followed the approach proposed by Dzeroski (2007) to develop generic algorithms (in our case kNN), complemented with a database of definitions of data types and distance functions on these types. Moreover, the database contains basic building blocks for constructing distance functions on structured data and allows the user to custom create new ones, as well as choose from existing distance functions. To implement this, we have chosen a functional programming approach, which supports the higher-order nature of the operations that manipulate functions necessary for this.

Our work is related to inductive databases (IDBs, Imielinski and Mannila 1996): IDBs store patterns (and models) in addition to data. Most of the work in this area has focused on storing (and querying) local (frequent) patterns expressed in logical form. Our DDTD can be viewed as an inductive database storing global predictive models: the combination of a dataset, a distance function and a generic algorithm (such as kNN) yields a predictive model.

Allison (2004) also considers a functional programming approach to machine learning. He uses functional programming to define data types and type classes for models (where models include probability distributions, mixture models and decision trees) that allow for models to be manipulated in a precise and flexible way. However, he does not consider distance-based learning.

Finally, we consider the work on modular domain-specific languages and tools (Hudak 1998) relevant to our approach, especially for further work. Namely, we believe our approach can be extended to arrive at domain-specific languages for data mining. These might be coupled with domain-specific languages in a specific area of interest, e.g., a multi-media language. We believe that this would greatly facilitate the development of domain-specific data mining approached and their practical applications.

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THE STATISTICAL INTERPRETATION OF SIMULATED EMERGENCY BRAKING EVENT TIME SERIES DATA

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ABSTRACT

Over three hundred four-second / 40hz time series datasets (from simulated emergency braking manoeuvres at English fatal accident sites and field trials) (see Fig 1) were classified using key characteristics of the braking sequences extracted for each event. These characteristics were then tested for significant difference between road surface types and braking system types. One key marker, average deceleration, was also compared against existing benchmark 'typical' values for acceptable performance as found in the literature.

The views expressed in this Paper are those of the Author.

1 INTRODUCTION

During the course of the investigation of a fatal or near-fatal road traffic accident (RTA) occurring in the UK, tests may be undertaken by qualified Police collision investigators to quantify the frictional properties of the road surface at the scene. The fundamental physics behind the test methodology was first tested in court in the 1940's [1].

Fig 1: The diverse range of vehicles contributing to the database of deceleration ('skid') tests

These tests are commonly carried out using equivalent vehicles if those involved in the collision cannot be used. The momentary accelerations and decelerations of the vehicle during a simulated emergency braking manoeuvre ('skid test') undertaken at the scene are recorded using a device equipped with an accelerometer and a timing circuit.

The data so recorded is typically presented to the collision investigator in the form of two summary statistics: average and maximum deceleration during the skid test. The average deceleration is often compared against what the collision investigator personally considers to be 'typical' and any departure commented upon accordingly in subsequent accident reports. The average value can be used in reconstruction formulae.

Data recorded at the scene of a a number of fatal and/or near fatal RTAs were collected for this study, with the support of a number of Police forces around England, these tests were classified using the BRAKING STATE of the tests: (with ABS [Anti-Blockieren System / Anti-lock Braking] or without ABS, [NoABS, where the tyres can lock then slide on the road surface]), the SURFACE TYPES (see Fig 2) were either traditional POSITIVE TEXTURE (PTS) surfaces such as Hot Rolled Asphalt and Surface Dressing or the more recently adopted NEGATIVE TEXTURE (NTS) surfaces such as Stone Mastic Asphalt (SMA) , the SURFACE STATE was recorded as WET or DRY.

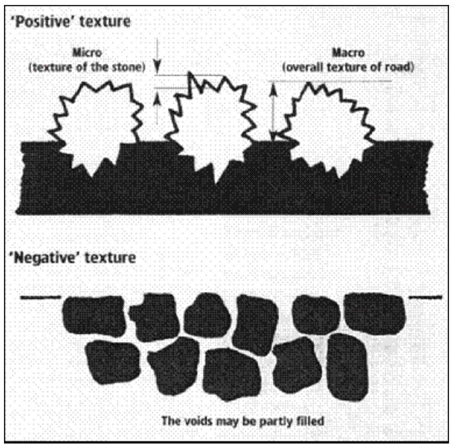


Fig 2 Idealized negative and positive textures [2]

As tests were more commonly undertaken on DRY surfaces, the great majority of tests fortunately fell within the group of DRY tests required for the PhD study.

It should be noted that road surface frictional conditions (not caused by ice or snow etc) were not a

significant contributory factor in any personal injury RTAs in the UK [3].

2 EXTRACTING DETAILED DATA

Interrogation of the time series of momentary accelerations or decelerations used to derive the summary statistics were expected to provide useful information with respect to the behaviour of the road surface when interacting with the tyres of vehicles either with ABS or without ABS (NoABS).

Two decelerometer devices are in common police use in the UK: the Turnkey Instruments Skidman (known as Brakesafe when equipped with a test speed output) and the Vericom Computers VC series [4]. The internally calculated AVERAGE and MAXIMUM decelerations downloaded from the Skidman device (40hz data) using the manufacturers software (Skidcalc) were shown in the course of this analysis to correspond to a moving average of 8 or 9 adjacent readings, whereas the Vericom device downloads (100hz data) using the Vericom Profile package returns the true momentary values from the accelerometer. This difference has little impact with respect to average deceleration but significantly lowers the maximum values retrieved.

For the purpose of this study, the momentary data from Skidman tests was retrieved using a DOS package (SIMRET) and a download cable (as used with Skidcalc), these momentary readings were downloaded in CSV format and then transposed and combined into a single database (one row per test, up to 253 readings per test).

3 IDENTIFYING KEY DATAPOINTS IN THE TIMESERIES DATA

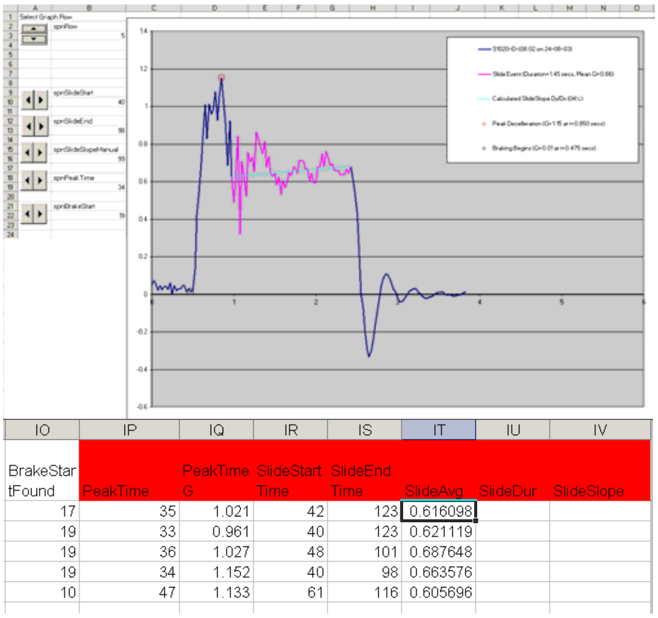
The literature regarding the interpretation of skid test results has identified the maximum and average decelerations as key parameters of interest [5, 6]. The viewing of the time series as graphs in Microsoft Excel enabled other key features to be identified in addition to the maximum and average decelerations.

A Microsoft Excel Visual Basic macro (The ‘classification macro’) was also developed to enable ‘tags’ to be placed on specific points in the time series (via the use of spin box functionality in Visual Basic) to enable further calculations to be undertaken via the integration of the decelerations between specified limits and via the tabulation of the ‘tagged’ key points. A typical screenshot is shown in Fig 3.

The following points were extracted tabulated using the ‘classification ’ macro’:

1. Start of braking
2. ABS maximum deceleration
3. NoABS maximum deceleration before sliding phase
4. NoABS Start of sliding phase (associated with onset of wheel lock)
5. NoABS End of sliding phase
6. End of braking / Start of Suspension Bounce

These points were also highlighted on the deceleration graph in question as a circle on a point.



IO	IP	IQ	IR	IS	IT	IU	IV
BrakeStartFound	PeakTime	PeakTime G	SlideStart Time	SlideEnd Time	SlideAvg	SlideDur	SlideSlope
17	35	1.021	42	123	0.616098		
19	33	0.961	40	123	0.621119		
19	36	1.027	48	101	0.687648		
19	34	1.152	40	98	0.663576		
10	47	1.133	61	116	0.605696		

Fig 3 Screen shots of the “Classification Macro”

Any time interval between these points could then be calculated, the individual decelerations could be integrated (to derive average deceleration during braking) and the average and maximum decelerations derived from the data could be compared against those calculated internally by the device.

The relatively small number of tests on WET surfaces led to a decision to focus on DRY tests for the subsequent analysis.

4 DIFFERENCES BETWEEN INTERNAL AND POST TEST AVERAGE AND MAXIMUM DECELERATION

By integrating the momentary decelerations during braking in the time series it is possible to establish the average deceleration for comparison against the internally calculated average values generated by the Skidman at the time of the test.

A consistent under-measurement of the peak deceleration when calculated internally by the Skidman against the average values from the Skidman was seen whereas the internally generated and extracted peak values from the

Vericom VC3000 DAQ device compared well. This discovery is only of interest to those likely to have an interest in peak deceleration; such a group may be those studying critical speed behaviour (the behaviour of vehicles at the point of loss of control during cornering manoeuvres [7]).

5 INITIAL INTERPRETATION OF EXTRACTED DATA

It was anticipated that variations would exist between DRY tests with the same SURFACE TYPE and BRAKING STATE combination, as a result of the variation between vehicle braking systems, tyre compounds and driver technique, and such variation had already been described in the literature *[8]*, thus simple box plots showing the distribution of average deceleration against Police Force were generated in SPSS to aid the initial interpretation of the DRY test dataset between ABS and NoABS tests. (See *Fig 4*). These common characteristics for AVERAGE deceleration between SURFACE TYPE and BRAKING STATE were seen to exist between these force-by-force plots despite the spread:

(i) ABS NTS > ABS PTS (typically)
(ii) NoABS PTS > NoABS NTS (typically)
(iii) ABS > NoABS (typically)

No such trends existed for MAXIMUM deceleration (plot not shown). Since average deceleration trends could be so easily defined visually from the data, key values from the individual tests were simply analysed statistically using T tests in MiniTAB 14 to quantify any significant differences. With the visible trends seen in the box plots between ABS and NO ABS braking in combination with NTS and PTS surfaces there was no real requirement for complex statistical analysis and a simple T test of difference would provide a numerical measure of the differences seen between SURFACE TYPE and BRAKING STATE

6 STATISTICAL DIFFERENCES BETWEEN SUBSETS

The statistical comparisons undertaken identified very significant differences between the average deceleration measured with NoABS braking between NTS and PTS surfaces, as expected ABS braking performed significantly better on both DRY PTS and DRY NTS

Since NOABS braking is likely to deliver higher peak deceleration before wheel lock whereas ABS systems aim to prevent wheel lock, the significantly higher MAXIMUM decelerations for NoABS test is not unexpected.

Table 1 summarises the output of multiple T tests undertaken in MiniTab 14

AVERAGE Deceleration (SlideG) DRY SURFACES				
Sig. diff. (>99%)	ABS NEG	ABS POS	NOABS NEG	NOABS POS
ABS NEG	X	X	**ABS Higher**	X
ABS POS	**NEG Higher**	X	X	**ABS Higher**
NOABS NEG	X	X	X	X
NOABS POS	X	X	**NEG Lower**	X

MAXIMUM Deceleration (PeakG) DRY SURFACE				
Sig. diff. (>99%)	ABS NEG	ABS POS	NOABS NEG	NOABS POS
ABS NEG	X	X	**ABS Lower**	X
ABS POS	**NO DIFF**	X	X	**ABS Lower**
NOABS NEG	X	X	X	X
NOABS POS	X	X	**NO DIFF**	X

Table 1 Summary of T Test results on DRY ROAD tests

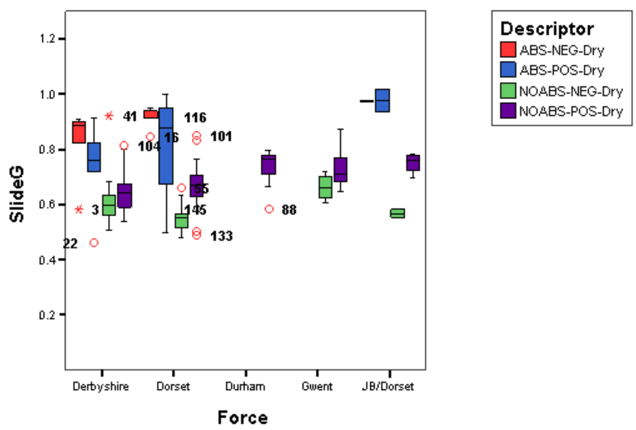


Fig 4: Distribution of Average (Slide) deceleration between Police Forces

7 OBSERVATIONS

The use of the Visual Basic classification macro enables complex time series data to be visualised and key values easily recorded and extracted for use in subsequent analysis. From the perspective of the key aims of the PhD study, the highly significant difference seen in the lower average deceleration with NoABS braking (see Fig 4) on NTS when compared against PTS surfaces supports similar findings in the literature [9, 10] as regards the typically poorer performance on NTS under NoABS emergency braking.

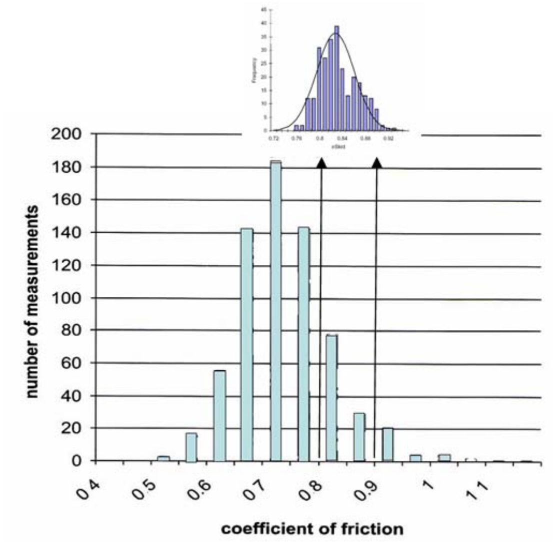


Figure 5: Distribution of Typical Southern UK Values of Dry Friction [11] compared against that given in Goudie et al [12]

8 CONCLUSIONS

Tabulation of data extracted from time series decelerometer records have confirmed that NoABS simulated emergency braking on NTS surfaces delivers a significantly lower level of average deceleration than for NoABS tests on PTS or ABS tests on PTS or NTS. These values are also typically below (05-0.7) those considered typical for dry road surfaces (0.75 – 0.85) (See Figure 5). Tabulation of data extracted from time series decelerometer records have also confirmed that the internally calculated values of average and maximum deceleration generated by the Skidman device are smoothed and in the case of maximum values, typically an underestimate of the momentary maximum deceleration.

9 ACKNOWLEDGEMENTS

The work described in this paper formed part of a PhD study at the Transportation Research Group (TRG) of the University of Southampton (UK) investigating the interaction of tyres and road surfaces during DRY skidding. More specific details of the diverse investigations undertaken can be found in Bullas [13].

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TRIPLET EXTRACTION FROM SENTENCES USING SVM

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ABSTRACT

In this paper we present a machine learning approach to extract subject-predicate-object triplets from English sentences. SVM is used to train a model on human annotated triplets, and the features are computed from three parsers.

1. INTRODUCTION

As described in [1][2][3] a triplet is a representation of a subject-verb-object relation in a sentence, where the verb is the relation. In [3] triplet extraction methods based on heuristic rules have been described. In this paper a machine learning approach using SVM is tried. The data comes from triplet annotations made by linguists on the Reuters news article corpus. First the triplet extraction method using SVM is presented, then the evaluation method and the results, and finally the conclusions are drawn.

2. EXTRACTION METHOD

In this section the triplet extraction method using SVM will be explained. First we assume that a model is available and we explain how triplets are extracted from a sentence using that model, and then the method for training the model will be explained.

The triplet extraction process is depicted in Figure 1. The input is a sentence, *'The increase will cover all kinds of wheat including durum and milling wheat.'*, in our example. The sentence is tokenized and then the stop words and punctuation (which are grayed out in the picture) are removed. This gives us a list of the important tokens in the sentence, [*increase*, *cover*, *kinds*, *wheat*, *including*, *durum*, *wheat*]. The next step is to get all possible ordered combinations of three tokens from the list. In our case, as there are 8 tokens, we obtain $336 = 8 \cdot 7 \cdot 6$ such combinations, but due to lack of space only 8 of them are shown in the picture. In what follows we shall call these combinations *triplet candidates*. From now on the problem is seen as a binary classification problem where the triplet candidates must be classified as positive or as negative. The SVM model assigns a positive score to those candidates which should be extracted as triplets, and a negative score to the others. The higher the positive score, the 'surer' it is that the triplet candidate is in fact a correct triplet. On the right side of the image in Figure 1eight triplet candidates ordered descending based on their classification scores are shown. The negative ones are grayed out. From the positive ones the resulting triplet is formed. It can be seen that for all positively classified candidates the subject is *increase* and the verb is *cover*, so the first two elements of the triplet are settled. As opposed to the subject and the verb, the objects are different among the positively classified triplet candidates. In such cases an attempt to merge the different triplet elements (in this case objects) is made. The merging is done in such a way that if two or more words are consecutive in the list of important tokens, then they are merged. In our example it was possible to merge all different objects into a single one, and the triplet (*The <u>increase</u>, will <u>cover</u>, all <u>kinds</u> of <u>wheat</u> <u>including</u> <u>durum</u> and <u>milling</u> <u>wheat</u>*) was obtained. The tokens which were obtained from the positive triplet candidates are underlined. Where merges have been done (in the object) the tokens are connected by the stop words from the original sentence. In all cases before the leftmost token all the stop words which come before it in the original sentence are included. Of course, in the merging method described above, it will not always be possible to merge all tokens into a single set. In this case several triplets (one for each of the three sets) will be obtained. An important note which has to be made is that in practice in the classification described above there are many false positives, so it does not work to take them all for the resulting triplets. Instead only the top few from the descending ordered list of triplet candidates are taken (more on how many is in the section describing the results)

3. TRAINING OF THE SVM MODEL

In the previous section describing the triplet extraction method it was assumed that an SVM model is available. Here the training of that model and the features taken into account in the classification of the triplet candidates are presented.

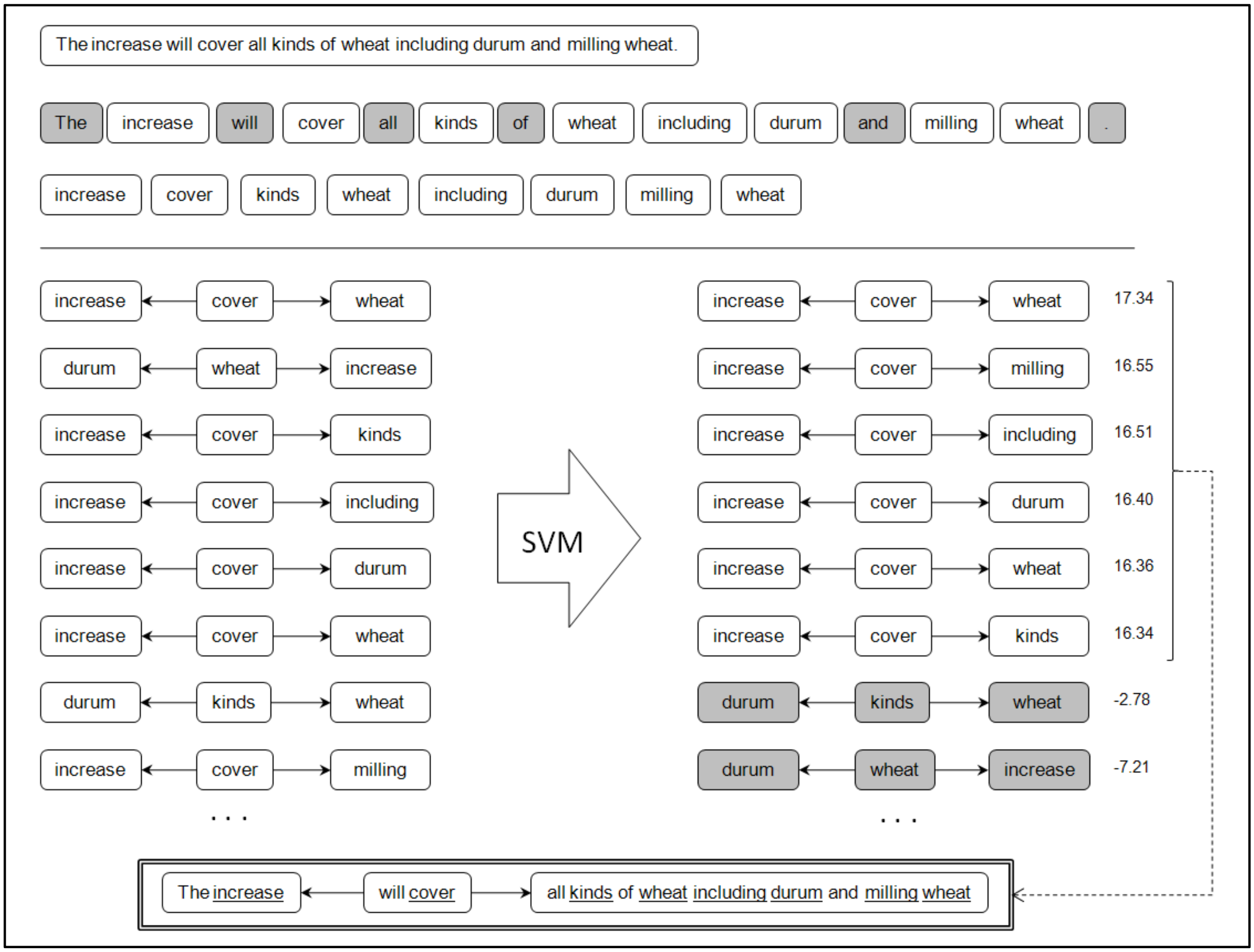

Figure 1 Triplet Extraction Process

The training data comes from human annotated triplets from the Reuters news article corpus. To train the model, from each sentence the triplet candidates are obtained and over 300 features are computed for them. The features can be grouped into the following categories:

– Features depending on the sentence (e.g. length of the sentence, number of stop words etc)
– Features depending on the triplet candidate (e.g. subject, verb and object candidate words, order, subject-verb token distance, context of verb, etc.)
– Features depending on the Treebank parse tree of the sentence (e.g. depth of tree, depth of subject, part of speech of the candidate elements)
– Features depending on the Linkage of the sentence obtained by LinkParser (e.g. number of link types, number of left links from the object etc.)
– Features obtained by the Minipar dependency parse tree of the sentence (e.g. diameter of the subject subtree, category and relation of the uncle of the verb etc.)

The top twenty features in a ranking obtained by information gain are shown below:

1	verb candidate word	11	subj left context word1
2	verb left context word0	12	is the candidate ordered?
3	verb right context word0	13	subj left context word0
4	verb left context word1	14	obj left context word1
5	verb right context word1	15	obj left context word0
6	subject candidate word	16	obj right context word1
7	subj right context word0	17	subj-verb distance
8	subj right context word1	18	obj right context word0
9	object candidate word	19	average word length
10	last 2 characters of verb	20	subj-obj distance

A triplet candidate is labeled positive if its subject token is a substring of a human annotated triple in its sentence, and if both its verb and its object are substrings of the verb and of the object of that triplet.

4. EVALUATION METHOD

For evaluation a way of comparing triplets is needed. To just check whether two triplets are identical would penalize too much those triplets which are almost correct. This is why we define a triplet similarity measure.

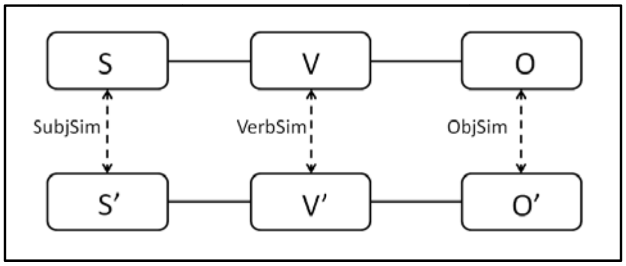

Figure 2 Triplet Similarity Measure

To compute the similarity between two triplets, the subject, verb, and the object similarities are computed and the numbers are averaged. All similarities are real numbers between 0 and 1, where 1 means identity and 0 means no overlap at all. Because the similarity is between 0 and 1 it can be seen as a percentage. As all three elements of a triplet are strings, a string similarity measure is used to compute each of the subject, verb and object similarity measures. The similarity between two strings is obtained by tokenizing an removing the stop words from each of them thus obtaining a collection of tokens for each of the strings. Then we count how many tokens appear in both collections and divide this number by the number of tokens in the larger collection.

Having defined the triplet similarity, we can now compare the triplets extracted with the triplets annotated. For each sentence we have the set of extracted triplets and the set of annotated triplets. We compute the similarity between the corresponding triplets and average the numbers over all sentences. The corresponding triplet of a triplet is the triplet in the other set which is most similar to it. In one of the two triplet sets (depending on the direction of comparison) we can have triplets which have one, more or no corresponding triplets. In the other set each triplet will have exactly one corresponding triplet. We can either compare the extracted triplets to the annotated ones or the annotated triplets to the extracted ones. If we do the first thing we see what proportion of the extracted triplets were annotated (are correct), and we shall consider this proportion the **precision** of the system. If we compare the other way round then we see what proportion of the annotated (correct) triplets have been extracted. We shall consider this proportion showing the **recall** of the system.

5. RESULTS

Applying the methods described previously using a training set of human annotated triplets of 700 sentences and a test set of 100 sentences, a precision of 38.6% and a precision of 46.80% have been obtained. The tables in Figure 5 show how the precision and the recall vary when the training set size and the top proportion of triplet candidates selected as positives are changed. It is apparent that an increased training set size has a positive effect on both precision and recall. A higher proportion of triplet candidates selected as positives increases the recall but deteriorates the precision. We can conclude that it is a good compromise to select the top 1% of the triplet candidates as positives.

Other arguments in favor of choosing the top few from the ordered list of triplet candidates are shown in the histogram in Figure 3 showing how many true positive triplet candidates are on each position in the ordered list. It can be seen that all are in the top 10% in, and the vast majority are in the top 2%.

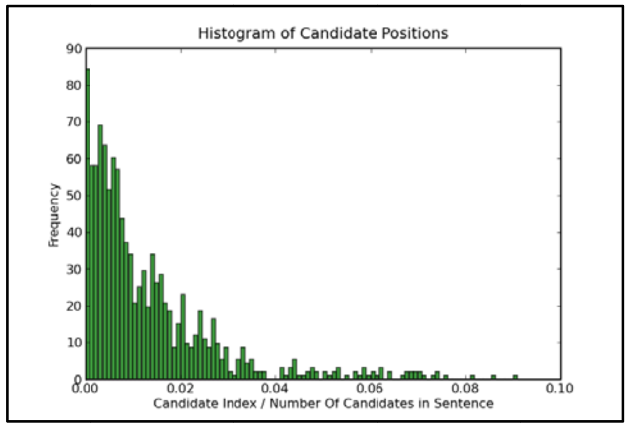

Figure 3 Histogram of the positions of the true positives in the list of ordered triplet candidates

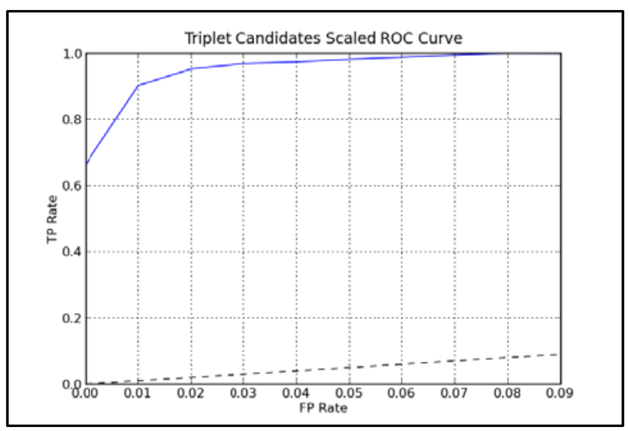

Figure 4 Scaled ROC curve of the triplet candidates

Figure 4 shows the ROC curve with the horizontal axis scaled up 10 times. We can see from it that by selecting

Top Proportion	#1	0.2%	0.5%	1%	2%	3%	4%	5%
Precision(%)	38.14	38.43	**39.70**	38.36	37.23	36.83	36.25	35.67
Recall(%)	29.58	40.23	43.22	46.80	47.29	47.30	47.38	**47.38**

#Train Sent	100	200	300	400	500	600	700
Precision(%)	30.06	36.15	36.55	38.69	35.97	37.37	38.36
Recall(%)	41.64	43.21	44.73	45.14	45.59	46.05	46.80

Figure 6 Influence of training set size and top proportion selection on precision and recall

in such a way that 5% of the negative instances are included in the selection we catch close to 100% of the positives.

It is interesting to see how the different feature types influence the performance. In Figure 6 the first pair of bars is the result of random selection of positive triplet candidates. The second shows the results obtained by evaluating the triplets extracted bay heuristic rules using the OpenNLP parser [3]. In the third bar pair the results of the machine learning approach is shown, but only taking into account features which give part of speech and context information. In the next bars the performance figures obtained by adding the features from diffent parsers incrementally are shown. It can be seen thet by taking into account parsing information the performance does not change significantly.

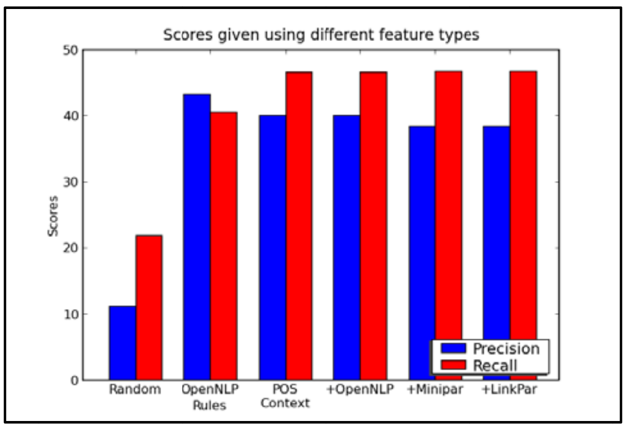

Figure 5 Performance figures obtained by using the different kinds of features

6. CONCLUSIONS

The conclusions which can be drawn are the following. Although the small size of training and test sets does not allow us to be very conclusive, we can say that the approach presented is promising. The fact that parsing information failed to make a difference in the performance means either that in the small training set of 100 sentences there have been no examples which relied on parsing information to be classified, or that parsing information is not important for triplet extraction. Another issue which slows down the execution is that all ordered combinations of three tokens are considered as triplet candidates. This number increases exponentially with the length of the sentence. For the future the following improvements could be made:

- Building a probabilistic model which will say for a triplet candidate what is the probability of it being a triplet. This would help because as it is now we always select a top ranked proportion, say 5%, on the other hand if we would take those candidates as triplets which have probability more than 95% maybe more and maybe less than a fixed top rank would be selected. We would not assume any connection between the length of the sentence and the number of triplets.
- Solving the classification problem in two phases. First for each word in the sentence we would compute by a probabilistic model how likely it is that the word is a subject, a verb and an object. Having these 3 probabilities for every word we would build triplet candidates where the subject, the verb and the object are correct with a high probability, thus avoiding an exhaustive search of all combinations. This would much decrease execution time.
- Computing only the most relevant features in the classification process

7. ACKNOWLEDGMENTS

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HIERARCHICAL ANNOTATION OF MEDICAL IMAGES

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ABSTRACT

In this paper, we describe an approach for the automatic medical annotation task of the 2008 CLEF cross-language image retrieval campaign (ImageCLEF). The data comprise 12076 fully annotated images according to the IRMA code. This work is focused on the process of feature extraction from images and hierarchical multi-label classification. To extract features from the images we used a technique called: local distribution of edges. With this techniques each image was described with 80 variables. The goal of the classification task was to classify an image according to the IRMA code. The IRMA code is organized hierarchically. Hence, as classifer we selected an extension of the predictive clustering trees (PCTs) that is able to handle this type of data. Further more, we constructed ensembles (Bagging and Random Forests) that use PCTs as base classifiers.

1 INTRODUCTION

The amount of medical images produced nowadays is constantly growing. The cost of manually annotating these images is very high. This calls for development of automatic image annotation algorithms that can perform the task reliably. With the automatic annotation an image is classified into set of classes. If these classes are organized in a hierarchy then it is a case of hierarchical multi-label classification.

This paper describes the medical annotation task of ImageCLEF 2008 [1]. The objective of this task is to provide the IRMA (Image Retrieval in Medical Applications) code [2] for each image of a given set of previously unseen medical (radiological) images. 12,076 classified training images are provided to be used in any way to train a classifier. The results of the classification step can be used for multilingual image annotations as well as for DICOM standard header corrections. According to the IRMA code [2], a total of 197 classes are defined. The IRMA coding system consists of four axes with three to four positions, each in {0,…,9,a,…,z}, where "0" denotes "unspecified" to determine the end of a path along an axis:

- T (Technical): image modality
- D (Directional): body orientation
- A (Anatomical): body region examined
- B (Biological): biological system examined

This allows a short and unambiguous notation (IRMA: TTTT-DDD-AAA-BBB), where T, D, A, and B denotes a coding or sub-coding digit of the respective axis. Figure 1 gives two examples of unambiguous image classification using the IRMA code. The image on the left is coded: **1123** (x-ray, projection radiography, analog, high energy) – **211** (sagittal, left lateral descubitus, inspiration) – **520** (chest, lung) – **3a0** (respiratory system, lung). The image of the right is coded: **1220** (x-ray, fluoroscopy, analog) – **127** (coronad, ap, supine) – **722** (abdomen, upper abdomen, middle) – **430** (gastrointestinal system, stomach).

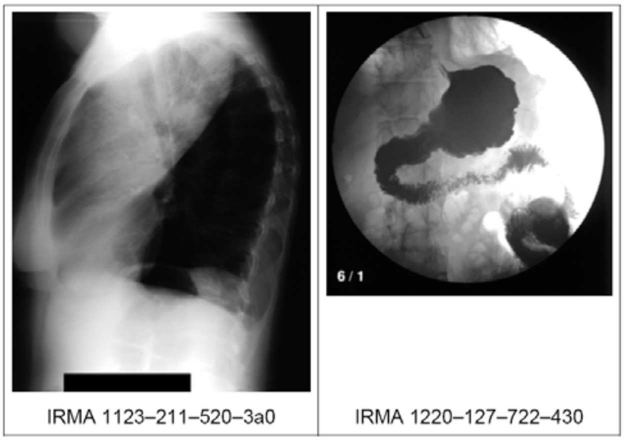


Figure 1: *IRMA-coded chest and abdomen radiograph.*

The code is strictly hierarchical – each sub-code element is connected to only one code element. The element to the right is a sub element of the element to the left. For example:

2 cardiovascular system
21 cardiovascular system; heart
216 cardiovascular system; heart; aortic valve

The aortic valve is an element of the heart, which in turn is an element of the cardiovascular system.

The difference between ImageCLEF 2008 task and the tasks from previous years is the distribution of images. To encourage the exploitation of the class hierarchy, the images in the 2008 test set are mainly from classes which have only few examples of the same class in the training data and thus it is significantly harder to consider this task as a flat classification task as most of the successful techniques did in 2007 [3]. Instead, it is expected that exploiting the hierarchy will lead to large improvements.

Automatic image classification relies on numerical features that are computed from the pixel values [4]. In our approach we use edge histogram descriptor to represents the spatial distribution of five types of edges (four directional edges and one non-directional, see Fig. 3).

For the classification task, we applied predictive clustering trees (PCTs) that are instantiated for handling hierarchical multi-label classification (HMLC) and ensembles of PCTs.The results show the increase of predictive power when ensembles are used as a classifier.

2 FEATURE EXTRACTION FROM IMAGES: HISTOGRAM OF LOCAL EDGES DISTRIBUTION

Edge detection is a fundamental problem of computer vision and has been widely investigated [5]. The goal of edge detection is to mark the points in a digital image at which the luminous intensity changes sharply. Edge representation of an image drastically reduces the amount of data to be processed, yet it retains important information about the shapes of objects in the scene. Edges in images constitute an important feature to represent their content. One way of representing such an important edge feature is to use a histogram. An edge histogram in the image space represents the frequency and the directionality of the brightness changes in the image. To represent this unique feature, in MPEG-7, there is a descriptor for edge distribution (EHD) in the image. The EHD basically represents the distribution of 5 types of edges in each local area called a sub-image. As shown in Figure 1, the sub-image is defined by dividing the image space into 4×4 nonoverlapping blocks. Thus, the image partition always yields 16 equal-sized sub-images regardless of the size of the original image.

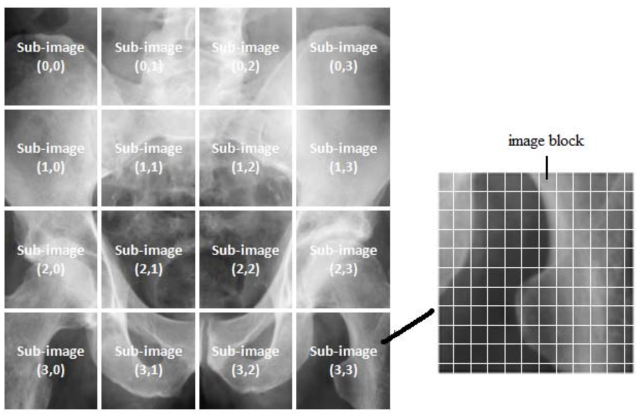


Figure 2: *Definition of sub-image and image-block.*

To characterize the sub-image, we then generate a histogram of edge distribution for each sub-image. Edges in the sub-images are categorized into 5 types: vertical, horizontal, 45-degree diagonal, 135-degree diagonal, and non-directional edges (see Figure 3). Thus, the histogram for each sub-image represents the relative frequency of occurrence of the 5 types of edges in the corresponding sub-image.

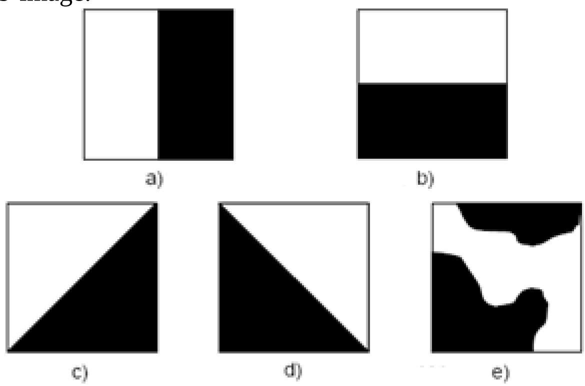


Figure 3: *Five types of edges: a) vertical edges, b) horizontal edge, c) 45-degree edge, d) 135-degree edge, e) non-directional edge*

As a result, each local histogram contains 5 bins. Each bin corresponds to one of 5 edge types. Since there are 16 sub-images in the image, a total of 5×16=80 histogram bins is required. Note that each of the 80-histogram bins has its own semantics in terms of location and edge type. For example, the bin for the horizontal type edge in the sub-image located at (0,0) in Figure 2 carries the information of the relative population of the horizontal edges in the top-left local region of the image. The edge detection was performed using Canny edge detection algorithm [6].

Because of the low contrast of the X-ray images we applied a contrast enhancement technique for the images used in our experiments. The contrast enhancement was done through histogram equalization for the central part of the images, because the image corners have only black pixels.

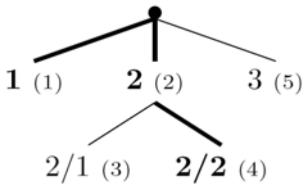
3 ENSEMBLES FOR PCTs

In this section we discuss the approach we used to classify the data at hand. We shortly describe the learning of the ensembles and the predictive clustering trees framework.

3.1 PCTs for Hierarchical Multi-Label Classification

In the PCT framework [7], a tree is viewed as a hierarchy of clusters: the top-node corresponds to one cluster containing all data, which is recursively partitioned into smaller clusters while moving down the tree.

PCTs can be constructed with a standard "top-down induction of decision trees" (TDIDT) algorithm. The heuristic that is used for selecting the tests is the reduction in variance caused by partitioning the instances. Maximizing the variance reduction maximizes cluster homogeneity and improves predictive performance. With instantiation of the variance and prototype function the PCTs can handle different types of data, e.g. multiple targets [8] or time series [9]. A detailed description of the PCT framework can be found in [7].



$$\begin{array}{l} \quad\;\; (1)\,(2)\,(3)\,(4)\,(5) \\ v_i = [1,\ 1,\ 0,\ 1,\ 0] \end{array}$$

Figure 4: *A toy hierarchy. Class label names reflect the position in the hierarchy, e.g., '2.1' is a subclass of '2'. The set of classes {1, 2, 2.2}, indicated in bold in the hierarchy, and represented as a vector.*

In order to apply PCTs to the task of HMLC, the variance and prototype parameters were properly instantiated.

First, the example labels are represented as vectors with Boolean components; the *i*'th component of the vector is 1 if the example belongs to class c_i and 0 otherwise (see Figure 4). Then the variance of a set of examples (*S*) can be defined as the average squared distance between each example's label v_i and the mean label $\bar{v}$ of the set, i.e.,

$$Var(S) = \frac{\sum_i d(v_i, \bar{v})^2}{|S|}$$

The higher levels of the hierarchy are more important: an error in the upper levels costs more than an error on the lower levels. Considering that, weighted Euclidean distance is used as a distance measure.

$$d(v_1, v_2) = \sqrt{\sum_i w(c_i) \cdot (v_{1,i} - v_{2,i})^2}$$

where $v_{k,i}$ is the *i*'th component of the class vector v_k of an instance x_k, and the class weights *w(c)* decrease with the depth of the class in the hierarchy.

Second, in the case of HMLC, the notion of majority class does not apply in a straightforward manner. Each leaf in the tree stores the mean $\bar{v}$ of the vectors of the examples that are sorted in that leaf. Each component of $\bar{v}$ is the proportion of examples $\bar{v}_i$ in the leaf that belong to class c_i. An example arriving in the leaf can therefore be predicted to belong to class c_i if $\bar{v}_i$ is above some threshold t_i, which can be chosen by a domain expert. A detailed description of the PCTs for HMLC can be found in [10].

3.2 Ensemble methods

An ensemble is a set of classifiers constructed with a given algorithm. Each new example is classified by combining the predictions of every classifier from the ensemble. These predictions can be combined by taking the average (for regression tasks) or the majority vote (for classification tasks) [11, 12], or by taking more complex combinations.

In this paper, we consider two ensemble learning techniques that have primarily been used in the context of decision trees: bagging and random forests.

Bagging [11] is an ensemble method that constructs the different classifiers by making bootstrap replicates of the training set and using each of these replicates to construct one classifier. Each bootstrap sample is obtained by randomly sampling training instances, with replacement, from the original training set, until an equal number of instances is obtained.

A random forest [12] is an ensemble of trees, where diversity among the predictors is obtained by using bagging, and additionally by changing the feature set during learning. More precisely, at each node in the decision trees, a random subset of the input attributes is taken, and the best feature is selected from this subset. The number of attributes that are retained is given by a function *f* of the total number of input attributes *x* (e.g., $f(x) = 1, f(x) = \sqrt{x}, f(x) = \lfloor \log_2 x \rfloor + 1, ...$). By setting $f(x) = x$, we obtain the bagging procedure.

In this work, the PCTs for HMLC are used as base classifiers. Average is applied to combine the different predictions. This is because the leaf's prototype is the proportion of examples that belong to it. This means that a threshold should be specified in order to make an prediction.

4 EXPERIMENTAL DESIGN

Here, we describe the setup we used to analyze the data.

For each of the axes (see the data description in Section 1) we have 4 training and 4 testing datasets. From each of the datasets we learn a PCT for HMLC and Ensembles of PCTs (Bagging and Random Forests). The ensembles consisted of 100 un-pruned trees. The feature subset size for Random Forests was set to 7 (using the formula $f(80) = \lfloor \log_2 80 \rfloor + 1$).

To compare the performance of a single tree and an ensemble we use Precision-Recall (PR) curves (see Figure 5). These curves are obtained with varying the value for the threshold: a given threshold corresponds to a single point from the PR-curve. For more information, see [10].

To decide for an optimal value of the threshold (*t*), 10-fold cross validation on the training set is performed. From the PR curves one can select few thresholds and evaluate the predictions of the models for each of the threshold.

5 RESULTS AND DISCUSSION

The results from the experiments are shown in Figure 5. For each of the axes we present a PR curves for the three methods we use.

From the curves we can note the increase of the predictive performance when we use ensembles instead of single tree. The lift in performance that ensembles give to their base classifier was previously noted in the cases of classification and regression [11, 12] and multiple targets prediction [8].

The excellent performance for the prediction task for axes T and B (AUPRC of 0.9994 and 0.9862) is due to the simplicity of the problem. Namely, the hierarchies along these axes contain only few nodes (9 and 27, respectively). This means that in each node in the hierarchy there are nice portion of the examples, thus learning a good classifier is not a difficult task. The classifiers for the other two axes have high predictive performance (AUPRC of 9064 and 0.8264), but here the predictive task is somewhat more difficult (especially for axis A). The sizes of the hierarchies for axes A and D are 110 and 36 nodes, respectively.

A successfull image annotation system highly depends of the performance of its two main components: the feature extractor and the classifier. The feature extraction process should provide a vector of features that best reflects the different aspects for distinguishing one class from the others. When such features are given to a classifier that is able to capture the nature of the task, then the predictive performance of such a classifier will be very high.

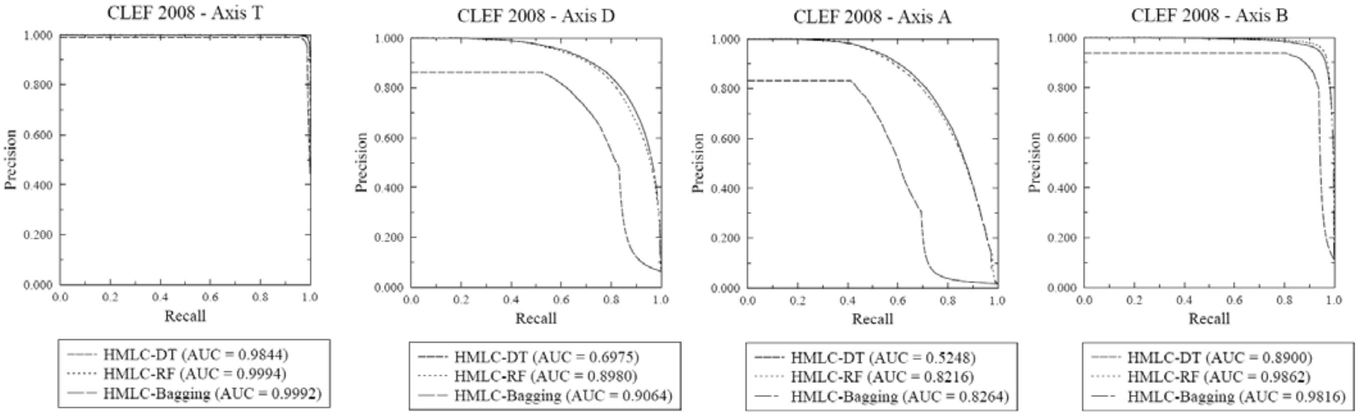


Figure 5: *Precision-Recall curves for the T,D,B and A axis, respectively*

6 CONCLUSIONS

This paper presented a hierarchical multi-label classification (HMLC) approach to medical image annotation. For efficient image representation we used local distribution of edges. The edge histogram is robust feature for representing gray-scale radiological images.

We applied PCTs for HMLC and ensembles of PCTs in order to accurately classify the image in the IRMA code hierarchy. The ensembles of PCTs showed increased performance as compared to a single PCT.

There are few possibilities for improvements of the results, that we plan to further investigate. First, we can further exploit the hierarchical nature of the IRMA code: instead of learning a classifier for each axis separately, one can learn a classifier for all the axes (or combinations of axes). Second, we plan to use other algorithms for feature extraction from images (e.g. Scale-invariant feature transform, SIFT) that were previously successfully used in image annotation [4].

Another line of further work is extensions of the machile learning algorithm. One such extension is enabling the algorithm to learn a model that ia aware of a covariate shift (the test set distribution is different from the train set distribution). Also, we plan to implement other distance measures for hierarchies (e.g. Jaccard similarity coefficient - like).

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FUZZY CLUSTERING OF DOCUMENTS

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ABSTRACT

This paper presents a short overview of methods for fuzzy clustering and states desired properties for an optimal fuzzy document clustering algorithm. Based on these criteria we chose one of the fuzzy clustering most prominent methods – the c-means, more precisely probabilistic c-means. This algorithm is presented in more detail along with some empirical results of the clustering of 2-dimensional points and documents. For the needs of documents clustering we implemented fuzzy c-means in the TextGarden environment. We show few difficulties with the implementation and their possible solutions. As a conclusion we also propose further work that would be needed in order to fully exploit the power of fuzzy document clustering in TextGarden.

1 INTRODUCTION

Clustering is an unsupervised classification of objects (data instances) into different groups. In particular we are talking about the partitioning of a dataset into subsets (clusters), so that the data in each subset (ideally) share some common property. This property is usually defined as proximity according to some predefined distance measure. The goal is to divide the dataset in such a way that objects belonging to the same cluster are as similar as possible, whereas objects belonging to different clusters are as dissimilar as possible. The computational task of classifying the data set into k clusters is often referred to as k-clustering. Although estimating the actual number of clusters (k) is an important issue we leave it untouched in this work.

Fuzzy clustering [1, 2] in contrast to the usual (crisp) methods does not provide hard clusters, but returns a degree of membership of each object to all the clusters. The interpretation of these degrees is then left to the user that can apply some kind of a thresholding to generate hard clusters or use these soft degrees directly.

All the algorithms that we consider here are partitional, deterministic and non-incremental (based on the taxonomy defined in [4]). The property that we want to change using fuzzy methods instead of crisp clustering is exclusiveness, as there are cases in which algorithms constructing overlapping partitions of set of documents perform better than the exclusive algorithms.

Text-Garden [3] is a software library and collection of software tools for solving large scale tasks dealing with structured, semi-structured and unstructured data – the emphasis of its functionality is on dealing with text. It can be used in various ways covering research and applicative scenarios. Our special interest in TextGarden is the OntoGen tool [7]. Ontogen is a semi-automated, data-driven ontology construction tool, focused on the construction and editing of topic ontologies based on document clustering. Actually we want to upgrade OntoGen with fuzzy clustering properties; however, since it is based on TextGarden we must provide the implementation of the fuzzy clustering algorithm in its library.

2 FUZZY CLUSTERING ALGORITHMS

In this section, we present some of the fuzzy clustering algorithms mainly based on the descriptions in [5]. We devote the majority of space to the hard c-means, fuzzy c-means and possibilistic c-means. For the other methods we provide just a short description, as we did not find them appropriate for our needs.

All algorithms described here are based on objective functions, which are mathematical criteria that quantify the quality of cluster models. The goal of each clustering algorithm is the minimization of its objective function. The following syntax will be used in the equations, algorithms and their explanations:

J ... objective function

$\mathrm{X} = \{\mathbf{x}_1, \dots, \mathbf{x}_\mathrm{n}\}$ ... dataset of all objects (data instances)

$\mathrm{C} = \{\mathbf{c}_1, \dots, \mathbf{c}_\mathrm{c}\}$ ... set of cluster prototypes (centroid vectors)

$d_{ij} = \|\mathbf{x}_1 - \mathbf{c}_1\|$... distance between object $\mathbf{x}_\mathrm{j}$ and centre $\mathbf{c}_\mathrm{i}$

u_{ij}... weight of assignment of object $\mathbf{x}_\mathrm{j}$ to cluster i

$\mathbf{u}_j = (u_{1j}, \dots, u_{cj})^T$ ... memberships vector of object $\mathbf{x}_\mathrm{j}$

$\mathrm{U} = (u_{ij}) = (\mathbf{u}_1, \dots, \mathbf{u}_n)$ ... partition matrix of size $c \times n$

2.1 Hard c-means (HCM)

Hard c-means is better known as k-means and in general this is not a fuzzy algorithm. However, its overall structure is the basis for all the others methods. Therefore we call it hard c-means in order to emphasize that it serves as a starting point for the fuzzy extensions.

The objective function of HCM can be written as follows:

$$J_h = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij} d_{ij}^2. \tag{2.1}$$

As mentioned HCM is a crisp algorithm, therefore: $u_{ij} \in \{0, 1\}$. It is also required that each object belongs to exactly one cluster: $\sum_{i=1}^{c} u_{ij} = 1, \forall j \in \{1, \dots, n\}$.

Before outlining the algorithm, we must know how to calculate new membership weights:

$$u_{ij} = \begin{cases} 1, & \text{if } i = \operatorname{argmin}_{l=1}^{c} d_{lj} \\ 0, & \text{otherwise} \end{cases}, \tag{2.2}$$

and based on the weights, how to derive new cluster centres:

$$\mathbf{c}_i = \frac{\sum_{j=1}^{n} u_{ij} \mathbf{x}_j}{\sum_{j=1}^{n} u_{ij}} \tag{2.3}$$

The algorithm can now be stated very simply as shown in Table 2.1.

```
INPUT: A set of learning objects to be clustered
and the number of desired clusters c
OUTPUT: Partition of learning examples into c
clusters and membership values u_ij for each example
x_j and cluster i.
ALGORITHM (2.1) The hard c-means algorithm:
(randomly) generate clusters centres
repeat
    for each object recalculate membership weights
    using equation (2.2)
    recompute the new centres using equation (2.3)
until no change in C can be observed
```

Table 2.1: Pseudocode of the HCM clustering algorithm.

The HCM algorithm has a tendency to get stuck in a local minimum, which makes it necessary to conduct several runs of the algorithm with different initializations. Then the best result out of many clusterings can be chosen based on the objective function value.

2.2 Fuzzy c-means (FCM)

Probabilistic fuzzy cluster analysis [1, 2] relaxes the requirement: $u_{ij} \in \{0, 1\}$, which now becomes: $u_{ij} \in [0, 1]$. However $\sum_{i=1}^{c} u_{ij} = 1, \forall j \in \{1, \dots, n\}$ still holds. FCM optimizes the following objective function:

$$J_f = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^m d_{ij}^2. \tag{2.4}$$

Parameter *m*, *m*>1, is called the fuzzyfier or the weighting exponent. The actual value of *m* determines the 'fuzziness' of the classification. It has been shown [5] that for the case *m*=1, J_f becomes identical to J_h and thus FCM becomes identical to hard c-means.

The transformation from the hard c-means to the FCM is very straightforward; we must just change the equation for calculating memberships (2.2) with:

$$u_{ij} = \frac{1}{\sum_{l=1}^{c} \left(\frac{d_{ij}^2}{d_{lj}^2} \right)^{\frac{1}{m-1}}} = \frac{d_{ij}^{\frac{-2}{m-1}}}{\sum_{l=1}^{c} d_{lj}^{\frac{-2}{m-1}}}, \tag{2.5}$$

and function for recomputing clusters centres (2.3) with:

$$\mathbf{c}_i = \frac{\sum_{j=1}^{n} u_{ij}^m \mathbf{x}_j}{\sum_{j=1}^{n} u_{ij}^m}. \tag{2.6}$$

Equation (2.5) clearly shows the relative character of the probabilistic membership degree. It depends not only on the distance of the object $\mathbf{x}_j$ to the cluster $\mathbf{c}_i$, but also on the distances between this object and other clusters.

Although the algorithm stays the same as in HCM (Table 2.1), we get probabilistic outputs if we apply above changes. The (probabilistic) fuzzy c-means algorithm is known as a stable and robust classification method. Compared with the hard c-means it is quite insensitive to its initialization and it is not likely to get stuck in an undesired local minimum of its objective function in practice. Due to its simplicity and low computational demands, the probabilistic FCM is a widely used initializer for other more sophisticated clustering methods.

2.3 Possibilistic c-means (PCM)

Although often desirable, the relative property of the probabilistic membership degrees can be misleading. High values for the membership of object in more than one cluster can lead to the impression that the object is typical for the clusters, but this is not always the case. Consider, for example, the simple case of two clusters shown in Figure 2.1. Object $\mathbf{x}_1$ has the same distance to both clusters and thus it is assigned a membership degree of about 0.5. This is plausible. However, the same degrees of membership are assigned to object $\mathbf{x}_2$ even though this object is further away from both clusters and should be considered less typical. Because of the normalization the sum of the memberships has to be 1. Consequently $\mathbf{x}_2$ receives fairly high membership degrees to both clusters. For a correct interpretation of these memberships one has to keep in mind that they are rather degrees of sharing than of typicality, since the constant weight of 1, given to an object, must be distributed over the clusters.

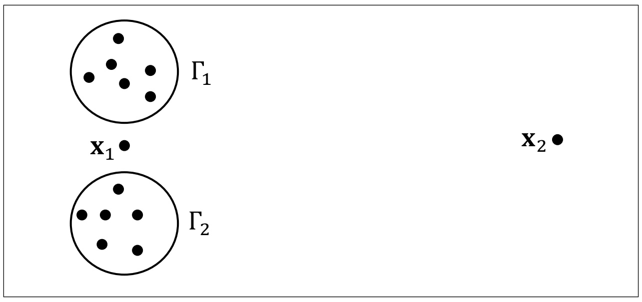

Figure 2.1: Example of misleading interpretation of the FCM membership degree.

Therefore PCM, besides relaxing the condition for u_{ij} to $u_{ij} \in [0, 1]$ as in case of FCM, also drops the normalization requirement: $\sum_{i=1}^{c} u_{ij} = 1, \forall j \in \{1, \dots, n\}$. The probabilistic objective function J_f that just minimizes squared distances would be inappropriate because with dropping of the normalization constraint a trivial solution exists for $u_{ij} = 0$ for all $i \in \{1, \dots, c\}$ and $j \in \{1, \dots, n\}$, i.e., all clusters are empty. In order to avoid this solution, penalty a term is introduced that forces the memberships away from zero. Objective function J_f is modified to:

$$J_p = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^m d_{ij}^2 + \sum_{i=1}^{c} \eta_i \sum_{j=1}^{n} \left(1 - u_{ij}\right)^m, \qquad (2.7)$$

where $\eta_i > 0$ for all $i \in \{1, \dots, c\}$.

In the PCM algorithm, the equation for calculating cluster centres stays the same as in FCM (2.6). But the equation for recalculating membership degrees changes from (2.5) to:

$$u_{ij} = \frac{1}{\left(\frac{d_{ij}^2}{\eta_i}\right)^{\frac{1}{m-1}}}. \qquad (2.8)$$

This also slightly changes the original procedure (Table 2.1) since we must recompute η_i using the equation (2.9) before calculating the weight u_{ij}.

$$\eta_i = \frac{\sum_{j=1}^{n} u_{ij}^m d_{ij}^2}{\sum_{j=1}^{n} u_{ij}^m}. \qquad (2.9)$$

Properties of PCM [5] are the following:

- Cluster Coincidence: since PCM is not forced to partition data exhaustively it can lead to solutions where two or more clusters occupy the same space (same objects with the same membership weighting).
- Cluster Repulsion: objective function J_p is, in general, fully optimized only if all clustered centres are identical. Because of that, other, not optimal solutions are found just as a side effect of J_p getting stuck in a local optimum.

Because of these unwanted properties we did not choose PCM to be our choice for the implementation. However we also did not decide that this method is totally inappropriate for us. Thus we leave this matter open as the future possibility of implementing PCM in TextGarden library.

2.4 Other reviewed algorithm

During the review of fuzzy clustering algorithms we considered also the following algorithms. We will not precisely describe them in this paper, since we decided that they are not the best choice for our implementation. An interesting reader can find their descriptions in [6] or [5].

- Gustafson-Kessel Algorithm: while FCM and PCM can only detect spherical clusters GKA can identify also clusters of different forms and sizes. It is more sensitive to initialization and has higher computational costs.
- Fuzzy Shell Clustering: can, in contrast to all the algorithms above, identify also non-convex shaped clusters. They are especially useful in the area of image recognition. We think that this property in not needed in text clustering.
- Kernel-based Fuzzy Clustering: are variants of fuzzy clustering algorithms that modify the distance function to handle non-vectorial data, such as sequences, trees or graphs, without the requirement to completely modify the algorithm itself. In text clustering we are dealing with vectors so there is no need for such an advanced method.

3 IMPLEMENTATION

3.1 Evaluation on 2-dimensional points

Before having implemented FCM in the TextGarden environment we tested the algorithm on 2-dimensional points. Data was generated artificially using normally distributed clusters of random size, position and standard deviation. Empirical evaluations showed us some of the advantages of FCM compared to hard c-means:

- Lower probability of getting caught in the local optimum. We found few test scenarios where HCM gets stuck in local optima in approximately 50% of all runs but FCM never, using the same initial distributions. We could not find example where FCM would provide a non-optimal solution, but it should be noted that we knew and used the correct number of clusters c for both algorithms.
- Better correct centre (centroid vector) localization (at least on the normally distributed artificial data).

The main reason against using FCM is its higher computational complexity.

3.2 Definition of a distance measure

One of the problems that we encountered during the implementation was how to define a measure of distance between objects (or between an object and a centre of clusters). TextGarden library uses mainly a measure of similarity based on the cosine similarity. This proximity measure ranges from 0 to 1 where 0 means no similarity and 1 means total equality of vectors:

$$sim(\mathbf{x}_1, \mathbf{x}_2) = \cos\theta = \frac{\mathbf{x}_1 \cdot \mathbf{x}_2}{\|\mathbf{x}_1\| \|\mathbf{x}_2\|} \in [0,1], \qquad (3.1)$$

where $\mathbf{x}_\mathrm{i}$ is an object or more specifically in our case a bag-of-word vector representation of a document and θ is $\measuredangle(\mathbf{x}_1, \mathbf{x}_2)$. Our problem was that we actually needed the opposite of the similarity – a distance for the FCM algorithm. The two most obvious ways how to derive a distance are:

$$dist(\mathbf{x}_1, \mathbf{x}_2) = 1 - sim(\mathbf{x}_1, \mathbf{x}_2) \in [1,0], \qquad (3.2)$$

$$dist(\mathbf{x}_1, \mathbf{x}_2) = \frac{1}{sim(\mathbf{x}_1, \mathbf{x}_2)} \in [\propto, 1], \qquad (3.3)$$

The difficulty of (3.2) is that it's not preserving relations i.e. if $\mathbf{x}_1$ is two times more similar to $\mathbf{c}$ than $\mathbf{x}_2$ it is not necessary that $\mathbf{x}_1$ will be also two times closer to $\mathbf{c}$ than $\mathbf{x}_2$. On the other hand (3.3) has another unwanted property. Its image interval starts from 1 and not from 0 as we would like to have if vectors are equal.

We tried both distances and evaluated them also experimentally. We have not discovered any significant change in FCM behaviour regardless of the selected distance. Thus we decided for (3.2) because it is simpler for calculation and we do not need to check for infinite numbers which results in faster execution.

3.3 Time complexity

Time complexities of HCM and FCM are respectively:

$$O_{HCM} = O(i_{HCM} \cdot n \cdot c \cdot v), \tag{3.4}$$

$$O_{FCM} = O\big(i_{FCM} \cdot n \cdot c \cdot (v + c)\big), \tag{3.5}$$

where i is the number of required iterations and v is the length of an example vector. According to our experimental results i_{FCM} is slightly higher than i_{HCM}. Consequently we assume that they share the same order of magnitude and are therefore equal as this analysis is concerned.

We can declare that the statement:

$$O(i \cdot n \cdot c \cdot v) \sim O\big(i \cdot n \cdot c \cdot (v + c)\big) \tag{3.6}$$

holds if dimensionality of the vector v is much higher than the number of clusters c. This is also the case for text clustering in TextGarden, so we can confirm that the time complexity of fuzzy c-means is similar to the one of hard c-means. Certainly we must admit that there is probably some constant factor linking the actual speeds because of the higher complexity of the inner most loops (calculation of distances and weights) of FCM compared to HCM. We estimate this factor to be in the range from 1 to 3.

3.4 An experiment on the documents data

Table 3.1 shows the results of documents clustering for both algorithms (FCM and HCM). As a set of documents we used 1000 random texts from the Yahoo Finance dataset of the companies' descriptions. We partitioned the set into 5 clusters using the same initial distributions and the same shared parameters. For each cluster we provide the mean inner similarity value, the number of documents and the three most characteristic keywords. The clusters are aligned therefore the results can be directly compared. It is evident that both algorithms found similar clusters. The average mean similarity is lower for c-means which might be the result of better centre localization of c-means.

Documents: 1000 (FCM) Mean Similarity: 0.182	Documents: 1000 (HCM) Mean Similarity: 0.177
Mean Sim.0.443, 92 Docs. 'BANKING':0.854 'LOANS':0.254 'DEPOSITS':0.113	Mean Sim.0.369, 124 Docs. 'BANKING':0.770 'INSURANCE':0.404 'LOANS':0.166
Mean Sim.0.137, 269 Docs. 'GAS':0.247 'EXPLORATION':0.240 'PROPERTY':0.180	Mean Sim.0.145, 218 Docs. 'GAS':0.263 'POWER':0.244 'EXPLORATION':0.199
Mean Sim.0.180, 180 Docs. 'DRUGS':0.386 'PHARMACEUTICALS':0.260 'DISEASES':0.229	Mean Sim.0.181, 170 Docs. 'DRUGS':0.386 'PHARMACEUTICALS':0.263 'CHEMICALS':0.245
Mean Sim.0.244, 107 Docs. 'INSURANCE':0.623 'INVESTMENTS':0.261 'INSURANCE_COMPANY':0.173	Mean Sim.0.155, 187 Docs. 'PROPERTY':0.303 'INVESTMENTS':0.271 'SECURITIES':0.191
Mean Sim.0.129, 352 Docs. 'WIRELESS':0.202 'SOLUTIONS':0.181 'SOFTWARE':0.175	Mean Sim.0.134, 301 Docs. 'SOLUTIONS':0.203 'STORES':0.191 'SOFTWARE':0.181

Table 3.1: Comparison of HCM and FCM algorithms on the Yahoo Finance dataset

4 CONCLUSIONS

This paper presents an overview of fuzzy clustering algorithms that could be potentially suitable for document clustering, a new fuzzy c-means clustering algorithm implemented in the TextGarden environment, and an empirical comparison of hard c-means and fuzzy c-means as an application on documents and 2D points.

Further work will consider: connecting fuzzy c-means with Ontogen and designing and implementing some adaptive threshold approach for converting fuzzy cluster to its crisp equivalent. This should be done in such a way that one document could be assigned to none, one or more clusters according to its membership degrees and similarities to the clusters. Furthermore we will perform statistical evaluation of hard c-means and fuzzy c-means in terms of document classification using other quality measures (besides average similarity) for generated clusters.

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Semantic Modeling, Translation and Matching of QoS

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ABSTRACT

The variety of access and transport technologies available in modern computer networks pose significant challenges related to compatibility and quality of service (QoS) related issues. Applications and services can have many different and unique requirements towards the transportation services (TSs) they use to interconnect. Traditionally, applications are required to specify their QoS requirements in the language which the TSs understand. This results in reformulation of intuitive parameters (i.e. desired video resolution) to parameters understood by the TSs (i.e. required bandwidth).

This paper presents techniques for (a) automatic matchmaking of application requirements to the offers by TSs providers and (b) automatic translation of application requirements into the TSs QoS requirements. To this end semantic technologies, namely OpenCyc, are used for ontological modeling, translation and matchmaking. We present relevant examples on how semantic technologies can be used in the context of communication networks.

1 INTRODUCTION

The word "quality" is defined by [1] as the "totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs". "Service" is defined by the same standard as a "type of product […] always the result of an activity or interaction between a service supplier and a customer and can take many forms". The QoS framework assumes that a customer requests a service having a given QoS profile from a provider.

Throughout this paper, the customers will be applications using services over a network to which the access is possible over multiple different transport services (TSs). The differences between TSs can come from different technologies (i.e. WiFi vs. UMTS), different pricing (i.e. pay-as-you-go vs. flat rate), different availability, etc.

Selecting appropriate transport services for a specific application in a environment with many available TSs can pose significant technological challenges, especially with the emergence of software defined radios [2][3]. Providing multi-services in a multi-network environment has been previously investigated [4] for wired networks using multiple layers of abstraction to hide transport specific complexity. However, complexity management and the necessity for interoperability require more advanced approaches.

In this paper we present an approach for automatic matching of applications to the appropriate TSs based on application requirements and the QoS parameters offered by the TSs. In order to do the matching, we developed an approach for automatic translation of application level requirements into the QoS parameters understood by the TSs.

Both approaches are based on the Semantic web technologies [5] which were already successfully applied for the task of web service (WS) [6] composition, matching and monitoring as well as for modeling and mapping of WS QoS specifications [7]. However, research on semantic translation of application QoS requirements to the network QoS parameters is still open as existing attempts have been limited in scope [7][8][9].

Application QoS requirements differ from one application to another (e.g. a streaming service compared to a browsing service) and need to be properly recognized and translated to TS requirements, which are platform and technology dependent. In our approach, a reasoning engine uses a QoS model combined with a set of rules to map and match requirements. For instance, it must be able to infer that if an application requires streaming TS for a QCIF picture size with frame rate of 15 pictures per second, the network must meet the following requirements: 64 kbps bit rate, 300 ms latency, 20 ms jitter and 10^{-4} packet error rate.

This paper is structured as follows. Section 2 presents related work. Section 3 we discuss QoS representation and matchmaking using OpenCyc and Section 4 presents experiments relevant to using OpenCyc for translation and inference. Finally, we conclude the paper.

2 RELATED WORK

One recent trend in service oriented architecture (SOA) [10] related work is to develop QoS aware web services. In [6] and [11], the authors introduce the Web services-QoS architecture (WS-QoS) meant to close the gap between the WS layer and the underlying QoS-aware transport technologies. WS-QoS extends the Universal Description, Discovery and Interoperability (UDDI) by introducing a broker. QoS requirements and offers are defined using XML schema, approach that makes the architecture highly interoperable. However, service discovery and matchmaking lack semantics with this approach.

In [7], the authors discuss the shortcomings of non-semantic specifications of QoS for WS and propose a semantic QoS (SQS) framework. They built a QoS hierarchy ontology model encoded in RDFS and test the overhead of the ontology design. As opposed to [11], this work does not go down to the transport network QoS, thus not considering this aspect of QoS for WSs. They actually use a middleware approach that passes application QoS specifications to the underlying technology.

Developments of semantic representations for QoS for WSs in the form of ontologies can be found in [8][9] and [12]. In the first two, the authors report on the development of QoSOnt using Web Ontology Language [13]. The latter reports on an ontological encoding for QoS developed in DAML-S and then ported to OWL. They also provide results regarding matchmaking and measurement using the ontology. A survey on other representations for QoS services can be found in [14].

In [15] the authors develop OWL-QoS ontology for the purpose of finding matches between offers from the TS providers, called adverts, and the consumer requests (called request). Example of an advert can be seen in Figure 1.

Figure 1 ProviderProfile Class

The OWL-QoS ontology uses a three layer representation of QoS: QoS Profile Layer, QoS Property Definition Layer and QoS Metrics Layer. Profile layer stands for matchmaking purpose, the property definition layer specifies the domain and range constraints of the properties and metrics layer contains metrics definition and measurement. The authors use reasoning engine Racer [16] for performing matching adverts to the requirements.

The work in this paper uses available QoS representations and investigates their usability for application to TSs QoS translation. We base our ontology on the one presented in [7] and we use OpenCyc [17] for ontology modeling, semantic matchmaking and QoS parameter translation.

3 QOS REPRESENTATION AND MATCHMAKING USING OPENCYC

In this section we first describe how the QoS domain and its parameters are modeled using OpenCyc and then show an example of how we can use the model to do the matchmaking between the TSs providers and consumers.

After trying and working with several different available semantic models of QoS [7][8][15] we decided for the approach presented in [7]. The main advantage was the hierarchy of applications which can be used to better determine the QoS characteristics. The dimensions of QoS are represented in the base-class layer of the ontology, on top of which the QoS domain ontology layer is built. We recreated a part of the base-class ontology in OpenCyc.

The Cyc ontology consists in a few numbers of collections, predicates and implication rules. For example, relevant characteristics for a video application can be represented, among others, by the frame rate of the video, the video codec used and the resolution or format of the screen. We modeled this data by creating the following collections: VideoCodec (as a subclass of Codec collection), VideoResolution and VideoFormat. A video format is characterized by video resolution and for this we created a predicate which links the VideoFormat with the correspondent resolution. Also video codecs are typically standardized so these relations can be stated. For instance, some resolutions are related to some frame rates based o the codec used; for this we created another predicate, but this time for linking three objects: one video codec, one video resolution and one numerical value for the frame rate. In the next section we will explain how we used this structure for the inferring the data rate.

In the previous section we described the OWL-QoS ontology and how it was used for matchmaking between the advert and the request: a match is a pair (*advert*, *request*) where the objectives requested by the *request* are satisfied by the *advert*. The matchmaking algorithm presented in [12] introduces degrees of matching, and Racer reasoning engine is used to infer the matches between requests and adverts and their degrees.

We implement the matchmaking similar to the one described in [12], without introducing the degrees of matching however. OpenCyc was used for both modeling and for reasoning. We created a QoSProfile collection which holds both adverts and requests. It has two predicates which define the cost for a service and the response time which a generic system takes to react to a given input. QoSRequest and QoSAdvert are subcollections of QoSProfile and they inherit the defined predicates for QoSProfile. An advert is a match for a request if the cost for the service provided by the advert is lower than the price the requester can pay and the response time advertised is also lower than the one requested.

The matchmaking conditions can be stated in CycL using rules as in Figure 2. The matching predicate takes two arguments: the first one is a request profile and the second one is an advert profile. The first rule from Figure 2 matches the response time between an advert and a request. X stands for a QoSRequest and Y for a QoSAdvert. It can be noticed that there is one condition that verifies that X is a request (isa ?X QoSRequest). This is there only for making the rule more human readable, otherwise the condition is redundant as X is the first argument of the "matchTime" predicate.

For every new QoSProfile added, request or advert, the rule will automatically calculate every possible match, since these rules are designed to be forward rules. This enables fast retrieval of matching adverts. For example if there are two adverts in the knowledge base (KB), the first offering a response time of 3000 milliseconds at the cost of $1 per second and the second one a response time of 1000 milliseconds for $3 per second, when a new request stating that it needs a response time of 2000 millisecond for $5 per second is added, then the second advert will be automatically found as a match, without having to specifically ask for the match to be done. Another advantage of using OpenCyc is that there are some concepts for units of measure already defined and integrated in the KB.

```
(implies
    (and
      (isa ?X QoSRequest)
      (responseTime ?X (MillisecondsDuration ?T1))
      (isa ?Y QoSAdvert)
      (responseTime ?Y (MillisecondsDuration ?T2))
      (or(equals ?T1 ?T2) (lessThan ?T2 ?T1)))
    (matchTime ?X ?Y))

(implies
    (and
      (costPerSecond ?X (USDollarFn ?C1))
      (costPerSecond ?Y (USDollarFn ?C2))
      (or(equals ?C1 ?C2) (lessThan ?C2 ?C1)))
    (matchCost ?X ?Y))

(implies
    (and
      (matchCost ?X ?Y)
      (matchTime ?X ?Y))
    (match ?X ?Y))
```

Figure 2 Matching rules in CycL

4 USING OPENCYC FOR INFERRING NETWORK QOS

This section describes an approach for automatic translation of QoS requirements from the application point of view into the QoS parameters that the TS providers understand. Combining the translation with the matchmaking presented in the previous section results in a system where application requests, expressed in a language intuitive for their domain (i.e. video streaming) can be automatically matched to the appropriated TS according to their QoS specifications.

Based on the approach from [7] which introduces a QList as a support for specifying the requirements of one application we created a similar structure in OpenCyc, for the translation of application requirements to network requirements. For a video application, the list of requirements can specify, for instance, the video resolution and the codec; others may specify only the video format. Along with other specific requirements for a video application, like color depth or frame rate, we want to translate all of them into network requirements. One of the network requirements is the data rate needed by the application and this data rate can be inferred from the application requirements even if these are incomplete. The formula based on which the data rate is calculated is expressed in and the rules for OpenCyc to make the necessary inferring are shown in Equation 1.

$$DR = FrameHeight \cdot FrameWidth \cdot FrameRate \cdot Color\ Depth$$

Equation 1 Computing data rate

Table 1 specifies two lists with different requirements and the inferred data rates. The first list specifies the video codec, the maximum frame size (as video resolution), frame rate and color depth. From the first three requirements, using the rule on the left side of Figure 3 and the information from the KB, the compatible frame size will be inferred. In the KB, relations are specified between codec, frame rate and the related resolution for that combination; in this case for a frame rate of 20 fps and MPEG4 codec, the video resolution inferred is 320x240. The second list specifies only three parameters: video format, color depth and frame rate. Knowing the video format, OpenCyc will infer, based on the KB, that the frame size is 320x240. Then, by applying the rule on the right side of Figure 3 the data rate is computed. So, the system is resilient to different formats of specifications. The requirements can be different as long as there is enough knowledge in the KB.

	QoSList1	**QoSList2**
Video Codec	MPEG4	
Video Resolution	320 x 320	
Video Format		QVGA
Color Depth (bits)	8	8
Frame Rate (fps)	20	20
Inferred Data Rate (bit/sec)	**12288000**	**12288000**

Table 1 QoS requirements and inferred bits per second

Another issue which can appear when there are multiple users and each one "speaks" its own language is the way they can understand each other. For instance, in the above example, we used *frame size* and *video resolution* referring to the same thing and it is easy for humans to understand that. However, for a machine this equivalence must be explicitly specified. In OpenCyc, a fast way to say that *frame size* is the same with *video resolution* may look like this: "(isa FrameSize VideoResolution)". Having this rule, it will not matter which term one uses in the list of requirements. But as anything easy and fast to do, it is not really correct, because in this way FrameSize represents a subclass of VideoResolution, not an equivalent class. This happens due to the fact that OpenCyc applies Unique Name Assumption (UNA) for all the concepts that were set in the KB there must be different names only for different entities. A way to solve this problem is to associate one or more strings to a concept so that it will be possible for that concept to be found also by different names. In our

(implies
    (and
        (hasCodec ?Q ?C)
        (hasFrameRate ?Q ?FR)
        (hasMaxResolution ?Q ?MR)
        (hasColorDepth ?Q ?CD)
        (hasResAndFR ?C ?R ?FR)
        (frameWidth ?R (Pixel-UnitOfCount ?W))
        (frameHeight ?R (Pixel-UnitOfCount ?H))
        (frameWidth ?MR (Pixel-UnitOfCount ?MW))
        (frameHeight ?MR (Pixel-UnitOfCount ?MH))
        (or
            (lessThan ?W ?MW)
            (equals ?W ?MW))
        (or
            (lessThan ?H ?MH)
            (equals ?H ?MH))
        (evaluate ?BS (TimesFn ?W ?H ?FR ?CD)))
    (computeDR ?Q ?BS))
	(implies
	    (and
	        (hasVideoFormat ?Q ?VF)
	        (hasFrameRate ?Q ?FR)
	        (hasColorDepth ?Q ?CD)
	        (formatHasResolution ?VF ?R)
	        (frameWidth ?R (Pixel-UnitOfCount ?W))
	        (frameHeight ?R (Pixel-UnitOfCount ?H))
	        (evaluate ?BS (TimesFn ?W ?H ?FR ?CD)))
	    (computeDR ?Q ?BS))

Figure 3 Rules for inferring data rate

example, the concept is defined as VideoResolution, and to this concept a string is attached adding the following assertion: (nameString VideoResolution “FrameSize”) to the English Micro Theory.

5 CONCLUSIONS

In this paper we studied the existing ontologies for QoS and performed several experiments to study the way these can be used to perform matchmaking between providers and consumers of transfer services and how to do automatic translation from application level requirements to the QoS parameters which TS can understand. To this end, we modeled in OpenCyc several QoS profiles to simulate matching between adverts and requests. We also constructed several rules in OpenCyc which were used to inferre network QoS parameters from application parameters.

Because of the large number of applications and network technologies existing nowadays, semantic technologies seem suitable for QoS modeling. However, larger taxonomies and more complex experiments are required to assess the full potential of this approach. In the future we plan to extend the ontology for the translation of QoS application characteristics to network characteristics and do a tighter integration between the matchmaking and the parameter translation. Furthermore we want to integrate this into OpenCyc because of the good inference it provides.

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EXTENDING ONTOLOGIES FOR ANNOTATING BUSINESS NEWS

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ABSTRACT

Ontologies are commonly used for annotating textual data mainly based on human language technologies [1]. This research focuses on manual extensions of ontologies to support the annotation of business news. Experiments were conducted on a well known Cyc ontology and using Cyc annotator on two business news datasets. We show that the proposed extensions of ontology results in annotation with better coverage of terms that are relevant for the business domain. The results of identifying financial terms in business news using the original Cyc ontology show the average precision of 56% and recall of 41% in case of Reuters news and the average precision of 69% and the recall of 57% in case of Yahoo financial news. Using the proposed extension results with increased performance, the average precision of 82% and average recall of 73% for Yahoo financial news and average precision of 84% and average recall of 63% for Reuters news.

1 INTRODUCTION

News reports are considered to be one of the largest sources of information about society. The analysis of news allows to make the important conclusions about trends in the society life. Since the news domain has several characteristics that difference it from other domains, the semantic technologies might be a good choice for news analysis [3]. One of the goals of this research is to contribute to the analysis of the financial news by the means of semantic technologies - in particular by creating and extending the Financial ontology in Cyc, which is known to have one of the largest knowledge base in the world.

There exists several challenges while using semantic technologies in the news analysis. News are dynamic, interactive and socially biased. News agencies produce huge amounts of content.

According to Jarrar [6], the following challenges should be dealt with while building any kind of ontology: Ontology reusability, Ontology application/task-independence and Ontology evolution.

The challenges of Ontology reusability and Ontology application/task-independence can be efficiently handled by Cyc, given the fact that Cyc allows using its extensive knowledge base for different tasks and purposes. Ontology evolution can also be followed in Cyc and in case of Financial ontology it should be considered as an extremely important challenge.

The creation of the Financial Ontology might be difficult due to several reasons. According to Zhang, Zhang and San Ong [12], in the financial environment the tasks are dynamic, distributed, global, and heterogeneous in nature. They are characterized by the large amount of continually changing, and generally unorganized, information available, the variety of all kinds of information (like market data, financial report data, breaking news, etc.) and many sources of uncertainty in the environment.

Mónica Martínez Montes et al. [9] as well mention several reasons explaining why the creation of the ontologies in the financial domain is difficult. Slow standardization efforts and high complexity of the financial standards, high competition and dynamics of the financial sector influence the implementation of the new technologies. Consequently, there exists a very few number of ontologies connected to the financial sphere of life. At the same time, there is a high necessity in the creation of the extensive financial ontologies which could be effectively used and reused by the financial institutions.

2 METHODOLOGY

In order to create a coherent and relevant ontology a number of methodological principles or criteria should be considered.

2.1 Design criteria for Ontology Development

Gruber [4] defines the following design criteria for ontology developing: Clarity, Coherence, Extendibility, Minimal encoding bias and Minimal ontological commitment.

Jarrar [6] states two additional methodological principles: Ontology double articulation principle and Ontology modularization principle. Since financial news are dynamic and heterogeneous, Clarity is one of the most important principles in case of Financial ontology.

In view of the fact that there exist a very limited number of ontologies in the financial domain, Extendibility and Ontology modularization principles can be considered essential as well.

2.2 Overview of Methodologies

There exist several methods and methodologies of the ontology creation: Cyc method [7], Uschold and King's method [11], Grüninger and Fox's methodology [5], METHONTOLOGY [2], On-To-Knowledge [10] etc.

Uschold and King's methodology for developing ontologies includes the following stages:

- Indentify Purpose.
- Building the Ontology.
    - Ontology capture.
    - Ontology coding.
    - Integrating Existing Ontologies.
- Evaluation.
- Documentation.

The methodology by Grüninger And Fox can be described by the next steps:

- Capture of motivating scenarios.
- Formulation of informal competency questions.
- Specification of the terminology of the ontology within a formal language.
    - Getting informal terminology.
    - Specification of formal terminology.
- Formulation of formal competency questions using the terminology of the ontology.
- Specification of axioms and definitions for the terms in the ontology within the formal language.
- Establish conditions for characterizing the completeness of the ontology.

One the most famous and frequently used methodologies are METHONTOLOGY and On-To-Knowledge methodology. According to the developers of METHONTOLOGY, the METHONTOLOGY framework includes:

- The identification of the ontology development process.
- A life cycle based on evolving prototypes and
- the methodology itself, which specifies the steps for performing each activity, the techniques used, the products to be output, and how the ontologies are to be evaluated.

On-To-Knowledge methodology distinguishes such phases of the ontology development:

- Feasibility Study.
- Kickoff.
- Refinement.
- Evaluation and
- Application & Evolution.

Due to the fact that Cyc gives an extremely powerful possibility of creating and using different ontologies, Cyc method has been chosen as a main methodology in our research. Cyc method and Cyc knowledge base are widely discussed in the following chapter.

3 CYC

Cyc Knowledge Base (Cyc KB) appears to be one of the largest knowledge bases in the contemporary IT world. It is stated as "a formalized representation of a vast quantity of fundamental human knowledge: facts, rules of thumb, and heuristics for reasoning about the objects and events of everyday life" [13] and divided into the large number of "microtheories", each of which represents the set of assumption for a particular knowledge domain.

At the present time, the Cyc KB contains nearly two hundred thousand terms and several dozen hand-entered assertions about/involving each term. New assertions are continually added to the KB by human knowledge enterers. Additionally, term-denoting functions allow for the automatic creation of millions of non-atomic terms, such as (LiquidFn Nitrogen); and Cyc adds a vast number of assertions to the KB by itself as a product of the inferencing process. [13]

According to Cyc method [7], the phases to build the Cyc ontology are following:

- Manual encoding of the explicit and implicit knowledge appearing in the knowledge sources.
- Knowledge codification that is aided by tools using knowledge already stored in the Cyc KB.
- Delegating to the tools the majority of the work.

In each phase two tasks are performed: 1. Development of a knowledge representation and top level ontology containing the most abstracts concepts. 2. Representation of the rest of the knowledge using this primitives.

There exist several reasons for using Cyc including the following. The large number of assertions currently existing in Cyc KB. Existance of several version of the system available under different licences (OpenCyc, ResearchCyc). Flexible and convenient language (CycL). Suitable interface.

The Cyc method can be also considered the most useful for news analysis due to the extensive amount of versatile integrated information in the Cyc KB. Controversially, METHONTOLOGY and OTK methodology can be more useful for the creation ontologies which are going to be used in the particular applications.

4 PRELIMINARY EXPERIMENTS

In spite of the fact that Cyc contains a very extensive knowledge base, the representation of the financial and economical information in it is far from complete. As an experiment, two sets of the financial news - one from a well known Reuters news archive and another from Yahoo Finance news archive - have been analyzed.

4.1 Data Description

Reuters news archive contains the selected collection of 1450 news in 1996 year. News are categorized into 354 categories which enables an easy identification of a subset of business news [8] We have taken all the news that are assigned one the following categories:

I8 FINANCIAL AND BUSINESS SERVICES
I81 BANKING AND FINANCIAL SERVICES
I82 INSURANCE
I831 FINANCIAL SERVICES
I84 RENTING AND LEASING EQUIPMENT
I85 REAL ESTATE DEALING

Yahoo news for the experiment have been taken from the news archive on the Yahoo! finance website [14] It contains the raw, uncategorized, news materials for the last three months (in our case, second half of May – first half of August 2008) all together around 26000 news articles. However, all news from the archive have financial connotation.

4.2 Experimental results

Experiments were conducted on a randomly selected sample of ten documents from each dataset. The documents were manually annotated for financial terms. Then Cyc annotator was applied on them using the original Cyc ontology as well as our extension of the original Cyc ontology.

Table 1. shows the results of Cyc annotation of random samples of Reuters financial news. The first column contains the name of the news article. Then we give the total number of the words in the article, followed by the number of financial terms in the article (as selected manually). The forth column gives the number of financial terms tagged by Cyc and the fifth column contains the number of financial terms tagged by Cyc correctly. The following two columns contain the precision and recall of tagging of the financial terms by Cyc and the last two columns contain the precision and recall after adding to Cyc mis-tagged and untagged terms from Yahoo Financial Glossary. The results using the original Cyc ontology show the average precision of 56% and recall of 41% (in case of Reuters news) and average precision of 69% and the recall of 57% in case of Yahoo financial news (table with Yahoo results is omitted due to space restrictions).

Consequently, improving Cyc knowledge on finances may be a key factor in a better analysis of the financial news using Cyc. In order to estimate possible improvement of an annotator with the proposed extension of the ontology we have provisionally added to the Cyc ontology all untagged and mis-tagged financial terms that appear in the sample of the news. The experiment shows that when we add all the untagged and mis-tagged financial terms to Cyc ontology, the average precision increases up to 99% and average recall to 98%.
However, to avoid the assumption that we already know all the relevant terms that need to be annotated and thus possibly added for a particular document set, we have checked the overlap between such terms in our sample and a publicly available glossary of financial terms. We found that around 50% (52% for Yahoo financial news and 54% for Reuters) of the financial terms untagged or tagged incorrectly by Cyc, can be found in the publicly available glossary of financial terms (Yahoo Financial Glossary).

Adding mis-tagged and untagged terms from Yahoo Financial Glossary increases the average precision to 82% and average recall to 73% for Yahoo financial news and average precision to 84% and average recall to 63% for Reuters news.

This means that by extending Cyc ontology by the terms from the glossary we can considerably improve precision and recall of the annotator. Based on the experimental results we conclude that the conducted experiment shows the insufficient representation of financial domain in Cyc and the ways to effectively improve it by the means of extension of Cyc financial knowledge base.

5 DISCUSSION AND CONCLUSIONS

This research focuses on manual extensions of ontologies to support the annotation of business news. Experiments were conducted on Cyc ontology on two business news datasets (Reuters and Yahoo). We show that the proposed extensions of ontology results in news annotation with better coverage of terms that are relevant for business domain. However, we belive that the proposed approach can be applied to other domains beyond business news.

In this research we are proposing extending ontology for better coverage of business terminology by adding terms from financial glossary. However, other relevant terms from different sources of financial information can be added, such as, terms describing stock market mechanisms and stock exchange instances. Extension of the Cyc ontology in direction of stock exchange is ongoing and its evaluation is part of our future work.

6 ACKNOWLEDGMENTS

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Table 1. Financial news tagged by Cyc (Reuters)

Article name	Total words	Fin. Terms	Fin. Terms tagged	Fin. Terms tagged correctly	Precision, %	Recall, %	Precision after adding terms from Yahoo glossary, %	Recall after adding terms from Yahoo glossary, %
Doc. 1 Lloyd's of London serves notice of emergency stay.	648	14	13	8	62%	57%	93%	93%
Doc. 2 UK Lloyd's moves to ward off doubts on recovery.	489	13	9	6	67%	46%	75%	69%
Doc. 3 CANADA: Canadian banks poised for higher third-quarter profits.	612	45	30	17	57%	38%	69%	40%
Doc. 4 Malaysia's Intria buys into two construction firms.	432	24	15	9	60%	38%	80%	50%
Doc. 5 Slovak PM sees banks releasing funds for bad debts.	156	10	10	2	20%	20%	90%	90%
Doc. 6 ArgentBank to buy Assumption Bank & Trust.	64	9	7	6	86%	67%	100%	78%
Doc. 7 Nationwide, Halifax bid for UK defense sale - paper.	123	9	5	4	80%	44%	80%	44%
Doc. 8 Australia: Current Australian Takeovers (A to E) - Aug 26.	481	19	17	8	47%	42%	82%	74%
Doc. 9 AUSTRALIA: RTRS-Australia's COAL in A$300 mln float - paper.	365	18	13	4	31%	22%	100%	83%
Doc. 10 China state firms form new insurance company.	67	11	7	6	86%	55%	100%	64%
Avrg.	344	17	13	7	56%	41%	84%	63%

CHURN PREDICTION MODEL IN RETAIL BANKING USING FUZZY C-MEANS CLUSTERING

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ABSTRACT

The paper presents model based on fuzzy methods for churn prediction in retail banking. The study was done on the real, anonymised data of 5000 clients of a retail bank. Real data are great strength of the study, as a lot of studies often use old, irrelevant or artificial data. Canonical discriminant analysis was applied to reveal variables that provide maximal separation between clusters of churners and non-churners. Combination of standard deviation, canonical discriminant analysis and k-means clustering results were used for outliers detection. Due to the fuzzy nature of practical customer relationship management problems it was expected, and shown, that fuzzy methods performed better than the classical ones. According to the results of the preliminary data exploration and fuzzy clustering with different values of the input parameters for fuzzy c-means algorithm, the best parameter combination was chosen and applied to training data set. Four different prediction models, called prediction engines, have been developed. The definitions of clients in the fuzzy transitional conditions and the distance of *k* instances fuzzy sums were introduced. The prediction engine using these sums performed best in churn prediction, applied to both balanced and non-balanced test sets.

1 INTRODUCTION

Due to intensive competition and saturated markets, companies in all industries realize that their existing clients database is their most valuable asset. Retaining existing clients is the best marketing strategy to survive in industry and a lot of studies showed it is more profitable to keep and satisfy existing clients than to constantly attract new ones [1,4,8,11]. Churn management, as the general concept of identifying those clients most prone to switching to another company, led to development of variety of techniques and models for churn prediction. Next generation of such models has to concentrate on the improved accuracy, robustness and lower implementation costs, as every delay in reaction means increased costs for the company [2].

The aim of this study was to show that the data mining methods based on the fuzzy logic could be successfully applied in the retail banking analysis and, moreover, that the fuzzy c-means clustering performed better than the classical clustering algorithms in the problem of churn prediction. Although the clustering analysis is in fact an unsupervised learning technique, it can be used as the basis for classification model, if the data set contains the classification variable, what was case in this study.

To our best knowledge this is the first paper considering application of fuzzy clustering in churn prediction for retail banking. Studies of churn prediction in banking are very scarce, and the most of papers used models based on logistic regression, decision trees and neural networks [9,11]. Useful literature review of attrition models can be found in [11]. Some of them [9] reported the percentage of correct predictions varying from 14% to 73%, depending on the proportion of churners in the validation set. The others [3] obtained AUC performance in subscription services varying from 69,4% for overall churn to 90,4% but only for churn caused by financial reasons, which is much easier to predict. Results are not perfectly comparable due to differences in churn moment definitions, data sets sizes or industries, but still can provide valuable subject insight.

2 FUZZY C-MEANS CLUSTERING ALGORITHM

Classical clustering assigns each observation to a single cluster, without information how far or near the observation is from all the other possible decisions. This type of clustering is often called *hard* or *crisp* clustering [1,10,12]. Two major classes of crisp clustering methods are hierarchical and optimization (partitive) clustering, with number of different algorithms, used in the study.

Based on the fuzzy set theory, firstly introduced by Zadeh in 1965. [5,6,10] and on the concept of membership functions, the fuzzy clustering methods have been developed. In fuzzy clustering entities are allowed to belong to many clusters with different degrees of membership.

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Fuzzy clustering of X into p clusters is characterized by p membership functions μ_j, where

$$\mu_j: X \rightarrow [0,1], j = 1, \dots, p, \quad (1)$$

$$\sum_{j=1}^{p} \mu_j(x_i) = 1, \; i = 1,2,\dots,n, \quad (2)$$

and $$0 < \sum_{i=1}^{n} \mu_j(x_i) < n, \; j = 1,2,\dots,p. \quad (3)$$

Membership functions are based on a distance function, such that membership degrees express proximities of entities to cluster centers (also called *cluster prototypes*).
The most known method of fuzzy clustering is the fuzzy c-means method (FCM), initially proposed by Dunn, generalized by Bezdek [5] and used in this study.
FCM involves two iterative processes: the calculation of cluster centers and the assignment of the observations to these centers using some form of distance. FCM is attempting to minimize a standard loss function

$$l = \sum_{k=1}^{p} \sum_{i=1}^{n} [\mu_k(x_i)]^m \|x_i - c_k\|^2 \quad (4)$$

from which two fundamental equations necessary to implement FCM are derived [5].
Expression (5) is used to calculate a new cluster center value:

$$c_j = \frac{\sum_i [\mu_j(x_i)]^m x_i}{\sum_i [\mu_j(x_i)]^m} \quad (5)$$

and expression (6) to calculate the membership in the $j-th$ cluster:

$$\mu_j(x_i) = \frac{\left(\frac{1}{d_{ji}}\right)^{\frac{1}{m-1}}}{\sum_{k=1}^{p}\left(\frac{1}{d_{ki}}\right)^{\frac{1}{m-1}}} \quad (6)$$

The symbols in the equations (4), (5) and (6) denote:
l is the minimized loss value;
p is the number of fuzzy clusters;
n is the number of observations in the data set;
$\mu_k()$ is a function that returns the membership of x_i in the $k-th$ cluster;
m is the fuzzification parameter;
c_k is the centre of the $k-th$ cluster;
d_{ji} is the distance metric for x_i in cluster c_j;
d_{ki} is the distance metric for x_i in cluster c_k.

3 CHURN PREDICTION PROBLEM IN RETAIL BANKING AND INPUT DATA SET

There is no unique definition of churn problem, but generally, term churn refers to all types of customer attrition whether voluntary or involuntary [1,3]. How to recognize it in practice depends on industry and case. In this study, client is treated as churner if he had at least one product (saving account, credit card, cash loan etc.) at time t_n and had no product at time t_{n+1}, meaning that he cancelled all his products in the period $t_{n+1} - t_n$. If client still holds at least one product at time t_{n+1}, he is considered to be non-churner.
The programs for all research phases, as well as prediction engines, were written in SAS 9.1. [12].

3.1 Input data set

The input data set has 5000 clients, chosen by random sampling from the client population in 2005, aged between 18 and 80 years, preserving the distribution of population according to introduced auxiliary variable which was product level of detection (PLOD). The class imbalance problem [2,9] was solved in the way that precisely 2500 churners and 2500 non-churners entered the final data set, what is in line with results in [2]. Regarding the moment of churn for 2500 churners five sample data sets, with different configuration of churners, have been explored. The analysis showed that the “clear” set, with churners all lost in the same quarter of the year, is best for further clustering. All clients who quitted the relationship with bank in some period, but returned after 6 months or later, were removed from the sample, as the analysis showed they behave similarly to real churners and introduce the noise.

3.2 Variable selection

Not all variables of interest were allowed for study, and the availability of more transactional variables would surely lead to better model performance [11]. This was partially proved through inclusion of derived variables (differences in time, ratios, etc.), what led to the improved accuracy of fuzzy clustering in comparison to clustering results with only original variables. All variables were measured in five equidistant points of time: t_0 to t_4. Preliminary clustering analysis showed that, as far as the original variables are statical in their character, including the values of more than two periods leads to more noise than to greater precision. All the combinations of two periods were tested and finally the values in t_0 and t_2 were chosen for the further analysis. Table 1. gives the description of the 73 variables finally chosen for the further work.

time	socio-demographic	banking products in charge	financial	bad-behavior	derived for Δt=t2-t0
t_0	3	16	14	2	6
t_2	—	16	14	2	—
total	3	32	28	4	6

Table 1: *Variables for the final FCM.*

3.3 Canonical discriminant analysis

Canonical discriminant analysis (CDA) finds the linear combinations of the variables that provide maximal separation between clusters [12]. CDA helped in identifying the variables that best describe each of two classes/clusters: churners and non-churners. In some way CDA confirmed that the combination of $t_0 - t_2$ variable values is more adequate for FCM then the other combinations. All the coefficients and corresponding variables have been carefully examined.

3.4 Detection and removal of outliers

Although the majority of variables is not normally distributed, the standard deviation [10] in combination with CDA and k-means revealed most serious outliers better than other methods. The most serious outliers were detected for all 73 variables separately and the intersection of those 73 sets was found. For all the outliers the data values have been checked in the data warehouse. The check confirmed that all the data are correct and that the outliers are not the consequence of the errors in database. Top 50 outliers from that intersection were removed from the data set. The outlier removal significantly improved the performance of classical clustering and slightly improved the performance of FCM.

3.5 Results of hierarchical and crisp k-means clustering

To prove that fuzzy clustering performs better than the classical methods on the real retail banking data, hierarchical clustering and k-means clustering were done. Applied to all 5000 clients, almost all hierarchical methods, as well as repeated k-means, failed on the same outliers.
Most of them separated only one client in the first cluster and all other 4999 were appointed to the second cluster. All the methods were repeated on the data set without top 50 outliers and some of them performed better.

$$\boldsymbol{tp\ rate}\ (recall, hit\ rate) = \frac{positives\ correctly\ classified}{total\ positives}$$

$$\boldsymbol{fp\ rate}\ (false\ alarm\ rate) = \frac{negatives\ incorrectly\ classified}{total\ negatives}$$

$$\boldsymbol{accuracy} = \frac{true\ positives + true\ negatives}{positives + negatives}$$

$$\boldsymbol{specificity} = 1 - fp\ rate$$

Figure 1: *Common performance metrics calculated from confusion matrix.*

Figure 1 shows the standard measures [7] for comparison of the results in churn prediction, as stated in [2] and Table 2 shows some of the results of classical clustering. To get the full comprehension on algorithm performance several measures have to be considered simultaneously. Recall rate of 100% means unsuccessful churners recognition, if comes in combination with specificity under 1%. Losing one client causes greater losses for the bank, then investing in marketing campaign for several clients incorrectly classified as possible churners, which means that costs of false negatives are much higher then costs of false positives. In real clients population there are much less positive then negative instances, so liberal classifiers obtaining high recall rate and acceptable specificity are considered successful in business.

4 MODEL SETUP AND PREDICTION RESULTS

FCM has been repeatedly applied on the complete data set and on the data set without top 50 outliers, with 10 different values of the *fuzzification parameter* m, and different initial cluster seeds. It performed slightly better without outliers, what means that FCM is very robust against outliers' presence. From application point of view that is very good property of FCM, since it will not always be profitable for the bank to detect and remove outliers, not to mention the fact that these outliers are sometimes the most active and profitable clients and they need to be included in the model development. With crisp k-means it would not be possible, because it performed incredibly poorly with these clients.
Data set was splitted into two parts: training set and test set, in three different ratios. The ratio of 90% of clients in the training set and 10% of clients in test set was chosen. According to the values of the membership functions, the clients in fuzzy transitional conditions (FTC) were detected. For that purpose two new definitions were proposed.

Definition 1. *Let* p *be the number of clusters in the FCM algorithm. Let us denote* $max_{j=1}^{p}\{\mu_j(x_i)\} = \mu_{MAX}^1$ *and* $max_{j=1}^{p}\{\mu_j(x_i) \setminus \mu_{MAX}^1\} = \mu_{MAX}^2$ *for the entity* x_i. *The entity* x_i *is said to be in the fuzzy transitional condition of the 1st degree if, for arbitrary small* $\varepsilon > 0$, *holds that* $\mu_{MAX}^1 - \mu_{MAX}^2 < \varepsilon$.

Definition 2. *Let* p *be the number of clusters in the FCM algorithm. Let us denote* $max_{j=1}^{p}\{\mu_j(x_i)\} = \mu_{MAX}^1$. *The entity* x_i *is said to be in the fuzzy transitional condition of the 2nd degree if, for arbitrary small* $\varepsilon > 0$, *holds that* $\mu_{MAX}^1 - \frac{1}{p} < \varepsilon$.

Table 2: *Results of preliminary classical clustering.*

CLUSTERING ALGORITHM	STANDARDIZATION METHOD	tp rate (recall)	fp rate	accuracy	specificity
Average Linkage	standard deviation	99,96%	100,00%	50,44%	0,00%
Average Linkage	range	100,00%	99,47%	50,73%	0,53%
Centroid Linkage	standard deviation	99,96%	100,00%	50,44%	0,00%
Centroid Linkage	range	100,00%	99,96%	50,48%	0,04%
Ward's Minimum Variance	standard deviation	84,67%	66,92%	59,11%	33,08%
Ward's Minimum Variance	range	73,58%	60,81%	56,55%	39,19%
Complete Linkage	standard deviation	99,96%	99,92%	50,48%	0,08%
Complete Linkage	range	87,39%	70,07%	58,93%	29,93%
Flexible Beta	standard deviation	81,55%	64,89%	58,55%	35,11%
Flexible Beta	range	72,18%	59,01%	56,73%	40,99%
McQuitty's Similarity Analysis	standard deviation	99,96%	100,00%	50,44%	0,00%
McQuitty's Similarity Analysis	range	98,08%	89,27%	54,81%	10,73%
Median Linkage	standard deviation	99,96%	100,00%	50,44%	0,00%
Median Linkage	range	100,00%	99,96%	50,48%	0,04%
Single Linkage	standard deviation	99,96%	100,00%	50,44%	0,00%
Single Linkage	range	100,00%	99,96%	50,48%	0,04%
Crisp k-means*	standard deviation	100,00%	99,96%	50,02%	0,04%
Crisp k-means	standard deviation	99,88%	80,67%	59,61%	19,33%

**** performed on complete data set, without outlier removal***

Subsets of clients in the FTC of both degrees, and with floating ε values, were further analyzed and the information gained from the fact about their membership values helped in explaining their behavior. Four prediction models were developed, based on the main idea of the distance of the new client from the clients in the training data set. For the predictive purpose in the 4th model, the definition of *distance of k instances* (DOKI) *sums* was introduced.

Definition 3. *Let p be the number of clusters in the FCM algorithm and X be the set of n entities with assigned membership values μ_j, $j = 1, \ldots, p$. Distance of k instances sum i.e. $DOKI_j^k(x)$ sum for the new entity x_{n+1} is defined as the sum of membership values $\{\mu_j\}$ in the $j-th$ cluster of the k nearest entities from X, according to distance metric used in FCM.*

Calculation of DOKI sums requires the input parameter k and several different values were applied. Table 3 presents the results of FCM on the training set and prediction engine with DOKI sums applied on balanced and non-balanced test sets. Concept of DOKI sums might seem similar to k nearest neighbors approach, but DOKI sums up *values of membership functions* and not the pure distances. Recall rate for test sets were even higher then recall rate obtained with FCM on the training set. Improvement in recall was paid in slight decrease in specificity. As mentioned previously, it is more important to hit churners, even if it is paid by hitting some percentage of loyal clients. The cost minimization can be achieved later through more intelligent and multi-level communication channels.

DATA SET	tp rate (recall)	fp rate	accuracy	specificity
training	79,64%	55,61%	62,00%	44,39%
test - nonbalanced	87,60%	60,82%	63,64%	39,18%
test - balanced	88,52%	62,45%	63,04%	37,55%

Table 3: *Results of FCM and DOKI prediction model.*

5 CONCLUSIONS AND FURTHER WORK

It is always challenging to deal with real data and business situations, where classical methods can rarely be applied in their simplest theoretical form. The main idea of the study – to prove that fuzzy logic and fuzzy data mining methods can find their place in the reality of retail banking – was completely fulfilled. FCM performed much better than the classical clustering and provided more hidden information about the clients, especially those in fuzzy transitional conditions. Three new definitions were introduced and had the impact on the overall work. Implementation of DOKI sums increased hit rate (recall) by 8,88% in comparison to pure FCM. A lot of work still needs to be done. In the near future every client and every selling opportunity will become important. Methods which require a lot of preprocessing and, above all, removing many outlying clients, will lose the battle with more efficient and robust methods. More accuracy should be obtained through better information exploitation of clients in fuzzy transitional conditions, and not through clients removal. Monitoring clients in FTCs and reacting as they approach to churners could be a way for more intelligent churn management. This requires analysis on larger data sets, including more transactional variables into the model and tuning ε. Model should also include costs of positive and negative misclassifications. Different segments of clients or clients having similar product lines could be modeled on their own, to find empirically best FCM parameters for each segment/product line.

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STOCHASTIC SUBGRADIENT APPROACH FOR SOLVING LINEAR SUPPORT VECTOR MACHINES – AN OVERVIEW

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ABSTRACT

This paper is an overview of a recent approach for solving linear support vector machines (SVMs), the PEGASOS algorithm. The algorithm is based on a technique called the stochastic subgradient descent and employs it for solving the optimization problem posed by the soft margin SVM - a very popular classifier. We briefly introduce the SVM problem and one of the widely used solvers, SVM light, then describe the PEGASOS algorithm and present some experiments. We conclude that the algorithm efficiently discovers suboptimal solutions to large scale problems within a matter of seconds.

1 INTRODUCTION

Since the nineties Support Vector Machines (SVMs) have become one of the most popular supervised machine learning methods used for regression and classification problems [3]. Although SVMs can be used to find nonlinear classification or regression functions, this paper focuses on the case of linear classification SVMs. Training the algorithms for nonlinear SVMs scales super-linearly in the number of training examples and the algorithms can handle tens of thousands of data points. In recent years it has been shown that the linear SVMs on the other hand can be trained in linear time with respect to the number of training examples. These new approaches can deal with millions of training points. The purpose of this paper is to compare one of the most popular SVM implementations, SVM-light [2] and a recent solution, Pegasos [1] based on stochastic subgradient optimization.

2 SUPPORT VECTOR MACHINE

This chapter is composed of two subchapters. The first one will introduce the basic intuitions behind the support vector machines and some formal problem definitions and the second one will introduce the problem in the dual representation.

2.1 Intuitions and problem formulation

In a two class classification task we are presented with a training sample, S, of m labelled data points : $S = \{(x_i, y_i)\}_{i=1:m}$, where $x_i \in R^n$ are the training vectors and $y_i \in \{-1,1\}$ are their corresponding labels. The task is to find the linear functional $f\colon R^n \rightarrow R$, $f(x) = <w,x> + b$ that satisfies a certain criterion. We denoted the inner product by $<.,.>$, and we will also use the notation $w'x := <w,x>$, where w' denotes vector w transposed. Vector w is commonly referred to as the normal of the classification hyperplane and b is referred to as bias. Let us first consider the case where data is linearly separable (there exists an f that perfectly classifies all the examples from the set S), a case also known as the hard margin SVM. SVM optimization criterion is based on finding the f that separates the data best in the sense of the highest minimal distance between the hyperplane and the data points. Figure 1 shows two possible hyperplanes (a blue and a black one). They both perfectly separate the data, but the margin (or the minimum distance) between data points and the black line is much higher than the margin of the blue line. The black hyperplane is more likely to perform better on new instances than the blue line. By using geometry we can show that the margin of a hyperplane f is proportional to $1/<w,w>$. This can be formally stated as the following constrained optimization problem:

- Hard margin SVM

Minimize: w'w
Subject to: $y_i\ (<w, x_i> -b) > 1,\ i=1,...,m$

The constraints are equivalent to $f(x_i) = (<w, x_i> -b) > 1$ if $y_i = 1$ and $f(x_i) = (<w, x_i> -b) < -1$ if $y_i = -1$, for all $(x_i, y_i) \in S$, which are the conditions for correct classification of the training sample. All the constraints are linear functions of w and b and the objective is a quadratic function of w. Problems of this form are known as quadratic programs.

Since data is usually noisy it is often the case that a separating hyperplane does not exist. In such cases we search for a hyperplane that misclassifies a few points but has a high margin with respect to the correctly classified points. This case is known as the soft margin SVM. The task is to find a hyperplane with a good trade-off between the training loss (high training loss usually leads to poor performance on new instances but small training loss can lead to overfitting) and the margin (large margins lead to good generalization ability, whereas small margins can lead to overfitting). The margin plays the role of regularizing the loss function and controls the complexity of the classification model. One part of the training task is to find a good trade-off parameter between the margin and the loss and this is usually accomplished by cross-validation. There are two equivalent formulations of the soft margin SVM optimization problem: regularized hinge loss formulation and slack variable formulation (softening the hard margin constraints). Here follows the latter formulation:

- Soft margin SVM – slack variables

Minimize: $w'w + C\Sigma_i\xi_i$
Subject to: $y_i(<w, x_i> -b) \geq 1- \xi_i$, for all $i=1,...,m$

The ξ_i variables are called slack variables and they allow the w and b variables to violate the hard margin constraints and by adding the sum $\Sigma_i\xi_i$ to the objective we penalize those violations. The parameter C controls the trade-off between the margin size and the amount of data that lies inside the margin or is even misclassified. This problem is also a quadratic programming problem:

- Soft margin SVM – regularized hinge loss

Minimize: $w'w + C\Sigma(1 - y_i(w'x_i - b))_+$

In the equation above $()_+$ represents the function $(x)_+ := max\{0,x\}$. Notice that this problem is an unconstrained optimization problem and that by contrast to the slack formulation it is not differentiable, since $()_+$ is not smooth.

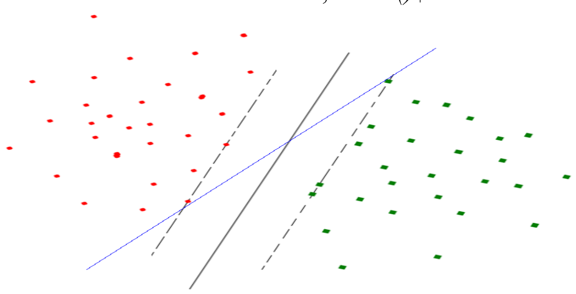

Figure 1: *Separating hyperplanes*

2.2 Optimization problem: dual

The formulations presented so far are searching for a w of the same dimension as training vectors x_i. We call such formulations primal formulations. By writing down the Lagrangian, analysing the Karush-Kuhn-Tucker (KKT) conditions [4] and some algebraic manipulation we can express the solution w as a m-dimensional (size of the training set) vector in terms of dual variables. This can be beneficial if the number of features is much higher than the number of training examples and these formulations can easily be adopted to handle nonlinear optimizations (this is known as the kernel trick, see [5]). We will omit the derivations and present the dual soft margin SVM optimization problem.

Minimize: $\Sigma_i\alpha_i\alpha_jy_iy_j<x_i,x_j> - \Sigma_i\alpha_i$
Subjetc to: $0 \leq \alpha_i \leq C,\ i= 1,...,m$
$\Sigma_iy_i\alpha_i = 0$

We notice that this is again a quadratic problem with particularly simple linear constraints, box constraints. Vector w can be expressed as $w = \Sigma_i\alpha_iy_ix_i$. The solution is written as a linear combination of those training vectors whose corresponding α_i coefficients are non zero, and these vectors are called support vectors. One of the consequences of KKT theory is that the solution would remain the same even if we remove all but the support vectors from the training set S.

3 SOLVING THE OPTIMIZATION PROBLEM

This chapter will introduce two approaches to solving the SVM optimization problem. The first one is based on an active set method of the dual soft margin SVM and the other one is the main focus of this article – the stochastic subgradient descent optimization of the regularized hinge loss formulation of soft margin SVM.

3.1 Active set dual optimization: svm-light

One of the main problems with directly optimizing the dual soft margin SVM are the super-linear convergence rate and high memory requirement (quadratic in the number of training examples since the matrix of the quadratic objective function has m rows and m columns). We have mentioned that the solution of the problem is completely determined by the set of support vectors (or their corresponding α variables). Active methods try to identify that set by starting with a random set working set and then iteratively keep adding or removing variables from that set. In this way that they decompose the large problem into a series of smaller, tractable, quadratic problems, by optimizing only over the variables in the working set and fixing all the other variables. After that step the method tries to find a better working set. This can be posed as an optimization which can be efficiently solved. The solutions found by SVM-light are highly accurate.

3.2 Stochastic subgradient descent primal optimization: PEGASOS

Pegasos algorithm optimizes the primal view regularized hinge loss formulation instead of the quadratic program. It is based on a search method called stochastic subgradient descent. The method iteratively searches for the optimum of a function. It starts with a random starting point, finds the best search direction, computes the new point and repeats these steps until it converges. It uses subgradient descent, since the gradient of the hinge loss function does not exist and it uses the stochastic version, because computing the gradient of the optimization function can be expensive when the training set is large. We will first define the subgradient of a function and present the subgradient of the regularized hinge loss function.

3.2.1 Stochastic subgradient

Vector v is a subgradient of function f at a point x_0, if:
$f(x) - f(x_0) \geq v'(x - x_0)$
for every x in some open neighbourhood of x_0.
The authors of Pegasus optimize the following function (slightly different trade-off constant and ignoring the bias coefficient)
$f(w) = \lambda/2\ w'w + 1/m\ \Sigma_i\ (1 - y_i\ w'x_i)_+$
Subgradient of each of the summands in the above sum is equal to 0 if $y_i w'x_i > 1$ and equal to $-y_i x_i$ otherwise (non zero loss case). Subgradient of the full expression is thus equal to:
$\partial f = \lambda\ w - 1/m\ \Sigma_{i+}\ y_i x_i,$
where Σ_{i+} denotes the sum over the indices with nonzero loss. Computing a stochastic subgradient is very similar, the only difference is that we create a subsample of the training points, A, and compute the subgradient of an approximated function:
$f_A(w) = \lambda/2\ w'w + 1/k\ \Sigma_{i\, \epsilon\, A}\ (1 - y_i\ w'x_i)_+,$
where k is the size of the subsample A.

3.2.2 The algorithm

The algorithm has an additional step besides the subgradient descent step in each iteration and that is projection onto a ball with diameter $1/\sqrt{\lambda}$. It can be proven that the optimal solution always lies in that ball and if the current iterate moves out of that ball, projecting it brings it only closer to the optimal solution. The step size, η, is initialized as $1/\lambda$ and keeps decreasing with the number of iterations. In the t-th iteration we set it to $\eta_t = 1/(\lambda t)$. We denote the total number of iterations as T, and the size of the subsample in each step as k, which we chose manually .

Algorithm :
INPUT: S, λ, T, k
INITIALIZE: Choose w_1 randomly so that $||w_1|| \leq 1/\sqrt{\lambda}$
FOR t = 1, 2, ..., T
    Choose A_t, a random subset of S of size k
    Set $A' = \{(x,y)\ \epsilon\ A_t : yw_t', x < 1\}$
    Set $\eta_t = 1/(\lambda t)$
    Set $w_{t+1/2} = (1 - \eta_t\lambda)w_t + \eta_t/k\ \sum_{(x,y)\epsilon A'} yx$
    Set $w_{t+1} = min\{1,\ 1/(\sqrt{\lambda}||w_{t+1/2}||\ )\ \}\ w_{t+1/2}$
OUTPUT: w_{T+1}

3.2.3 Remark

One of the reasons why such an old technique has not been successfully applied to this problem until a few years ago is that the researchers used slower, less aggressive, learning rates. The Pegasos fast learning rate and the fact that it provably converges are the key to the success of the algorithm.

4 EXPERIMENTS

We will first describe the data set and proceed with analyzing several properties of the Pegasos algorithm.

4.1 Data

The experiments were conducted on the Reuters RCV2 corpus [6], which consists of 804.414 news documents. The documents are represented as 47.236 dimensional sparse vectors (bag of words document representation), with the sparsity 0,16%. Each document in the collection is assigned to a category from a hierarchy of categories. The four major categories are: CCAT, GCAT, ECAT, MCAT. We focused on testing the algorithms on the category CCAT, which consists of 381.327 positive documents (the rest are negative), and is very balanced.

4.2 Robustness to random initializations

We first investigated the robustness of Pegasos solutions to different choices of initial random starting vectors w. Figure 2 depicts several curves corresponding to different starting points. Each curve represents the value of the objective function as the iterations increase. One can notice that the behaviour of the Pegasos algorithm is more or less independent of the choice of initial solution.

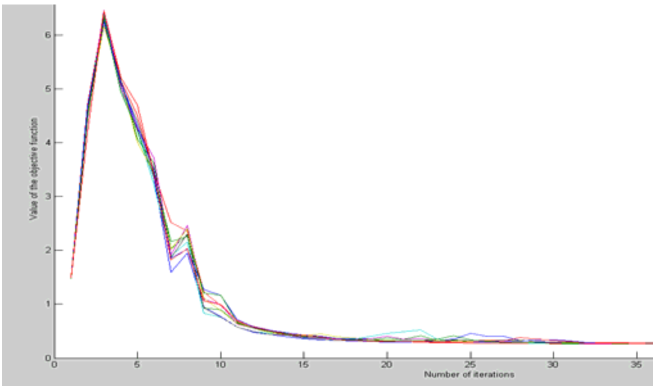

Figure 2: *Several runs with different initial vectors*

4.3 Convergence of pegasos

We evaluated the convergence speed of the Pegasos algorithm. Optimum objective value was computed by SVM-light, which took roughly four hours of CPU time. Computing the 200 iterations of the Pegasos algorithm took 9.2 seconds of CPU time and the the objective value was 0.3% close to the optimum. Pegasos needed 560 iterations to get within 0.1% error of the true optimum. This experiment demonstrates the rapid convergence of Pegasos towards approximate solutions. The k parameter was set to 8.000 and the λ parameter was set to 0.0001, as this value was observed to be optimal for the Reuters corpus and the category CCAT.

4.4 Testing the classification accuracy

The Reuters data set was split into the first 700.000 documents for training and the rest 104.414 documents for testing (the original order was preserved). We investigated how the classification error on the test set decreases with the number of iterations of the Pegasos algorithm. Figure 3 depicts the error on the test set with the number of iterations of the algorithm. We can see that the algorithm achieves 5.8% classification error within 50 iterations. SVM-light achieved the error of 5.6%.

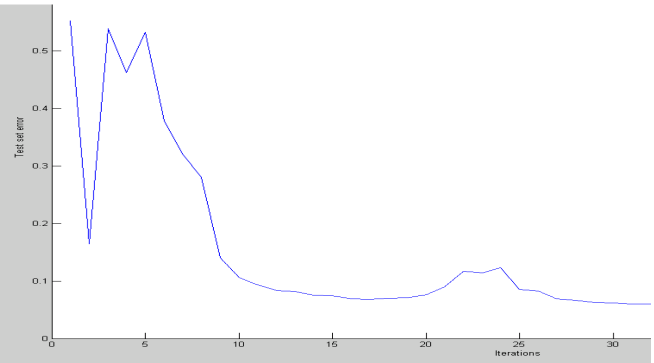

Figure 3: *The decrease of test error with the number of iterations*

4.5 Parameters k and T

One of the experiments involved examining the influence of different values of k and T parameters on the objective value. Figure 4 depicts the relationship between k and T when their product is fixed. The first thing to notice is that curves with larger kT are always dominated by curves with smaller kT (convergence). All three settings for different values of kT yielded similar curves, and we can notice that seting k too small can slow down convergence rate. This result is unexpected, since the authors of the Pegasos algorithm experimentally showed that the value of k is not important as long as the value of kT is fixed, although they left deeper analysis for future work. Note that they did not use the same data set for their experiments. They recommended setting the value of k to 1, although our experiments imply setting k to a higher value. One possible reason for slower convergence with low values of k, for example 1, is that the algorithm converges to solutions with low number (5 to 10 percent) of misclassified training examples very rapidly, even though the margin is still suboptimal. This means that when we sample a training point in each of the following iterations it is very likely to be correctly classified, so the value of w would not change in that iteration. The value of t on the other hand would still increase and consequently the step size will decrease too quickly. One possible way to prevent that is not to increase t in those cases. This can improve convergence rate although the convergence remains slower.

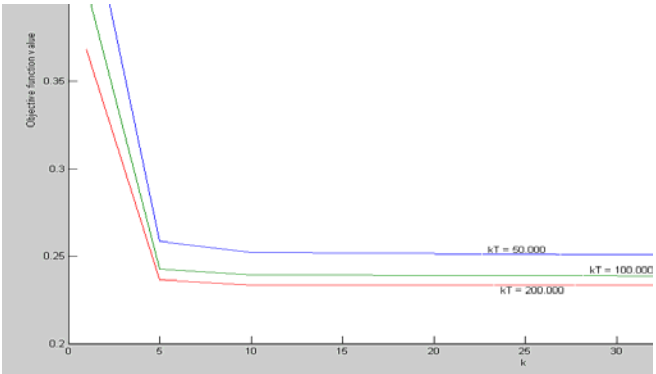

Figure 4: *Parameters k and T. The horizontal scale represents different values of k as the product kT is fixed.*

5 CONCLUSIONS

We have presented an examination of Pegasos - an efficient algorithm for solving the linear SVM optimization problem. The approach is based on stochastic subgradient descent and has strong convergence guarantees. The approach is easy to implement and converges extremely fast to a suboptimal solution. We have also demonstrated that high precision optimization of the objective function on the training set can be unnecessary, since optimal classification error on a test set can be achieved much sooner. SVM-light algorithm, a high precission SVM solver, was chosen as a baseline for comparison.

6 ACKNOWLEDGMENTS

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SEMANTIC GRAPHS DERIVED FROM TRIPLETS WITH APPLICATION IN DOCUMENT SUMMARIZATION

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ABSTRACT

Information nowadays has become more and more accessible, so much as to give birth to an information overload issue. Yet important decisions have to be made, depending on the available information.
As it is impossible to read all the relevant content that helps one stay informed, a possible solution would be condensing data and obtaining the kernel of a text by automatically summarizing it.
We present an approach to analyzing text and retrieving valuable information in the form of a semantic graph based on subject-verb-object triplets extracted from sentences. Once triplets have been generated, we apply several techniques in order to obtain the semantic graph of the document: co-reference and anaphora resolution of named entities and semantic normalization of triplets. Finally, we describe the automatic document summarization process starting from the semantic representation of the text.
The experimental evaluation carried out step by step on several Reuters newswire articles shows a comparable performance of the proposed approach with other existing methodologies. For the assessment of the document summaries we utilize an automatic summarization evaluation package, so as to show a ranking of various summarizers.

1 INTRODUCTION

The accessibility of information arises mostly from the rapid development of the World Wide Web and online information services. One has to read a considerable amount of relevant content in order to stay updated, but it is impossible to read everything related to a certain topic. A feasible solution to this admitted problem is condensing this vast amount of data and extracting only the essence of the message, in the form of an *automatically generated summary*.
In this paper we describe a method of text analysis with the stated purpose of extracting valuable information from documents. We shall attach a graphical representation, called semantic graph, to the initial document. The graph is based on triplets retrieved from the document sentences. Moreover, we are going to describe an application of semantic graphs generation– text summarization – as a method for reducing the quantity of information but preserving one important characteristic –its quality.
The paper is organized as follows. Firstly, the triplet based semantic graphs generation algorithm is presented. Two steps are detailed in this phase: triplet extraction from sentences, followed by the procedure of yielding the semantic graph of the document. In order to obtain the graph, named entity co-reference and anaphora resolution as well the semantic normalization of triplets are employed. Secondly, the summarization process is explained, followed by an evaluation of the system components. The paper concludes with several remarks.

2 TRIPLET BASED SEMANTIC GRAPHS

In English, the declarative sentence has the basic form *subject – verb – object*. Starting from this observation, one can think of the "core" of a sentence as a *triplet* (consisting of the three aforementioned three elements). We assume that it contains enough information to describe the *message of a sentence*. The usefulness of triplets resides in the fact that it is much easier to process them instead of dealing with very complex sentences as a whole.
For triplet extraction, we apply the algorithm for obtaining triplets from a treebank parser output described in [1], and employ the *Stanford Parser* [2].
The extraction is performed based on pure syntactic analysis of sentences. For obtaining semantic information, we first annotate the document with *named entities*. Throughout this paper, the term *"named entities"* refers to names of people, locations and organizations. For named entity extraction we consider *GATE* (*General Architecture for Text Engineering*) [3], which was used as a toolkit for natural language processing.
The *semantic graph* corresponds to a visual representation of a document's semantic structure. The starting point for deriving semantic graphs was [4].
The procedure of semantic graph generation consists of a series of sequential operations composing a pipeline:

- *Co-reference* resolution by employing text analysis and matching methods, thus consolidating named entities.

- *Pronominal anaphora* resolution based on named entities.
- *Semantic normalization* using WordNet synsets.
- *Semantic graph generation* by merging triplet elements with respect to the synset they belong to.

The following sub-sections will further detail these pipeline components.

2.1 Co-reference Resolution

Co-reference is defined as the identification of surface terms (words within the document) that refer to the same entity [4]. For simplification, we are going to consider co-reference resolution for the named entities only. The set of operations we have to perform is threefold. Firstly we have to determine the named entity *gender*, so as to reduce the search space for candidates. Secondly, in the case of named entities composed of more than one word, we eliminate the set of English stop words (for example Ms., Inc., and so on). Thirdly, we apply the heuristics proposed in [4]: two different surface forms represent the same named entity if one surface form is completely included in the other. For example, *"Clarence"*, *"Clarence Thomas"* and *"Mr. Thomas"* refer to the same named entity, that is, *"Clarence Thomas"*. Moreover, abbreviations are also co-referenced, for example *"U.S."*, *"U.S.A."*, *"United States"* and *"United States of America"* all refer to the same named entity – *"United States America"* (*"of"* will be eliminated, as it is a stop word).

2.2 Anaphora Resolution

In linguistics, *anaphora* defines an instance of an expression that refers to another expression; pronouns are often regarded as anaphors. The pronoun subset we considered for anaphora resolution is formed of: *{I, he, she, it, they}*, and their objective, reflexive and possessive forms, as well as the relative pronoun *who*.

We perform a sequential search, first backward and then forward, with the purpose of finding good replacement candidates for a given pronoun, among the named entities. Firstly, we search backwards inside the sentence where we found the pronoun. We select candidates that agree in gender with the pronominal anaphor, as suggested in [5, 6]. Next, we look for possible candidates in the sentences preceding the one where the pronoun is located. If we have found no candidates so far, we search forward within the pronoun sentence, and then forward in the next sentences, as in [4]. Once the candidates have been selected, we apply antecedent indicators to each of them, and assign scores (0, 1, and 2). The antecedent indicators we have taken into account are a subset of the ones mentioned in [5]: *givenness, lexical reiteration, referential distance, indicating verbs* and *collocation pattern preference.* After assigning scores to the candidates found, we select the candidate with the highest overall score as the best replacement for the pronoun. If two candidates have the same overall score, we prefer the one with a higher collocation pattern score. If we cannot make a decision based on this score, we choose the candidate with a greater indicating verbs score. In case of a tie, we select the most recent candidate (the one closest to the pronoun).

We summarize the anaphora resolution procedure in the algorithm in Figure 2.1.

function ANAPHORA-RESOLUTION (*pronoun, number_of_sentences*) **returns** a solution, or failure
    candidates ← BACKWARD-SEARCH-INSIDE-SENTENCE (*pronoun*) ∪ BACKWARD-SEARCH (*pronoun, number_of_sentences*)
    if *candidates* ≠ ∅ **then**
    APPLY-ANTECEDENT-INDICATORS (*candidates*)
    else
    candidates ← FORWARD-SEARCH-INSIDE-SENTENCE (*pronoun*) ∪ FORWARD-SEARCH (*pronoun, number_of_sentences*)
    if *candidates* ≠ ∅ **then**
    APPLY-ANTECEDENT-INDICATORS (*candidates*)

    result ← MAX-SCORE-CANDIDATE (*candidates*)
    if *result* ≠*failure* **then return** *result*
    else return *failure*

function APPLY-ANTECEDENT-INDICATORS (*candidates*) **returns** a solution, or failure
    result ← APPLY-GIVENNESS (*candidates*) ∪ APPLY-LEXICAL-REITERATION (*candidates*) ∪ APPLY-REFERENTIAL-DISTANCE (*candidates*) ∪ APPLY-INDICATING-VERBS (*candidates*) ∪ APPLY-COLLOCATION-PATTERN-PREFERENCE (*candidates*)
    if *result* ≠*failure* **then return** *result*
    else return *failure*

Figure 2.1 The anaphora resolution algorithm.

2.3 Semantic Normalization

Once co-reference and anaphora resolution have been performed, the next step is semantic normalization. We compact the triplets obtained so far, in order to generate a more coherent semantic graphical represenation. For this task, we rely on the synonymy relationships between words. More precisely, we attach to each triplet element the synsets found with WordNet. If the triplet element is composed of two or more words, then for each of these words we determine the corresponding synsets. This procedure will help in the next phase, when we merge the triplet elements that belong to the same synset.

2.4 Semantic Graph Generation

Based on the semantic normalization procedure, we can merge the subject and object elements that belong to the same normalized semantic class. Therefore, we generate a directed semantic graph, having as nodes the subject and the object elements and as edges the verbs. Verbs label the relationship between the subject and the object nodes in the graph. An example of a semantic graph obtained from a news article is shown in Figure 2.2.

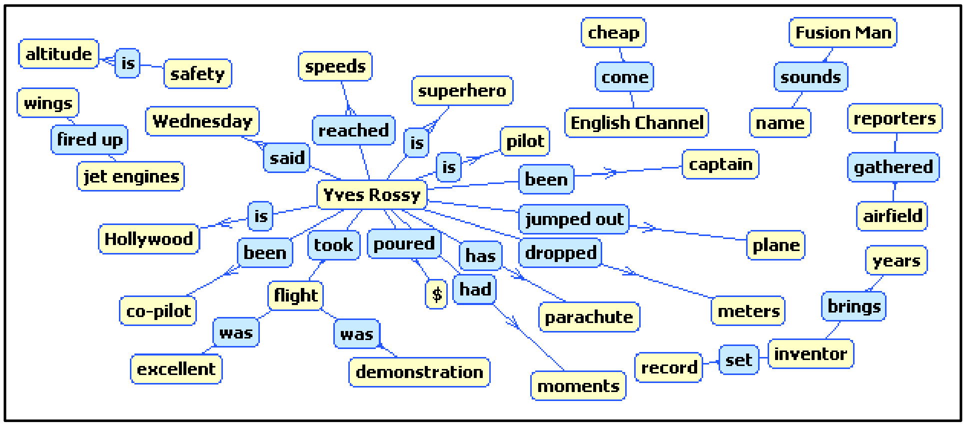

Figure 2.2 A semantic graph obtained from a news article.

3 DOCUMENT SUMMARIZATION

The purpose of summarization based on semantic graphs is to obtain the most important sentences from the original document by first generating the document semantic graph and then using the document and graph features to obtain the document summary [4]. We created a semantic representation of the document, based on the logical form triplets we have retrieved from the text. For each generated triplet we assign a set of features comprising linguistic, document and graph attributes. We then train the linear SVM classifier to determine those triplets that are useful for extracting sentences which will later compose the summary. As features for learning, we select the logical form triplets characterized by three types of attributes: *linguistic attributes*, *document attributes*, *graph attributes*. The *linguistic attributes* include, among others, the triplet type – subject, verb or object – the treebank tag and the depth of the linguistic node extracted from the treebank parse tree and the part of speech tag. The *document attributes* include the location of the sentence within the document, the triplet location within the sentence, the frequency of the triplet element, the number of named entities in the sentence, the similarity of the sentence with the centroid (the central words of the document), and so on. Finally, the *graph attributes* consist of hub and authority weights [7], page rank [8], node degree, the size of the weakly connected component the triplet element belongs to, and others.

Features are ranked, based on information gain, and the order is as follows (starting with the most important feature): object, subject, verb (all of these are words), location of the sentence in the document, similarity with the centroid, number of locations in the sentence, number of named entities in the sentence, authority weight for the object, hub weight for the subject, size of the weakly connected component for the object.

The summarization process starts with the original document and its semantic graph. The three types of features abovementioned are then retrieved. Further, the sentences are classified with the linear SVM and the document summary is obtained. Its sentences are labelled with SVM scores and ordered based on these scores in a decreasing manner. The motivation for doing this is presented in the next section of the paper.

4 SYSTEM EVALUATION

The experiments that were carried out involve gender information retrieval, co-reference and anaphora resolution and finally summarization. In the following, each of these experiments are presented, highlighting the data set used, the systems selected for result comparison and the outcome.

4.1 Gender Information Retrieval

Gender related information was extracted from two GATE resource files: *person_male* and *person_female* gazetteers. For evaluation we manually annotated 15 random documents taken from the Reuters RCV1 [9] data set. The two systems that were compared with the manually obtained results are:

- Our system, henceforward referred to as *System*
- A *Baseline* system, which assigns the *masculine* gender to all named entities labeled as persons.

The results are presented in Table 4.1.

	Masculine	**Feminine**	**Total**
System	170/206 (83%)	7/14 (50%)	177/220 (80%)
Baseline	206/206 (100%)	0/14 (0%)	206/220 (94%)

Table 4.1 Gender evaluation results.

The fact that *System* correctly labeled a significant percent of masculine as well as feminine persons shows it will carry out gender retrieval better than the baseline system when the number of persons belonging to either genders will be more balanced.

4.2 Co-reference Resolution

For the evaluation of co-reference resolution the same set of 15 articles mentioned in section 4.1 was used. Named entities were extracted based on GATE, and the co-reference resolution performed by *System* was compared with the one of GATE. The results are shown in Table 4.2. There are 783 named entities extracted using GATE. The *System* performance is better than that of GATE, 750 entities compared to GATE's 646 entities co-referenced.

	Co-References
System	750/783 (96%)
GATE	646/783 (83%)

Table 4.2 Co-reference evaluation results.

4.3 Anaphora Resolution

In the case of anaphora resolution, the *System* was compared with two baseline systems. Both of them consider the closest named entity as a pronoun replacement, but one takes gender information into account, whereas the other does not.

Pronouns	System	Baseline-gender	Baseline-no gender
He	35/42 (83%)	18/42 (43%)	18/42 (43%)
They	7/20 (35%)	8/20 (40%)	2/20 (10%)
I	4/15 (27%)	0/15 (0%)	2/15 (13%)
She	0/0	0/0	0/0
Who	0/0	0/0	0/0
It	11/35 (31%)	11/35 (31%)	11/35 (31%)
Other	2/4 (50%)	2/6 (33%)	3/6 (50%)
Total	**59/116 (51%)**	**39/118 (33%)**	**36/118 (31%)**

Table 4.3 Anaphora evaluation results.

The results are listed in Table 4.3, pointing out the *System* strength where the "*he*" pronoun is concerned.

4.4 Summary Generation

For summarization evaluation, two tests were carried out. The first one involved the usage of the DUC (*Document Understanding Conferences*) [10] 2002 data set, for which the results obtained were similar with the ones listed in [4]. For the second one the DUC 2007 update task data set was used for testing purposes. The data consisted of 10 topics (A-J), each divided in 3 clusters (A-C), each cluster with 7-10 articles. For this assessment, we focused on the first part of the task – *producing a summary of documents in cluster A* – 100-words in length, without taking into consideration the topic information. In order to obtain the 100-word summary, we first retrieved all sentences having triplets belonging to instances with the class attribute value equal to +1, and ordered them in an increasing manner, based on the value returned by the SVM classifier. Out of these sentences, we considered the top 15%, and used them to generate a summary. That is because most sentences that were manually labeled as belonging to the summary were among the first 15% top sentences.
In order to compare the performance of various systems, we employed ROUGE (*Recall-Oriented Understudy for Gisting Evaluation*) [11], an automatic summarization evaluation package. Our system was ranked 17 out of 25, based on the ROUGE-2 evaluation method, and 18 out of 25 based on the ROUGE-SU4 evaluation method.

5 CONCLUSION

The stated purpose of the paper was to present a methodology for generating semantic graphs derived from logical form triplets and, furthermore, to use these semantic graphs to construct document summaries. The evaluation that was carried out showed the system in comparison to other similar applications, demonstrating its feasibility as a semantic graph generator and document summarizer.
As far as future improvements are concerned, one possibility would be to combine the document summarizer with an online newswire crawling system that processes news on the fly, as they are posted, and then uses the summarizer to obtain a compressed version of the story.

6 ACKNOWLEDGMENTS

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TIME HISTOGRAMS WITH INTERACTIVE SELECTION OF TIME UNIT AND DIMENSION

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ABSTRACT

Many researchers are working on the improvement of the usability and efficiency of the sale data analysis methods which are required by the users – analytical staff and managers. In this paper, we present the improved technique of time histograms. We named proposed method Time Histograms with Interactive Selection of Time Unit and Dimension (THISTUD). Performed modifications and developed interactive user interface are described. The system is tested on the data warehouse that includes data for the ten years. The created sale data mart and visualization results are presented in the paper too.

1 INTRODUCTION

The use of visualization in the business environment as a method for an efficient information gaining is increasing rapidly, especially in the processes where the quick response time is required like those as data analysis and decision making [9]. The common methods for business information visualization are the x-y diagrams [3], histograms [1] and the combination of scatter-plots [5]. When the histograms are used for business information visualization, the data are commonly displayed as two or three dimensional shapes [12]. Even the sale quantity and the amount of income are usually selected as the histogram axes, time is often required as additional dimension, too. In 2D histograms, the visibility of the sale quantity and income is not satisfactory if the time is not included as an additional attribute. The visibility is very important when the mutlidimensional data like data from data warehouse is analyzed and correlations between variables are explored, for example the season trends. In that context, 2D histograms are improper for visualization because the user can see only one dimension at the same time on the same display. Therefore, we developed a method to improve the visualization introducing possibility for interactive selection of the time unit in the main window and an additional window to visualize data for the selected time unit. The main window provides general overview of the multidimensional time-dependent data. In the additional window, the data for the selected time unit is shown. Interaction is provided for the second window, too, enabling users to select data that is visualized in a new sheet (tab) of the window. The number of tabs is not limited. We used only two tabs in our example for visualization of sale regions or subregions for ten years.

2 METHOD THISTUD

Information visualization in 2D produces good results for analysis when using the histogram bars and x-y diagrams. The users can analyze data with drill-down property through dimension. This user-friendly feature is gained using OLAP Analyses services and OLAP cubes and their visualization possibilities [13]. Figure 1 shows the OLAP pivot chart for five years sale data. Data is presented by 2D histogram bars with different colors. The Pivot table lists all dimensions and measures. This tool offers interactive tools for data filtering enabling users to select one or combination of time period, city of sale and article. Results are presented according to user's requirements.
But, when the problem is multidimensional, the 2D techniques are limited and can not satisfy the user's requirements. Managers usually face this problem, when analyze the sale data for several years, depending on sale region, sub-regions or period of analysis.
Therefore, we developed the interactive method for multidimensional information visualization based on histograms. Instead of using one visualization plane, we use two windows. The main window displays general overview of data. The user can select time unit from the main window by added interactive tool and the data for selected time unit is represented in the second window. Interaction is added to the second window too, allowing users to change dimensions of data visualized in this window. The change of the dimension is possible by tab menu. We named proposed method Time Histograms with Interactive Selection of Time Unit and Dimension (THISTUD). The interface of developed system based on this method is presented in the Figure 2 and Figure 3.
In our previous paper, we proposed the method Time Histograms With Select and Zoom (THWS&Z) [6] with interactive possibilities but this method had a good response time for problems with a small number of values for each

dimension. When the dimension values are increasing, the response time do not satisfy the user's reqirements. Performed improvements of the THWS&Z were embedded in the method THISTHUD. The THISTHUD consists of the following steps:

- Preparing data in the aggregated tables
- Visualizing data in the main window
- Determining the slighter and selection visibility
- Waiting time unit selection
- Visualization of data for selected time unit
- Enabling selection of dimension
- Set up of ToolTip property in the second window

Data repositories with source data for visualization are created by the following procedure:

- Loading data from Transactional databases
- Data cleaning and loading in Data Warehouse or data marts [2]
- Creating the additional views and aggregated tables if they are necessary

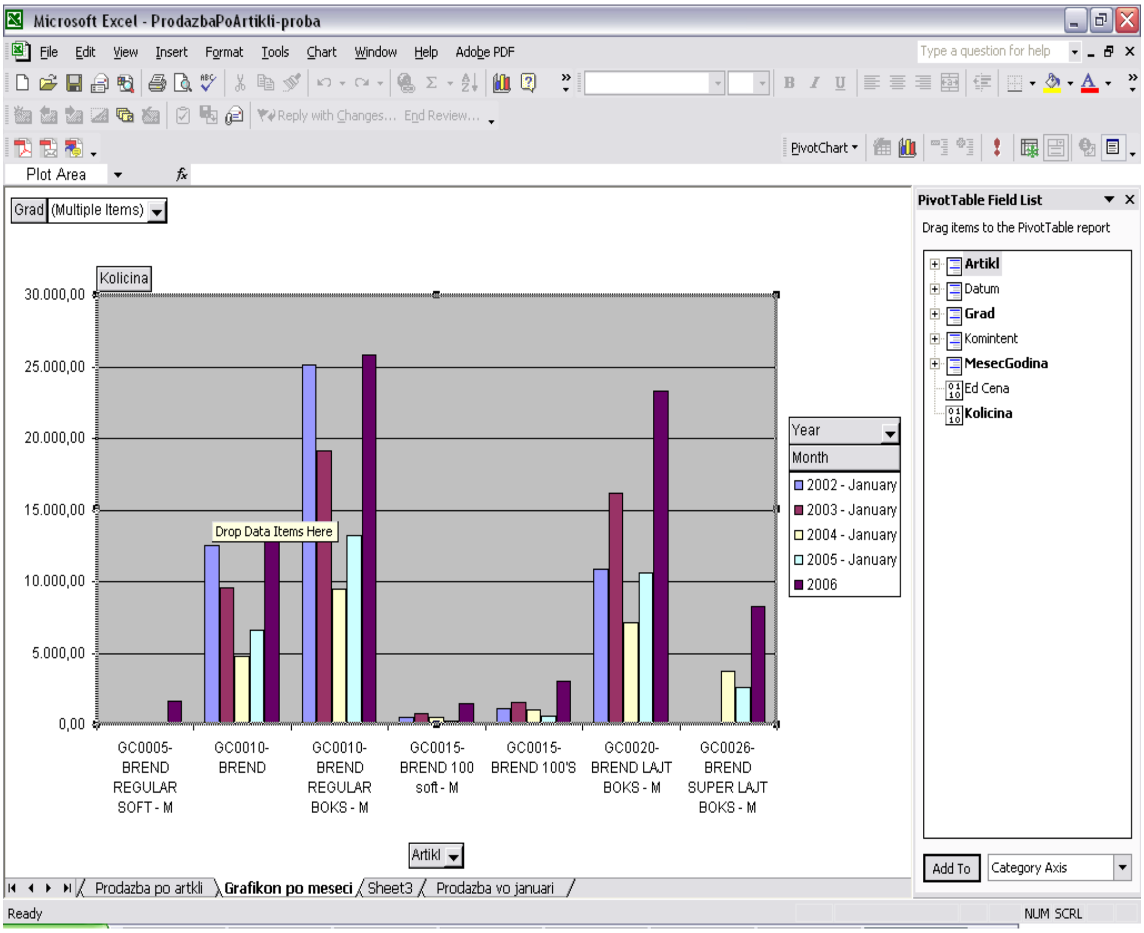

Figure 1: *OLAP visualization wizard*

3 THE PROBLEM OF SALE DATA VISUALIZATION

Our method is especially useful for visualization of monthly, quarterly or yearly sale quantity, financial data or income analysis, because it provides a global view of data and enables analysis of periodical data. We tested our system to the problem of visualization of sale data.

The sale data visualization requires possibility to change sale period and analyze data for many dimensions. We obtained the sale quantity data for ten years for Production and Trade Company, prepared for monthly analysis.

During preparation phase, we created the aggregated tables in data mart with unique dimension codes [2]. For this purpose, the additional codes are introduced and data is grouped according the dimensions (data as region, sub-region, city, production group or time slab in which sales are made). This approach by using Data Warehouse or data mart provides advantages because data can be updated each time when new data is added to the original databases [6].

The time period of 10 years is cited in month periods – time slabs. These time intervals represent the general dimension for this purpose [6]. Because the most important things for sale data analysis are the sale quantity and sale value, they will be analyzed for many independent variables – dimensions – regions, sub-regions, cities, production groups and other desired dimensions.

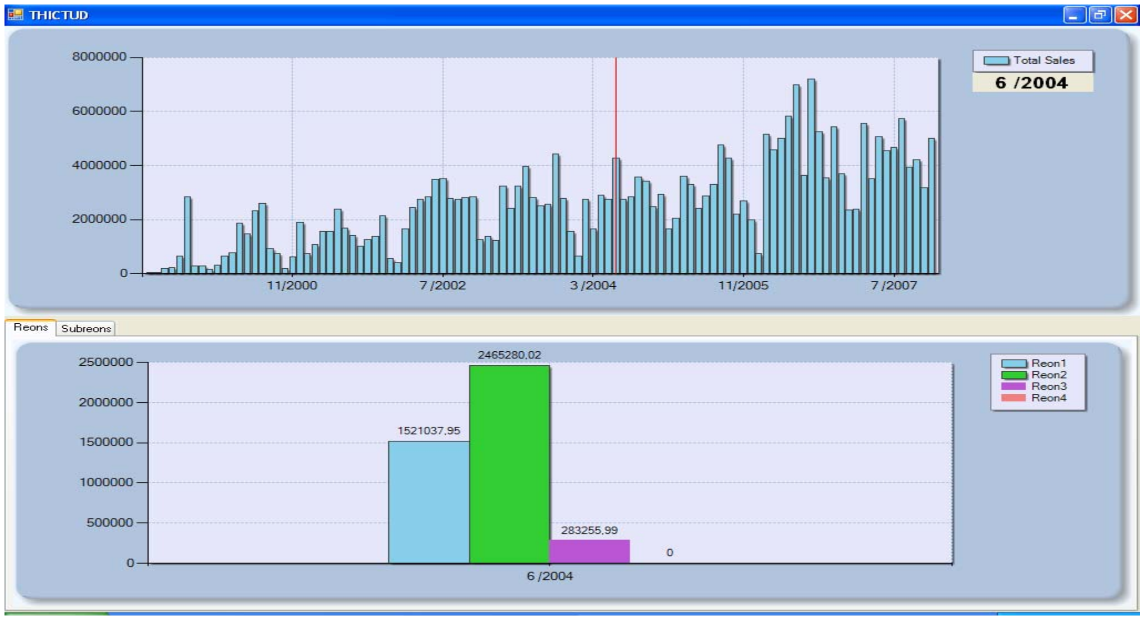

Figure 2: *Time histograms with interactive selection of time unit and dimension*

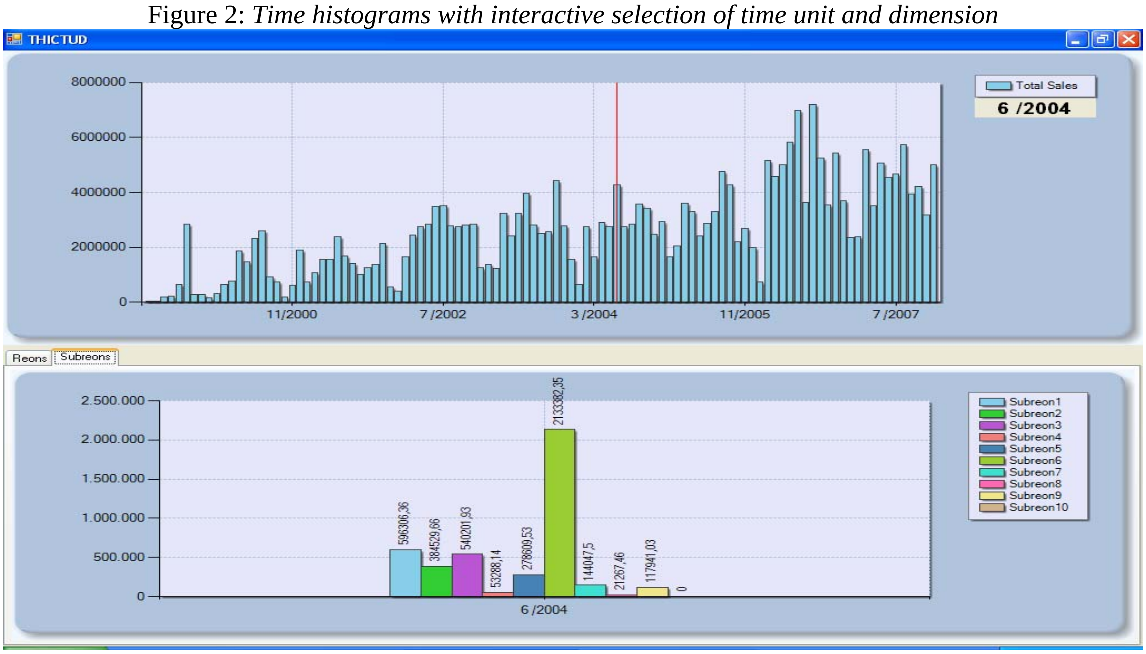

Figure 3: *Time histograms with interactive selection of time unit and dimension*

4 RESULTS

Figure 2 and Figure 3 present visualization for the sale data. The main window contains the visualization of the total sale data for time slabs. The user can see the sale trends over the years/months of all products and regions. The period of one month is selected as a unique time slab, but the period can be smaller as a half month, a week, a day or bigger like a quarter, a half-year or an entire year. The value of the selected time slab (x-axis) to which the pointer points is shown in the right upper corner. The pointer is a vertical line with color that is different from the bars color. The pointer enables users to select the time slab which data will be presented in the second window. The analytical values are shown on the second window. The system enables each time slab to be visualized in separate sheet in the lower window.

The user can move between sheets in the additional window by tab control button. When the region is selected by tab control, the user can analyze sale data for selected time slab for sale regions. Each region is presented with different color to provide easy recognition of the visual

representation. The value of sale are shown over each region bar because the ToolTip property is set.
The dimension in the additional window can be changed to represent region or sub-region (or city, product group,) for selected time slab. In the case presented in the Figure 3, there are ten different bars with values of the displayed measures for sub-regions, corresponding to the existing ten sub-regions. If the cities are is required as dimension for analysis, there will be 35 bars with assigned values and corresponding legend for each time slab (35 cities for sale analysis). In this manner, in the same windows, the user can analyze many dimensions of the problem.

5 FUTURE WORK

There are many possibilities for further improvement of this visualization technique. These improvements can be made in data acqusition, data preparing and visual data rendering phase and according to users needs and feedback of using this technique.
Data acquisition improvement can be done by adding trigger procedures that allow automation of data refresh in data repositoty. Using transitional databases helps in this case.
In the process of interaction programming, it is possible to define criteria for data selection and data filtering. For example the user can define the lower and upper sale border line. The radio buttons can be added to enable data selection and filtering criteria – all data in the graph, the sale data bellow the lower border line of sale, or data between the two border lines of sale.
Visual data delivery can be improved by creation of aggregated tables when the process of data updating in the Data Warehouse, located in the server site, is done. This method is known as batch data processing. In this way, the data is prepared for faster visualization and the response time is much shorter, compared to the response time in on-line data visualization. This is one of the less desired methods for data processing but useful for improving desktop data delivery response time.

6 CONCLUSION

The method Time histograms with interactive selection of time unit and dimension (THISTUD) enables visualization of multidimensional data. Providing two windows for data visualization, the user can interact with the data on-line. The system provides double interactivity tool enabling user to select time slab of the main window and to change the view of data in second window. It is obvious that this visualization tool provides good analytical possibilities and a solid base for visual pattern and trend recognition, especially when the selecton and filtering options are set.
The possibilities for further adjusment of this method to provide visualisation of different problems are practically unlimited. The user only have to define their requirements – topics of analysis, data filtering, knowledge-based patterns or criteria introducing for selection, clustering or some kind of data mining.

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OPTIMIZATION AS A STEP IN COREWAR PROGRAM ANALYSIS, EVOLUTION AND CATEGORIZATION

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ABSTRACT

In this paper, an optimizer for programs written in an assembly-like language called Redcode is presented. Relevance of code optimization in evolutionary program creation strategies and code categorization is discussed. CoreWar Optimizer is the first user-friendly optimization tool for CoreWar programs offering various optimization methods and a carefully picked benchmark. The methods at the user's disposal are: random, modified hill climbing algorithm, simulated annealing, predator-prey particle swarm optimization and genetic algorithms. All these methods use a speed-up trick which drives the value optimization across three fitness landscapes instead of just one.

1 INTRODUCTION

CoreWar was introduced to the scientific community by A.K. Dewdney in 1984 in an article published in Scientific American [1]. It represented an interesting, but not completely unfamiliar concept. It was based on a somewhat similar computer simulation, a game called Darwin, which was developed in Bell Labs some twenty years earlier.

In CoreWar, programs written in an assembly-like language called Redcode compete against each other in a simulated environment that is being controlled by MARS (Memory Array Redcode Simulator). The program that seizes complete control of the process queue is designated a winner of the encounter. CoreWar programs are referred to as *warriors.* Competing programs are being loaded into a looping memory array and are only given access to that part of the memory. There are many differences between Redcode and other assembly-like languages, but providing a full survey of those details is well beyond the scope of this paper.

CoreWar environment bears some peculiarities and as such can not be used to draw general conclusions about any aspect of code analysis. However, its relative syntactic simplicity, as well as clearly presented program goals make it easier to define strategic program categories. With that in mind, research on CoreWar could only suggest potential fruitfulness of such analysis in a more general setting and either encourage or discourage further application of employed methods.

2 EVOLUTION STRATEGIES AND OPTIMIZATION IN COREWAR

Even though CoreWar is a sort of a programming challenge, programs are often generated automatically, usually via genetic programming. This type of reasoning has worked really well, due to the natural mapping between CoreWar programs and corresponding genotypes. Evolutionary pressure is reflected in the competition itself and fitness can be determined according to benchmarking and competition scores [2].

Evolved CoreWar programs are still superior to human-coded programs in some of the basic confrontation environments. However, these *evolvers* have failed to produce programs of higher complexity and there is usually little diversity in the evolved sets [3].

Program optimization does not have to be related to changes in the code structure. Once a good program template is produced, there is usually an issue of choosing values for some variables in the code. Altering these instruction field values can lead to dramatic changes in program fitness.

Prior to CoreWar Optimizer, which will be presented in this paper, there was only one available optimizer for CoreWar – Optimax. Its focus was on simulation speed and it searched the value space at random. It was a command-line application with no graphical user interface [4].

The fitness landscape corresponding to variables in CoreWar programs and the respective average performance is characterized by many local optima. Such structure of the search space calls for methods that are able to cope with target function multimodality.

Some intuition about more general fitness landscapes in CoreWar can be obtained by analyzing the score surface plots in Figure 1. Some negative linear dependencies between the plotted variables are quite apparent. However, it must be noted that the images were generated for average scores against a single opponent (in both cases). For benchmarks of considerable size and a realistic case of having at least 5-6 variables to optimize, the search space would certainly become much more chaotic.

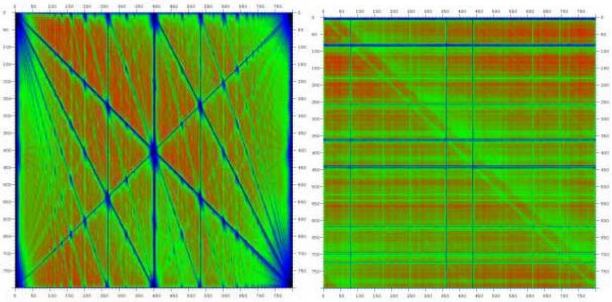

Figure 1: *Some 1-1 score surfaces for YAP (a replicator CoreWar program) for 2-value optimization task plotted across all possible value pairs. Blue colour denotes bad performance, while red areas represent high scores[5] .*

3 COREWAR PROGRAM CATEGORIES

3.1 Basic Strategies

In more than twenty years of competition, many interesting program strategies have been either devised by programmers or generated via evolutionary approach. Programs can rely on brute-force random attacks or implement various algorithms for opponent's code detection and elimination. Most programs can be roughly separated into three large categories – *stones, papers* and *scissors* – implying that there is no dominant approach in CoreWar. Due to the rise in strategic program diversity over the past years and continuous increase in deployment of hybrid programs utilizing more than one basic strategic block, a more flexible and detailed categorization was required. One such categorization has been presented in [6] and comprises 14 program types.

3.2 Automatic Categorization

In case of human-coded warriors, there is no need for automatic categorization, since a program category can easily be determined by looking at the code. It is different with evolved programs. Their code is much less structured, their behavior less straightforward and hundreds or thousands of them are being generated and tested in each iteration of CoreWar evolvers. It has already been mentioned that evolved populations often suffer from lack of diversity. This is precisely why dynamic diversity control is of great importance in such software tools. Accurate insight into the strategic composition of populations would allow for better dynamic changes in mutation weights, population size, parent selection, etc.

Attempts at creating classifiers for CoreWar program categorization and analysis of evolved data sets have been made, with moderate success [6] [7]. Two types of data representation had been used (as well as their combination):

- *Static* representation, based purely on syntactic analysis
- *Dynamic* representation, based on benchmark scores.

Best results were obtained when using the combined representation, achieving 84% accuracy with SVM. Static representation was not sufficient for reliable categorization and some alterations would need to be conducted in the future if it is to be used as a sole factor in predicting a CoreWar program category [6].

3.3 Impact of Optimization on CoreWar Program Categorization

It had been shown that classifiers trained on human-coded data sets were unable to achieve the same level of accuracy when used on evolved data sets. Since the dynamic representation has the most influence, a part of the issue must lie within the differences in benchmark scores of programs of the same class in evolved and human-coded sets. Once those scores were inspected, it became quite apparent what was the reason for such a mismatch. Even though there are good evolved CoreWar programs, these appear in the end of the process, as the populations begin to converge towards some program templates. Most of the CoreWar programs in those sets are not as optimized as their human-coded counterparts. This results in scores differing in a way that makes score-based categorization much more cumbersome, because the distribution of scores over the set of strategies in the opposing benchmark tends to become more uniform. This uniformity is never present in highly optimized programs. Programs from the same category achieve similar average scores against any particular strategic group.
It can be seen that the use of classifiers in determining population diversity in CoreWar evolvers would not be as informative as it might have appeared unless CoreWar program populations are at least slightly optimized before the automatic categorization takes place. Inserting optimization as a step in CoreWar program evolution has other benefits as well. After all, if a good program template is encountered, it would be rejected by the evolver unless it has scored above some static or dynamic threshold. If all the templates were optimized, better templates would be more likely to be passed on to the next generation.
There is also a possibility of extending and improving the syntactic representation of the data, but this would probably not be as helpful in evolved data sets, because majority of the code in most evolved CoreWar programs is junk code that is not used by the programs in the simulation. Including benchmark scores in the representation is necessary in this case.

4 COREWAR OPTIMIZER

4.1 General Description

CoreWar Optimizer is a tool that was developed with intent of allowing for both easier and more effective manual optimization of CoreWar programs and also integration into evolutionary optimization software for CoreWar.
Main features of CoreWar Optimizer are:

- Graphical user interface allowing program editing, parameter setting, optimization statistics overview, etc.
- Several methods for value optimization
- Speed-up achieved by splitting the optimization process into several phases

4.2 Optimization Phases

Speed is always one of the most important issues in CoreWar optimization, since it takes several minutes on a fast PC to benchmark a program instance. On the other hand, it was empirically determined that for some strategic categories, up to several thousand instances need to be examined. This is why there are three phases in all the algorithms in CoreWar Optimizer. In the first phase, an instance is set up against a single opponent (selected by the user). In the second phase, instances are competing against a selected strategic subset of the benchmark. Only in the third phase do programs compete against the entire benchmark. Thresholds for acceptable scores in the first two phases are set by the user. Most users prefer to set up high thresholds, allowing only about 1-3% of generated instances to enter the final optimization phase.

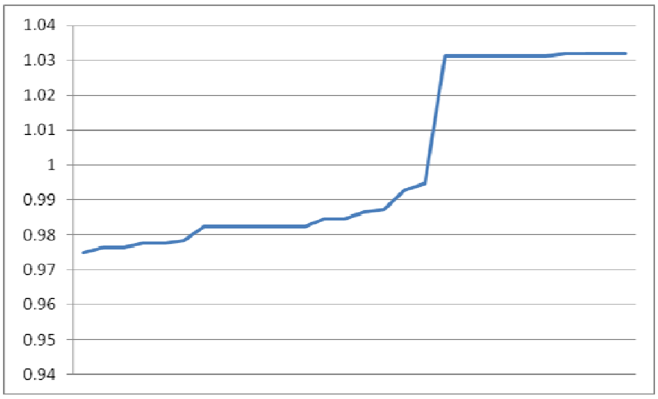

Figure 2: *Normalized plot of the highest achieved score of one tested replicator with GA being used.*

Selection of potentially good instances in the early phases leads to lower variance in the benchmarked set. This is illustrated in Figure 2. Even though the best achieved score in the end was only 6% better than the first one in terms of average highest score over the optimization run, these few score points are not insignificant. On the contrary, in most CoreWar competitions, competing instances are usually a fraction of a point apart.

4.3 Optimization Methods

Optimization in CoreWar depends on the program strategic category and the nature of the variables being optimized. This is why several methods have been included in CoreWar Optimizer, so that the user might select one of them according to his own judgement.

- Random search was included purely for reasons of comparison with the previous optimization tool, Optimax [4].
- Hill climbing is the simplest of the implemented algorithms. Steepest ascent is performed on a landscape until a point is reached where the threshold condition is satisfied. At that point, the ascent continues on the landscape of the next optimization phase. However, threshold conditions are constantly being checked for the previous phases. If none of the neighboring instances satisfy those conditions, optimization is reset to one of the earlier phases. Also, mutation amplitude depends on the time that has passed since the last instance entered the final optimization phase. This has been done to enable the algorithm to quickly leave depressions on the fitness landscape.
- Simulated annealing differs from hill climbing in an important way, since it offers a better trade-off between exploration and exploitation of the search space. The update formula that was used for calculating the probability of choosing a state if it offers no improvement is given below:

$$p(s_{i+1} = o_i \mid f(o_i) < f(s_i)) = e^{(f(o_i) - f(s_i))/Td}$$

  The cooling schedule was implemented according to [8]. This method optimizes over three fitness landscapes in the same way as the hill climbing method.
- Genetic algorithm implementation includes modules for small and big mutations, cross-over by swapping or affine combinations, etc. Mutation rates also evolve over time and are instance-specific – in other words, a part of the genotype [9]. The locality of mutation rates is motivated by the fact that each candidate solution serves as a representative of its neighborhood in the search space and the local properties of the fitness landscape vary accordingly. Thus, different mutation rates might be well suited for different areas in the domain. The mutation update rules are:

$$allele_i(t+1) = allele_i(t) + \lfloor \sigma_i(t+1) \cdot N(0,1) \rfloor$$

$$\sigma_i(t+1) = \sigma_i(t) e^{\tau \cdot N(0,1)}$$

- Particle swarm optimization is based on observations from social animal behavior – flocking of birds, schooling of fish, etc. Animals form groups in order to find more food and water. In particle swarm methods, a population of instances is initialized to some random points in the search space. These particles then share information about the most promising areas of the search space, thus driving the search towards both local and global high-fitness areas. In practice, this usually results in better search than in cases of hill-climbing and simulated annealing which are one-particle models [10]. One of the main problems with particle swarm methods is premature convergence. This is partially prevented by setting suitable inertia weights in the update rules. Method employed in CoreWar Optimizer follows the idea of introducing predator-prey relationships in the model. One predator particle is introduced and it acts as a repellant which follows the best particle in the swarm and forces other particles away from local optima. It has been shown that this has a positive influence on the quality of the search. This model has first been described in [11].

Extensive testing of all the implemented methods on representatives of all strategic categories with various number of parameters has not been performed, since such a testing would require too much time if any relevant results were to be obtained. All of the mentioned methods are equally efficient on average basis, considering all possible search spaces [12].

4.4 Benchmark

The benchmark used by the application has been selected to represent all the strategic categories with proportions relative to their frequency in existing data sets. This is shown in Figure 3.

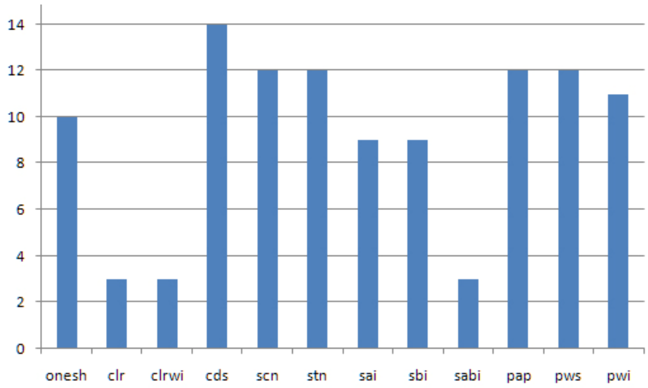

Figure 3: *Strategic distribution of the used benchmark*

5 CONCLUSION

Accurate automatic CoreWar program categorization requires benchmark testing. The results obtained this way can be quite ambiguous unless optimized CoreWar programs are involved. In order to allow for integration of the categorization modules in evolutionary CoreWar software, an optimizer has been implemented. CoreWar Optimizer provides an interface for use of several optimization methods. Initial tests have shown promising results and there has been no negative feedback from the community.

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Sodelovanje, programska oprema in storitve v informacijski družbi

Collaboration, Software ans Services in Information Society

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PREDGOVOR

Programska oprema in na informacijskih tehnologijah temelječe storitve predstavljajo gonilo napredka na vseh področjih informacijske družbe. Posameznikom in organizacijam omogočajo sodelovanje in vključenosti v dogajanja ne glede na oddaljenost ter morebitne družbene, lokalne in osebnostne omejitve. Storitve, predvsem semantične, bodo posameznikom in organizacijam omogočale enostavnejše komuniciranje, sodelovanje in poslovanje. Najnaprednejšim med njimi je omogočeno razpoložljive e-storitve, npr. geografske, poslovne, finančne, zdravstvene, smiselno povezati v večje, sestavljene inovativne storitve, ki bodo za odjemalce predstavljale dodano vrednost. Pri tem pa je potrebno zagotoviti ustrezni nivo kakovosti, zanesljivosti, odzivnosti, pravne varnosti in nenazadnje zaupanja v tovrstne kontekstno odvisne in personalizirane storitve. Tehnični osnovo predstavlja ustrezna programska oprema, zato je potrebno nadgraditi obstoječe in razviti nove tehnike, pristope, metode in orodja tako za razvoj storitvenih arhitektur, testiranje ter zagotavljanje ustreznega nivoja kakovosti programske opreme in storitev kot tudi za oblikovanje ustreznih uporabniških vmesnikov. Vse to so teme, ki jih naslavljajo prispevki letošnje konference CSS 2008, tudi skozi predstavitev konkretnih rešitev, aplikacij in storitev. Letošnja konferenca prav tako naslavlja ključne izzive nove znanstvene discipline, imenovane storitvena znanost. Gre za izrazito interdisciplinarno področje, ki celovito obravnava različne vidike storitvenih ekosistemov, tako s tehničnega inženirskega, kot tudi poslovnega, pravnega in sociološkega vidika. Ključnega pomena za uspeh te nove discipline pa je, kot običajno, sodelovanje. Področje, ki pomembna tematika te konference že osem let.

prof. dr. Marjan Heričko
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PREFACE

Software and ICT-based services are an integral part of all areas of information society. They enable people and organizations to collaborate across organizational, geographic and professional boundaries. Services, especially semantic services, simplify our ways of communicating, cooperating and conducting business. The most advanced actors can even orchestrate and integrate these services. For example, geographic, financial and public e-services can be integrated into larger innovative composite services that provide a new value for their consumers. However, we need to assure that these interoperable and personalized services are trustworthy and that they demonstrate the required level of quality, reliability, availability, safety, security, and legal certainty. Since ICT-based services are mainly based on software, it is imperative to improve existing (and also develop) new techniques, approaches, methods and tools for developing and testing software and service architectures. We have to define and apply appropriate metrics and processes to reach an agreed level of quality and also satisfy other characteristics, as defined by SLAs (Service Level Agreements). New approaches for user interface development are also needed. Essentially, all these topics are addressed by the papers in the proceedings -- together with some practical experiences and descriptions of concrete solutions, applications and services. In addition, our attention has also turned to a new academic discipline, called Services Science, which is inherently an interdisciplinary research area. Services Science addresses services, their creation, engineering, provisioning and management as well as service ecosystems -- not only from a technical and engineering perspective but also by adding and integrating business, legal and social dimensions in order to improve the understanding and performance of service systems. The success of this new discipline is to a great deal dependent on collaboration between experts across different domains - an area that has been an important topic of this conference for the last eight years.

Prof. Dr. Marjan Heričko
CSS 2008 – Collaboration, Software and Services in Information Society Conference Chairman

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SERVICE ARCHITECTURE AND SERVICE DEVELOPMENT PROCESS FOR LIMITED ON-BOARD PLATFORMS

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ABSTRACT

This work presents a service architecture for limited on-board hardware platforms and a specific methodology in order to develop services for the proposed architecture. Such work is useful for implementing a service architecture for on-board platforms with limited resources, and simultaneously provides a service development process compatible with such architecture.

The methodology used for this work is based on the integration of a set of elements, which define a service architecture for small on-board platforms based on ARM architecture. Moreover, it proposes a methodology to develop services by a suitable process.

This architecture integrates a model supported by OSGi framework, able to take advantage of every characteristic of a hardware platform that contains the whole set of components. In this way it offers the possibility to control the resources and the execution environment.

On the other hand, the proposed procedure for developing services, integrates a set of elements that offers the needed characteristics for designing and developing reliable services.

A service architecture of this type is a powerful alternative that permits to integrate a set of elements, with the purpose of offering powerful functionalities. In order to develop any service, it is necessary to consider a generic process highly suitable according to the functional requirements.

I. INTRODUCTION

Service architecture for on-board platforms is becoming an important research field for the automotive industries. Such field evolves quickly because it offers a reliable way for implementing more powerful functionalities. In this approach, the process for implementing such functionalities is based on a generic schema able to support different kind of requirements.

This work seeks to turn up on-board platforms more useful and capable, in order to offer powerful solutions by implementing such approach. This approach covers the most important features of a service architecture and a generic process for developing services supported from such architecture.

This type of approach aims at both: offering more powerful functionalities by the architecture suggested, and implementing the services requested by a generic process. Moreover, this approach is supported by a set of elements related to the specifications of the OSGi framework [1], specifically adapted to the automotive field.

In [2] useful literature about OSGi is considered, but more specific information related to the approach proposed is limited, mainly because most contributions in this research field, remain unpublished. They are carried out by private companies, but much previous work in service architecture for on-board platforms based on OSGi, is focused on architectures supported by both powerful devices and rich resources. On the other hand, previous work in service development process is only related to some specific development tool.

Classical approaches, do not specify architectural details for small platforms with limited resources and specific interactions with hardware devices implemented on such platform. They do not describe a complete methodology for service development supported by a specific architecture. Service development process, should be considered as an important topic that extends the capabilities of a service oriented architecture for limited on-board platforms.

For example, traditional service architecture in Figure 1 aims at implementing a set of components on platforms characterized by powerful hardware resources. This kind of approach is based on a service architecture for desktop applications capable to support each component of such architecture.

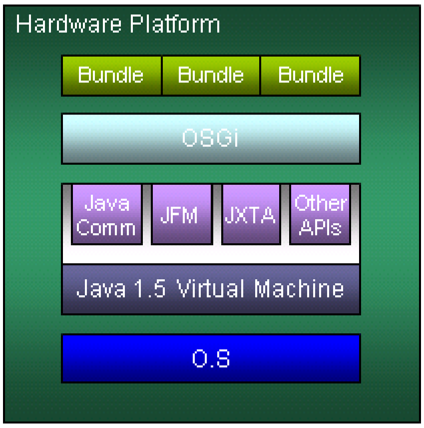

Figure 1. Traditional Service Architecture

In this paper, two topics are considered: the first one suggests a reliable service architecture for limited on-board platforms by defining a set of elements able to maintain each requirement. Moreover, the second topic describes a suitable service development process composed of five steps.

The goal is to propose an approach that considers, not only a more specific service architecture based on OSGi [3] for on-board platforms with limited resources, but also a service development process that facilitates the way in which the services will be developed.

The major contribution of this research is giving facilities to both designer and programmer, in order to implement an architecture in which is considered a hierarchical organization of its elements, and also providing an easy methodology to develop services.

This is an approach that considers small and limited on-board platforms, so to offer a set of concepts related to the possibility of implementing a service architecture, and simultaneously integrating a scalable and suitable process in order to develop services by following a specific set of steps.

Such approach is specially related to the automotive field [4], in order to suggest a solution able to offer powerful functionalities. Such solution considers an architecture capable to contain services that offer many kind of functionalities, developed by the process suggested in section III.

The rest of this paper is organized as follows. Section II describes the service architecture. Section III is related to the service development process. Section IV regards about related work. Section V involves conclusions and Section VI some references.

II. SERVICE ARCHITECTURE

OSGi was developed mainly for the creation of residential gateways, in order to develop intelligent house models as [5]. However, the powerful characteristics of such framework have been extended to other fields. The automotive field can be considered one of them.

Service architectures for on-board platforms are often characterized by a set of elements supported by powerful hardware components. In other words, such type of architectures is designed to be implemented on hardware architectures with powerful resources and software functionalities, not supported by embedded platforms.

Figure 2 shows the architecture designed for implementing services on the used on-board platform. All the resources related to information devices, are linked to the platform via USB. Such platform is a board based on ARM architecture, with a Linux operative system and a Java Virtual Machine, known as JamVM, compatible with such kind of platform. Equinox (OSGi implementation) is located over JamVM, in order to make the platform able to contain different types of services, for such purpose were studied also others service containers as [6], [7] and [8]. The set of elements over the service container layer allows connectivity and information exchange with other devices. The software applications located in the highest layer are known as bundles, and contain the implemented services.

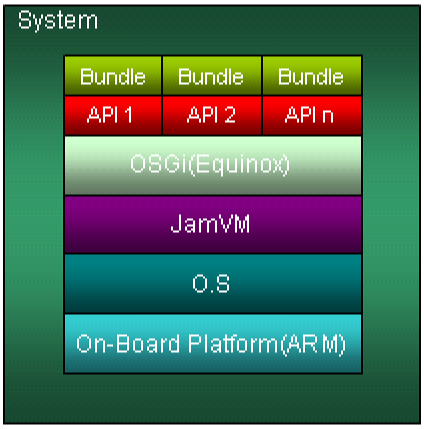

Figure 2. Service Architecture

In this architecture, the set of APIs over the service container, are the way by which the services developed establish the communication channel with other components. Such as requesting information from the devices in contact with the external environment. These APIs communicate with the device APIs, in order to get information through method calls.

Moreover, the quantity of APIs can change depending mainly on the functionalities from which it is possible and useful getting information. The architecture includes a set of functionalities contained into the bundles located in the last layer, that contains the logic related to the way in which the information requested is processed.

The service architecture designed for limited on-board platforms, has the possibility to offer more service functionalities by extending the hardware architecture. In other words, such architecture is characterized by a suitable structure, able to interact with new components linked to the main hardware platform.

III. SERVICE DEVELOPMENT PROCESS

In order to develop services, it is important to consider a generic process highly suitable. In this way it is necessary to define a standard procedure that integrates every component. Figure 3 shows such process:

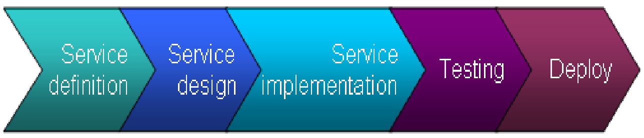

Figure 3. Service Development Process

1. Defining a service involves a set of characteristics that are related to functional aspects. In order to define a service, it is necessary to consider some aspects related to objectives, expectations, actions and reaction of such service, depending on the interaction with the user.

   On the other hand, these characteristics are useful to identify the use cases related to the functionalities offered by the service. Once focused the kind of problem to be solved by the service, the next step is defining the service functionalities by the use cases. Such use cases need to consider the following features: main objective, pre-conditions, post-conditions and eventual links to resources.

2. Designing a service is a process supported by an architecture in which is represented the service implementation as a unit called bundle. Such architecture considers a bundle as a container of four elements [9] (Interface, interface implementation, activator, manifest), each one of them executes a specific function (Figure 4):

   - The interface defines every offered functionality,
   - the interface implementation is related to the logic service,
   - the activator is related to the service execution,
   - and the manifest contains a resource description linked to the service.

   The current stage is a process applied to many scenarios. Therefore, it is necessary implementing a generic procedure, able to cover every implementative detail.

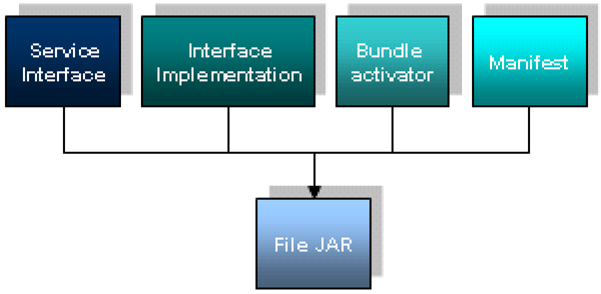

Figure 4. Service Design

3. Once designed the service according to the structure suggested, the developer is able to implement the service. It is possible to carry out such implementation by considering a development tool, able to support every component of the design schema. Moreover, our approach considers Eclipse [10] as the right development environment, in order to implement the services based on the design schema related before.

4. The latest Eclipse release integrates the whole runtime environment and the set of features required for the current step. In this approach, such tool is considered the best way for testing services developed by the proposed process.

5. The final stage is related to execute the tested service into the service platform. Once all tests, regarded to the previous stage, have been executed successful, the service is ready to be integrated to the service platform.

IV. RELATED WORK

The authors of service architectures based on OSGi as [11], create such approach focused on powerful platforms with not limited resources. Some architectures based on OSGi are similar to this work. In contrast to that work, this paper suggests an approach that considers at the same time two arguments which involve a service architecture and a powerful way to develop the services related to such architecture.

Furthermore, this approach offers the possibility of extending and improving the architecture features by associating new components at both hardware and software levels.

There exist also further research projects about service architectures, such as automotive projects in which important companies are involved. These projects focus on similar aspects, such as software components for on-board platforms.

V. CONCLUSIONS

This work presented an approach related to both a service architecture for limited on-board platforms and a service development process. Such topics should be considered together, in order to describe a complete way for implementing services supported by suitable architecture.

Previous work is related mainly to service architectures for not limited hardware platforms. Such work is not characterized by considering a whole service development process related directly to the proposed architectures.

This approach contains both a generic service architecture and a service development process. Such elements could be adopted to establish a reliable and suitable service environment for on-board platforms, and a good way to develop services for such architecture by following some steps related to a generic schema.

As future work, it could be interesting to improve the functionalities of the service platform. Connecting a new hardware platform via TCP/IP and adding a set of elements (client/server) permits the communication between the hardware components . Such work would extend the service architecture features by getting useful information from new hardware resources [12].

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TOWARDS AUTOMATED EXECUTION OF SEMANTIC WEB SERVICES IN SEMANTIC NETWORKS

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ABSTRACT

Semantic web technologies enable semantics based data integration and sophisticated reasoning capabilities on resources available in information systems. Although EU invests heavily in semantic web technologies and there has been a lot of research work done globally, semantic web technologies still lack in some aspects. Two mayor issues in our opinion are poor performance on large data sets and high data integrity costs with legacy information systems. This paper presents a concrete semantic web technologies based framework that incorporates service oriented architecture principles. The framework enables seamless integration and automated execution of web services in semantic networks.

1 INTRODUCTION

The idea of semantic web started developing more than a decade ago and got the push in 2001, when Tim Berners Lee published an article titled The Semantic Web[1]. He presented a vision, where computers would be able to autonomously find, read and process information on a Web scale. To be able to do that, information has to be presented in a way that computers are able to process the data based on their meaning. This vision has been widely accepted as the vision of Semantic Web. In order to realize the Semantic Web vision a set of Semantic Web Technologies has been developed.

Semantic Web Technologies (SWT) provide means for knowledge representation (KR). Opposite to past research efforts in the field of artificial intelligence, where KR systems were mostly centralized and isolated, SWT are designed to be used on a Web scale in heterogeneous information environment. While SWT provide fairly expressive formalisms for knowledge representation and reasoning, this often results in poor performance.

To overcome this issue, we propose division of information space represented in semantic network into two subsets:

- static information – information that is essential for reasoning purposes, hence has to be always available to the reasoner;
- dynamic information – information that is not needed for reasoning purposes, thus it can be fetched when needed.

By dividing information space into two subsets and excluding one from semantic network, we reduce the size of the semantic network; hence we reduce the amount of information that needs to be processed by the reasoner. For providing dynamic information, we propose use of semantic web services that are executed automatically, when the demand for dynamic information arises.

This way we not only increase the performance, but we also increase interoperability with legacy systems. Data provided by services is not limited to data that is excluded because of performance issues. Based on service oriented architecture paradigm, services can also act as information providers from legacy systems in loose coupling, higher reuse and greater interoperability manner.

This paper presents a framework that is based on semantic web technologies and uses automated execution of semantic web services for providing both, dynamic information as well as information from other information sources e.g. legacy systems, databases, Web etc. The organization of paper is as follows: section 2 outlines common architecture of SWT based systems; section 3 discusses prerequisites for automated web service (WS) execution and presents ontology for semantic representation of WS. In section 4 we present the architecture of the system and in section 5 algorithm for automated execution of web services. Section 6 presents related work and section 7 provides conclusion.

2 COMMON SWT BASED ARCHITECTURE

Semantic web technologies are usually represented in a layer cake model, where XML and URI are foundations for SWT building blocks. First SWT specific building block is RDF[8] – a language for describing resources, which are represented as URI-s. Next important building block is OWL [9] – a language for describing ontologies. Next to ontology building block in the last version of SWT layer cake is RIF. RIF stands for rule interchange format and includes rule languages that are compatible to RIF. One such rule language widely used in SWT is SWRL –

semantic web rule language. It enables reasoning on concepts defined in OWL ontologies.
These three building blocks represent core SWT. To be able to query semantic networks, SWT layer cake specifies SparQL – SQL like query language. SWT based systems use RDF as data backend, OWL for defining ontologies – data integration and SWRL for defining business logic based on logic rules. Typical SWT system architecture is shown on Figure 1.

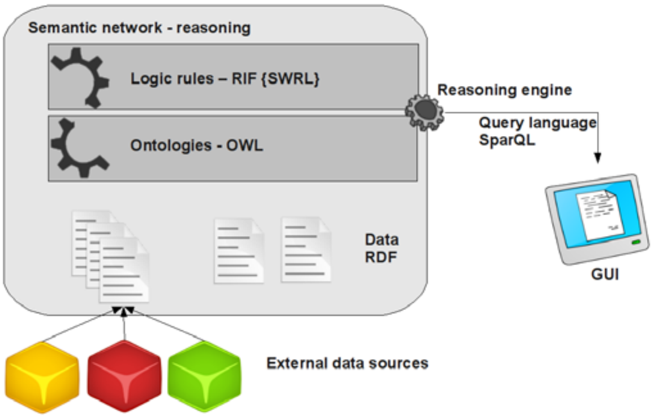

Figure 1: *Common SWT system architecture.*

We have already mentioned two mayor drawbacks of such architecture in the introduction, these are: (1) poor performance on large data sets and (2) high data integration and integrity costs with external data sources. Instead of using agents to import RDF data to semantic network, our approach uses web services.
Framework presented in this paper substitutes some data sources with web services that provide data on demand. This way, dynamic data as defined in introduction, is being provided by web services. To be able to combine static and dynamic data in a transparent manner, the framework has to be able to automatically execute Web Services, when the need for data they provide arises.

3 AUTOMATED EXECUTION PREDISPOSITIONS

Web Services are seen as technology of choice for implementing service oriented architecture (SOA) systems. While they provide state of the art data exchange platform for heterogeneous environments (being platform and programming language independent), they lack in automated service discovery and execution aspects.
Current WS descriptions rely only on syntax for defining WS interfaces. To be able to use a service, the consumer has to know what the operations of particular WS actually do and what is the meaning of data they return (XML Schema is not sufficient for this task). WS specifications do not provide means to describe this in a formal way.
These problems led to defining Semantic Web Services (SWS) [2], which is an approach that tries to combine Web Services with Semantic Web concepts. Main idea behind SWS is: if we define the semantics of WS operations and data that is being exchanged with the service in a formal computer readable and processable way (vision of Semantic Web), then we can automatically discover, compose and execute web services.
There are three main approaches to SWS; these are: WSMO [3], OWL-S [4] and SAWSDL [10]. WSMO and OWL-S are mainly concentrating on service discovery and composition. For these reason, they provide fairly complex ontologies to semantically model services. Both approaches enable use of Web Services for data exchange. Main difference between these two concepts is that OWL-S uses SWT for service modeling purposes (RDF, OWL, SAWSDL), while WSMO introduces its own language called WSML.
WSMO and OWL-S require a lot of effort to provide semantic service descriptions; SAWSDL, on the other hand does not define the way services are modeled, rather it just provide mechanisms to semantically annotate current web service descriptions (WSDL). How or in which language the consumer defines these concepts is out of scope of the specification. Because of that, SAWSDL is seen as an iterative approach from WS to SWS.
We chose to use SAWSDL in our framework, because of following facts: (1) defining WSMO and OWL-S services is a complex task, besides that we don’t need discovery and composition capabilities in our framework; thus we can use a simpler formalism, (2) WSMO uses it’s own language, that is not compatible with SWT, (3) research and development effort of OWL-S is fading and a lot of tools are already outdated, (4) existing WS can be easily converted to SAWSDL by just semantically annotating WSDL, (5) SAWSDL is not just compatible with SWT, but it is also compatible with current Web Services, (6) SAWSDL is interoperable with SOA implementations.
As we already mentioned, SAWSDL does not specify how the services are modeled. Because of that, we have developed a lightweight service modeling ontology that is targeted at automated execution of web services. The ontology is called semantic web services execution ontology (SWSEO). It is defined in OWL-DL and it is shown on Figure 2.
Main concept in SWSEO is service. Opposite to WSDL, SWSEO service is not a collection of operations, but it is actually a WSDL operation. There is no need to provide a concept that would group operations/services in a service group based on the same binding or port type (although this is useful for WS). When we refer to service, we are referring to SWSEO services.
Service concept has five data properties presented on the left side on Figure 2. These data type properties are used for web service invocation and are parsed from SAWSDL document at the registration time.
Every service has also some input and output messages. Web Services are based on XML language and use XML documents as input and output messages to services. To be able to use this data in semantic networks; XML data has to be converted to RDF format and vice versa. In case of input

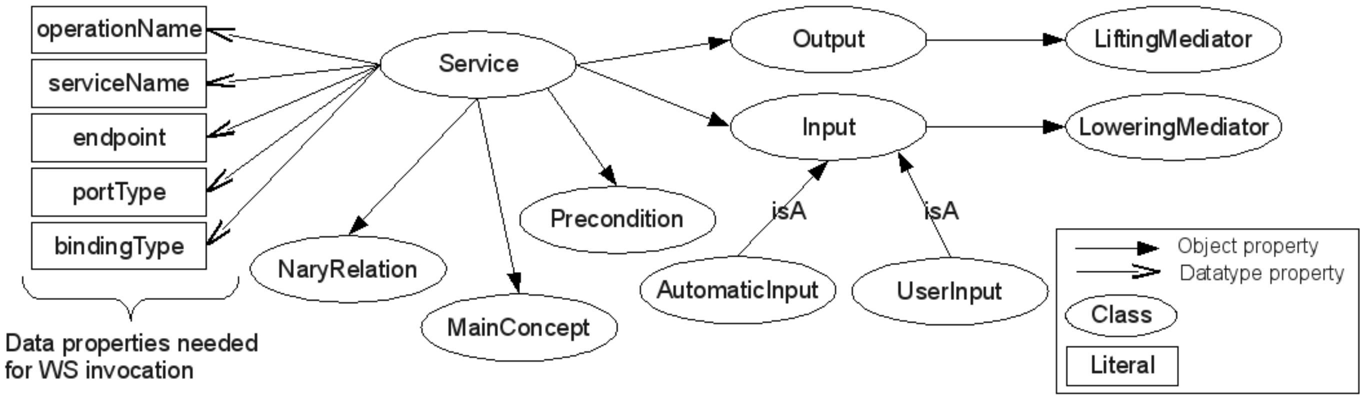

Figure 2: *Basic concepts of Semantic Web Services Execution Ontology (SWSEO).*

messages, semantic data represented in RDF has to be lowered to XML documents and in case of output messages XML data has to be lifted to RDF format. For this purpose we defined lifting and lowering mediators that take care of data conversion.

Lifting mediators can be XSL transformations [11], Java classes or even another Web Services. Lowering mediators on other hand have one additional mediator type: SparQL mediator. In RDF the same data can be represented in different ways. Because of that, XSLT, which does transformation based on XML document structure, can not handle all different data representation variations. For this purpose a combination of SparQL query and XSLT can be used. SparQL takes care of getting the right structure, after that XSLT is used to actually lower the data.

As seen on Figure 2, input messages can be of two types: (1) automatic input – data is being fetched automatically from the semantic network by the framework and (2) user input – input data is not stored in the semantic network, but it is provided by the user when querying semantic network.

There are three further concepts, we haven't mentioned yet. First is precondition. This concept is used in case more than one service provides the same type of data and the service that is being invoked is selected based on the instance, e.g. let us suppose we have an e-tourism application that uses web services for getting room availability information. Each hotel/apartment provides its own availability service; all the availability services provide same type of data (room availability). Service that is being invoked is selected based on precondition. Precondition defines for which hotel a particular service provides room availability information.

Concept named main concept is used for extracting automatic input messages from semantic network and for creating service execution plan. For example described in previous paragraph, main concept would be hotel. This means that the framework has to check room availability by executing the web service for each given hotel.

Last basic concept of SWSEO is nary relation. RDF and OWL support only binary relations between concepts. If we want to make a nary relation, we have to create a holding class [5]. There are situations where services provide nary relations for which holder class instances are not yet in the semantic network. This class actually serves as an instruction for the framework to create the holding class instance and connect it with the main concept.

4 SYSTEM ARCHITECTURE

Figure 3 shows system architecture for automated execution of semantic web services. The system acts like a wrapper to the SparQL endpoint. Whole process of service input retrieval, data conversion, service execution and model integration is transparent to the user; the user has to provide only the SparQL query.

Main components of the architecture are: (1) SparQL query processor – splits query into two parts (static and dynamic information), returns concepts from query that are service outputs and parses user service input information from where clauses, (2) input providers – provides data defined as automatic input, (3) input and output mediators – provide lifting and lowering capabilities (Java, XSLT and SparQL mediators), (4) service executor – invokes web services, (5) query executor wrapper – provides data from semantic networks needed by other components in an efficient way by caching data and reducing number of query executions.

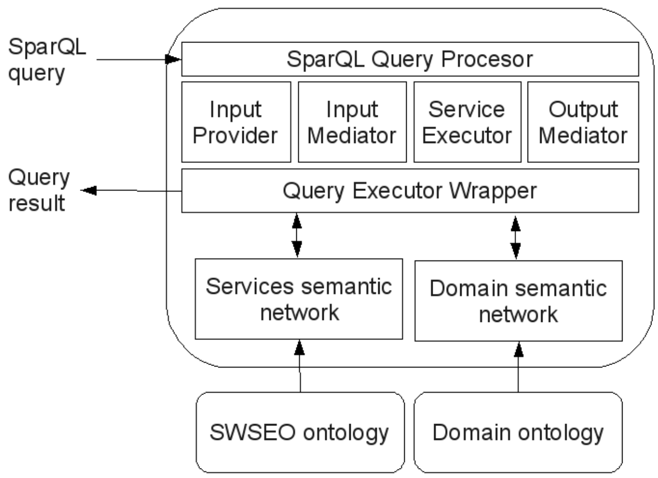

Figure 3: *Automated SWS execution architecture.*

5 ALGORITHM FOR AUTOMATED EXECUTION

Listing 1 presents algorithm for automated execution of web services that is based on SWSEO ontology and presented system architecture.

```
define extQuery(staticQuery,
 serviceOutputConcepts, userServiceInput)
define execItem(inputData, outputData,
 invocationDesc)
define execPlan

extQuery = parseSparQLQuery(inputQuery)
staticData = executeQuery(extQuery.staticQuery)

services[] = getServicesWithOutputConcepts(
 extQuery.serviceOutputConcepts)
foreach (service:services) do
begin
  mainConcepts[] =
 staticData.getMainConcepts(service)
  foreach (mainConcept:mainConcepts)
  begin
    execItem = new execItem()
execItem.inputData.add(extQuery.userService
 Input)
    automaticInput = getAutomaticInput(service,
 mainConcept)
    execItem.inputData.add(automaticInput)
execItem.invocationDesc(service.getInvocation
 Desc())
    execPlan.add(exeItem)
  end
end
foreach (execItem:execPlan.getItems())
begin
  execItem.lowerMessages()
  execItem.invokeService()
  dynamicData = execItem.liftMessages()
end

return staticData + dynamicData
```

Listing 1: *Algorithm for automated WS execution.*

6 RELATED WORK

Some similar research work has been done in this area, yet none of them concentrates on interoperability between data represented in semantic networks and web services. Almost all of the research work done in the area of semantic web services is oriented towards discovery and composition of services. There is a working group under OASIS called semantic execution environment (SEE), but they limit their activities only to WSMO, for which they provide a reference implementation of execution environment called WSMX [6]. Also an EU seventh framework programme project called SOA for all [12] has been started. Its goal is to create a web of services by combing semantics, Web Services and Web 2.0. There haven't been any contributions yet.

Most similar approach to ours has been presented by Langegger et al. They have presented a system for virtual data integration that uses SparQL endpoints as data source instead of Web Services [7].

7 CONCLUSION

This paper provides a complete framework for automated execution of semantic web services. By exposing data as web services, the size of semantic network can be reduced, which results in better performance. Yet this does not have a deterministic behavior and further research work should be done on this topic. On the other hand by enabling integration and automatic execution of web services better interoperability with other information systems can be achieved.

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SEMANTIC MASHUPS

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ABSTRACT

While mashups are getting popular by the day, almost every site on the web includes some data or services from third parties and aggregates them into mashups. There are a lot of ways other sources are accessible, but the problem is that each of them has different inputs and outputs, so at least basic programming skills are required to create mashups. To bridge this problem, we can use semantic technologies and provide common data formats which are the basis for connecting various contents.
In this paper, we will present and analyze semantic techniques that can facilitate the creation of mashups and take a closer look at each of them.

1 INTRODUCTION

The common method for creating today's mashup web applications is by using third-party content via APIs (Application Programming Interface), REST (Representational State Transfer) services or screen scraping and then combining them with custom code. Although mashups are meant for users that have no or very little programming knowledge, creating them requires a lot of programming effort. For example, if someone wants to retrieve data from RSS (Really Simple Syndication) or Atom feeds and present that data on Google Maps, they need to know at least the basics of some scripting language and understand API for Google service.
There are two options to make things easier. We can use mashup tools like Yahoo! Pipes, Microsoft Popfly, Google Mashup Editor and IBM QEDWiki. These are simple enough for the average user to make mashups, but also have a limited selection of services that may be used for creating mashups. They are typically internal to the company that created the tool or for standard output types like RSS or Atom[1]. Also, adding a new service or feature in such a tool demands modifications on all existing services or even on the entire environment, which is not scalable[2].
For a second option, we can use semantic techniques which help us achieve standard formats for services and data. These formats are machine-readable and form the basis for automating mashup creations. This kind of solution also solves some common problems for mashups. With standard syntax for equivalent services, a mashup creator can choose between several services from different providers. That way, whenever the service used for the mashup changes or does not respond or if provider makes it non-public, we can take another service that is equal to the previous one and leave the mashup unchanged. This is shown in code example bellow[3]:

If ServiceA is responding **Use** ServiceA
Else Use ServiceB
EndIf
Standard Service call goes here.

In the next part of this paper, we will present some semantic techniques that facilitate the creation of mashups. Some of them are more complex, so we will present basic concepts and show how that kind of solution may be used.

2 SEMANTICALLY DESCRIBED REST SERVICES USING ONTOLOGIES

Imagine that we want to build a system where users can add or remove any service at their will and which would be a matter of configuration and not programming. To reach this point, we need to make system so smart that it will know how to combine various services from different providers[4]. This is where we can use technologies like RDF (Resource Description Language), RDFs (RDF Schema) and OWL (Web Ontology Language).

2.1 Resource Description Framework

The Resource Description Framework is a language for representing information about resources on the World Wide Web[5]. What exactly is a resource? A resource can be just about anything. In our example, it could be a service, a mapping service, a bookstore and so on, but it must be referenced via URI (Uniform Resource Identifier). In RDF, resources are described with triples. Each triple consists of a subject, which represents a resource, a predicate, which is a property of a resource, and an object, which is actually a value of the property. The object can also be a resource, so we can get a net of connected resources. In one article, Allemangs declares that RDF is the ultimate mashup language, which provides a simple way of expressing information from different sources, allowing them to be merged into a single graph structure[8]. In our example, we can use RDF to describe services and data that could potentialy be used in mashups. In this way, properties for a single service could be URL (Uniform Resource Locators), title, input types and output types.

2.1 RDF Schema

Information about resources that we could specify with RDF are not enough for a system to understand, for example, which services represent mapping information and which of them represent Email services or even Email address validation services. In order to achieve this, we can include an RDF Schema, which allows for the creation of classes and relationships between them[4]. If we want to get more specific, we can create subclasses of existent classes. Then we can create individuals, which are instances with types based on classes, and the properties that we assign to classes. So, we get a structure like in object oriented language. When services are described, the computer has information about resources and their relationships but it is still not able to make inferences, so creating ontology would be the next logical step.

2.3 Web Ontology Language

For this part we can use OWL (Web Ontology Language) which is designed for use by applications that need to process the content of information instead of just presenting information to humans[7]. OWL is actually an extension of RDFs and it is meant to define concepts and create ontologies. With OWL, we can define everything we did with RDF in combination with RDFs and more. The most interesting is the use of different properties with which we add the ability to reason. In this manner, we could say, for example, if an email validation service is an email service, and email service is defined as service, then email validation service is also a service. Or in a mapping service, we could define the class that represents "Country" as equal to the class named "State". There are plenty of properties that may be used in OWL to help a computer infer things, but due to space constraints we will not present them here (you can find details in [7]).
Ontologies are just definitions of classes and the relationships between them in the form of properties. To use them on real data we have to create individuals or instances. So, individuals for the mapping service class would be Google maps, Yahoo maps or MapQuest, for example. Their properties would be inputs with the subproperties: latitude, longitude and HTML content. Latitude and longitude would be constrained with an xsd:decimal datatype and so on.
With such a system, users are able to choose not only services but also the properties that would be more appropriate in the final mashup. In this way, they can display one or many kind of places on the map, such as hotels or libraries that are available form various RSS or Atom feeds[8]. This kind of solution is not so bad, but someone would need to define every single service used in a system, which would be a sheer waste of time, but still better than hardcoding each service into the system.

3 MICROFORMATS, RDFa AND GRDDL

The next approaches are more data centric, in which more or less screen scraping techniques are relevant to building mashups. However, it is also useful for browsers and tools that are used to parse pages, especially web crawlers or web spiders. We are going to present how structured data formats can be embedded into web pages and include additional information to existing (X)HTML. The basic idea is creating common formats, which would be accessible by Web 2.0 applications[11]. In this part we will introduce Microformats, RDFa and GRDDL, in relation to mashups.

3.1 Microformats

According to Wikipedia, Microformats are a web-based approach to semantic markup that seeks to re-use existing (X)HTML tags to convey metadata and other attributes[9]. The main idea is making human readable format also readable for computers. It means that whenever a parser would go trough the (X)HTML source code, it would actually understand the meaning of each part. Microformats are embeddable to RSS/Atom feeds and XML documents as well[10], hence they can be used in REST services.
Embedding microformats involves putting little chunks of structured data into existing formats like HTML[10]. They can be used for marking locations, contacts, events, bookmarks and other data in standard formats. That way we can, for example, embed geographical data like longitude and latitude into HTML code, where some place is described as shown in the code snippet below:

```
<div class=”geo”>Description of some place
   <span class=”latitude”>46.5246</span>
   <span class=”longitude”>15.6445</span>
</span>
```

There are a lot of web sites that use microformats. Among them we can find well known sites like Yahoo! Local, Upcoming.org, LinkedIn and others. The problem is that microformats are useless if we do not have a tool that can parse them. For this purpose, we can use Operator, a Firefox extension that can handle microformats, connect acquired data with other services and even enable users to write their own scripts and perform actions on the gained data (https://addons.mozilla.org/en-US/firefox/addon/4106).
There is also the option of writing one's own program for extracting metadata from defined content. With such a tool, we can collect data of a particular data type from various sources and make a simple mashup. For example, if we are browsing the web with a browser that is able to detect events trough microformats, we can add each interesting event into a calendar like Google Calendar with a single click, so that we get a nice collection of preferred events.
The common problems we found about microformats are[10][11]:

- there is no standard way to get data out of them,
- validating them is difficult, because some formats can also include other formats (addresses and locations can be parts of a contact),
- there is no schema that could mitigate validation,
- they are domain specific, so we can not use microformats for everything.

We will subsequently present approaches that help overcome these difficulties and makes microformats more useful.

3.2 RDFa

RDFa has the same purpose as microformats: make a presentation page that is also comprehensible to machines. The difference is that RDFa uses vocabularies instead of predefined data structures and 'hard-wired' attributes. We can build these vocabularies on our own or simply take them from some central authority[12]. From its name (it stands for RFD in attributes) we can easily deduce that it relies on RDF language, hence RDF triples can be easily extracted from it. That way, information is referenced with URIs, so that duplication is reduced. So, when we want to publish some data, creating two separated documents, one for humans and one for machines, is unnecessary.

3.3 GRDDL

GRDDL is the abbreviation for Gleaning Resource Descriptions from Dialects of Languages and is used to transform metadata from XML and XHTML, which are structured with markups such as microformats and RDFa, to RDF[13]. The idea behind GRDDL is that documents embed RDF and references to rules. In this manner, some intentional tool would know how to get RDF out of the source document. To understand GRDDL, we have to understand its basic components[11]:

- The GRDDL-aware agent is a software agent that identifies GRDDL transformations and performs them to extract RDF.
- The source document is an XML or XHTML document that references one or more GRDDL transformations for a GRDDL-aware agent to extract RDF from it.
- GRDDL Transformation is an algorithm, usually specified as an XSLT transformation language, which is referenced inside a source document and enables a GRDDL-aware agent to perform transformations.

In addition to these components, we have to know how to include GRDDL into an existing document (we will describe only methods for XHTML, since XML uses similar principles). To get started, we have to define the *profile* attribute in the *head* element of the XML/XHTML document. This attribute denotes that the document uses GRDDL. We also have to apply a link to the transformation algorithm, which is usually an XSL document. Here we have two options. We can define the link to transformation inside a *link* element, which is part of the *head* element, or by using a profile. The value in the profile attribute can be a simple namespace or a reference to another GRDDL-compliant document. That document can then also be used to indirectly reference a GRDDL transformation, so when making some document GRDDL compliant, we do not need to define transformation explicitly but just pick a suitable namespace which also uses GRDDL.
GRDDL makes it possible to translate all documents that include semantic data to a common format: RDF (Figure 1). From there, creating mashups should not be a problem, but something is still missing. Services are not semantically annotated yet.

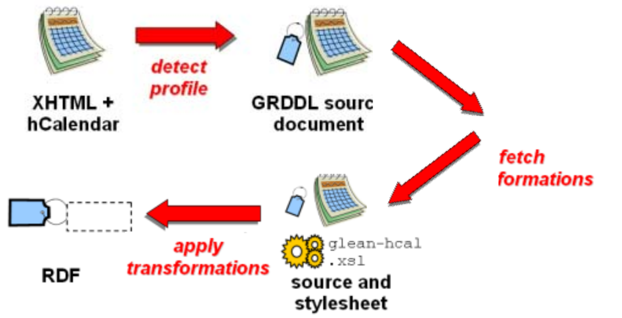

Figure 1: *Translating the denoted document to RDF form[13]*

4 SA-REST

So far we have seen some semantic approaches to making mashups, but creating mashups still requires a lot of effort. The next idea is to add some semantics directly to RESTful web services which are then used in mashups. This approach is called SA-REST[2]. This idea is taken from Semantic Annotations for WSDL (SAWSDL), which is used in traditional web services and adds semantic annotations to WSDL components[14]. In SA-REST, REST services are used, which differ from traditional web services in their simplicity.
Calling a REST service is all about sending a request through HTTP GET and POST methods, where the POST method is more applicable for changing data on the server. The server returns structured formats such as HTML, RSS/Atom feeds, JSON or XML, which are different from each other. SA-REST solves this by lifting and lowering a schema that translates each output and input to the data structure of the ontology, which is called the grounding schema[2]. To enable this, providers have to ensure lifting and lowering schemas, which are mostly XSLTs, for every REST service. That way, with every request, a given grounding schema is translated to a data structure service expects and response, which is translated back from output data structure to the ontology form. Like we saw, the grounding schema is some kind of common language for various REST services (Figure 2).
The next challenge revolves around describing REST services. While traditional web services are described through a WSDL document, where semantic annotations fit well, by REST services we do not have a separate document file, where we could put some semantics. But actually we do. Usually these kind of services are described via HTML on separate web pages, where we can find the formats of inputs and ouputs, what kind of operation it provides and so forth. Since HTML is meant for humans, we have to adjust it for machines. Here we can include technologies introduced in previous chapters and embed semantic annotations through RDFa. That way we can describe services through RDF triples where the subject should be expressed by a URL from where the service would be invoked. Since we are describing SA-REST properties, they should be predicated by some of the following:

- sarest:input,
- sarest:output,
- sarest:operation,
- sarest:lifting,
- sarest:lowering,
- sarest:action.

The object of the triple depends on predicate, so for input, output and operation, its value would mostly be an URI of an OWL formatted structure. For lifting and lowering schemas, it would be XSLT document and for action it would either be an HTTP GET or HTTP POST string. To get these properties out of an HTML document, we can use GRDDL, which was presented in the previous chapter.

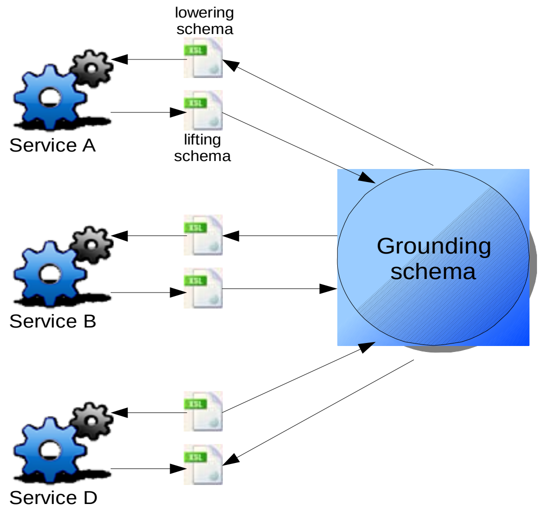

Figure 2: *Communitaction between services via a grounding schema*

So far, we have all the conditions necessary to create mashups automatically, without writing code. Now creating a mashup starts with choosing SA-REST services and specifying URLs to their annotated HTMLs[1]. To start up a created mashup, the user needs to enter the required inputs to the first positioned service. Outputs from the first service then lift to the grounding schema and are stored. When communication with the second service begins, precisely the opposite happens: inputs are lowered to suit to required format. The outputs from the entire mashup can also be adjusted to the user's needs. Here we can see that the most important part of the system is data mediation. Since creating standard mashups mediation is usually human work, with this approach it is performed automatically.

We can also find some problems that are related with SA-REST. First, this principle is not well known, so there are only a few public SA-REST services that are ready for mashups. It is not even standardized by W3C, which means that it could change over time.

5 CONCLUSION

To facilitate creating mashups, we got acquainted with different semantic web approaches and realized that even more complex mashups can be created visually, where coding is not necessary. Semantic mashups can also overcome situations where particular services are unreachable, which is one of the main mashup problems.

There have already been some attempts at implementing a system that supports creating mashups with various services in a visual way[2][4], but they are not what we were looking for. Hence, our next objective is to confirm a theory from this article and implement such a system.

In our opinion, semantic mashups will be more standardized and more widely adopted by developers with the passing of time. This may result in a greater number of semantic annotated services and tools for their aggregation. We think that with semantics, even standard web services will become more appropriate for mashups. This would provide a great opportunity for companies with many internal web services.

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GEOSPATIAL SEARCH SERVICE

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ABSTRACT

Every single day there are numbers of users searching in emails, documents, books, web pages, even in pictures or videos. Exceptions are geodata. There is no searching engine for geodata comparable with well-known services such as Google or Yahoo! Therefore we have focused on this issue. This paper presents an approach for development of a geodata search engine based on OpenGIS® Web Map Services standard. The presented search engine is providing a WMS compliant interface to different mapservers and allows to access data on them from a single map service.

1 INTRODUCTION

Full-text search is a common and effective method for data retrieval. Nevertheless geoinformatics lacks such a service. Users are forced to browse different web pages and search for addresses of mapservers and descriptions of their content. After an appropriate mapserver is found, it is usually relatively easy to access the geodata. We could observe quick adoption of open formats maintained by *Open Geospatial Consortium* (OGC) in geoinformatics in last few years. In OGC are participating representatives of large companies as well as independent professionals. Almost all leading geographic information systems are supporting these open standards. Hand-in-hand with adoption of these open standards there goes usage of different web map services – *Web Map Service*, *Web Feature Service*, etc. Large companies and governments are usually building their geospatial infrastructure on mapservers using these services. Therefore this project is focused on searching geodata in *Web Map Services* – probably the main on-line source of geodata. The general concept of this project was presented in [9].

2 WEB MAP SERVICE

The basic purpose of the *Web Map Service* (WMS) is to provide images with geodata on specified location (see *Web Map Server Specification* [1]). Requests are usually send through HTTP protocol. However both HTTP methods – GET and POST are supported, Clients are usually using the method GET. The structure of such request follows:

```
http://host[:port]/path?{pram=[value]&}
```

The first part of the request is identification of the map service. Behind the question mark is a set of parameters and their values describing the request (this method is also called KVP – key/value pairs). KVP are separated by "&". WMS supports three basic requests:

GetCapabilities – This request is mandatory (must be supported by all WMS compliant mapservers). Response on this request is an XML file with a description of provided map layers (their names, descriptions, keywords, coordinate systems, supported formats,…). Example of such a request is:

```
http://echo.mendelu.cz/cgi-bin/moebius/
moebius.py?service=wms&version=1.1.1&
request=getcapabilities&
```

`Service` identifies kind of map service, `version` its version supported by the client and meaning of `request` is obvious. Response is an XML file. Part of this XML follows:

```
<WMT_MS_Capabilities version="1.1.1">
  <Service>
    <Name>Moebius Mapserver</Name>
    <Title>This is Moebius Test Service</Title>
    …
  </Service>
  <Capability>
  <Request>
    <GetCapabilities>
      <Format>application/vnd.ogc.wms_xml</Format>
      <DCPType>
        <HTTP>
          <Get>
            <OnlineResource xlink:href="http://
            echo.mendelu …" xlink:type="simple"/>
          </Get>
        </HTTP>
      </DCPType>
    </GetCapabilities>
    <GetMap>
      <Format>image/jpeg</Format>
    …
  <Layer>
    <Title>Moebius mapset</Title>
    <Layer>
      <Name>topp:coast_earth@edit3.csic.es</Name>
      <Title>Coast line</Title>
      <Abstract>This layer describes coast lines…
      </Abstract>
      <SRS>EPSG:4326</SRS>
…
```

In the first part of the XML file there is described the mapserver itself – supported output formats, URLs for sending requests, etc. The second part describes all map layers. The second mandatory request is *GetMap*. Response is an image file with map layer or layers (see Fig. 1). General structure of the request is same as in previous case.

```
http://echo.mendelu.cz/cgi-bin/moebius/
moebius.py?service=wms&version=1.1.1&request
=getmap&layers=bluemarble_1@iceds.ge.ucl.ac.
uk&crs=EPSG:4326&bbox=-180,-90,180,90&
&format=image/png&width=520&height=400&
```

The only difference is in parameters which specify requested layer, coordinate system (EPSG:4326 is *World Geodetic System 1984*), bounding box and finally properties of target image file (format and resolution).

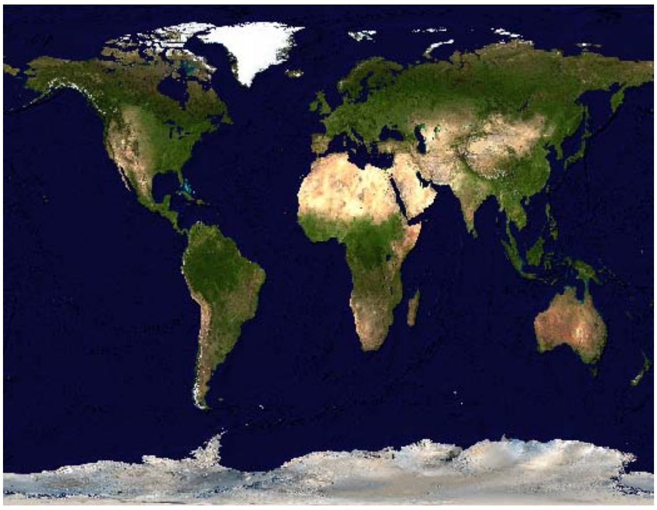

Figure 1: *Response on GetMap request. Image contains geodata from Project Blue Marble (http://echo.mendelu.cz)*

The last and optional request is *GetFeatureInfo*. If the `queriable` attribute is set to "1", this request is supported. In this case, the request returns information about the feature in the map layer specified in URL on the given location. This feature is not used in this project.

3 AGGREGATION AND GEODATA CATHALOGS

3.1 Ontology based principles

We could recognize two main approaches in geodata organizing. First one is development of different catalogs. These catalogs usually contain own metadata describing free web mapping services, paid geodata sources and often also geodata stored "off-line" in some organizations (see MIDAS (http://www.cagi.cz/midas/), *Micka* [2] and others). Because of their metadata about, they are usually called "metadata catalogs". This approach has three significant disadvantages. We could call them accessibility, recency and point-of-view. Under the term accessibility is meant on-line accessibility of mentioned data source through the Internet. This problem is currently partially solved. New catalogs are usually focused mostly on web services. But rest of the problems is still unsolved. Catalogs are based on approach, which could be called ontological classification. The basic gist is, that on the beginning an ontology that allows to classify every possible object in given area is formulated. For example: Every library has some classification method for books. Every book, even nonexistent one, has some theoretical place in this hierarchy. In geoinformatics a significant problem is to define such ontology from many reasons: geodata has different structures (we are working with rasters, vectors, files, services, …), geodata is complex (different number of dimensions, overlapping topics and areas). Moreover, there is one bigger problem for such catalogs than ill defined ontology. It is recency. There is need for human interaction. Every record in catalog must be edited by an administrator. This leads to delays in actualization, bad links, etc.

A specific group of projects is using ontological classification in a different way. They are focused on development of rules for interconnection of data in geodatabases (see [3], [4], [5]). For example "population" in one database table has in fact the same meaning as "inhabitants" in another one. Used ontologies are creating translation rules between database tables. Although this approach is based on a different principle, basic drawback is same. Ontologies must be carefully defined by an administrator. This is the main reason why this approach is used only between relatively small numbers of mapservers.

Ontologicaly based approaches are not bad at all. Geodata catalogs have even own OGC standard – *OpenGIS Catalogue Service* [6]. In some specific cases they are very useful, but for aggregation of huge number of complex records (which are constantly changing) they are usually not very effective. Therefore some projects are focused on development of more automatic systems.

3.2 Aggregation of a huge number of map services

Probably most successful example of such project is the *Geospatial Information Database (GIDB®) Portal System* by of the *Naval Research Laboratory's (NRL) Mapping Branch* [7]. The key part of their system is agent searching in the Internet for map services. Discovered service is indexed and it is created a WMS interface to this map service. This interface is in fact a kind of virtual mapserver. On the web page of GIDB® project is list of almost 1200 WMS compliant virtual mapservers. Although the used approach is very interesting, it has two significant drawbacks: Information about map layers is usually very brief (or is completely missing). This is understandable because usually there is almost no information presented in map services. Second drawback is the lack of some kind of search service or cataloging system.

Another interesting project from this area is *GeoBrain* [8].

3.3 Comparison of presented approaches

Almost all presented approaches have one common principle. If the user is searching for some specific map layer, he must go through some list of categories or virtual mapservers. The support of full-text search is an exception and it is usually only a supplement of a manually created catalog. Nevertheless full-text search is a widely spreading and effective way of information retrieval and it is promising also within this area.

Based on analysis of described projects and many others, we formulated following presumptions for successful geodata search engine:

1. The system must be almost fully automatic. Manual administration leads to delays and inconsistency.
2. Ontologies should be only a supplement, because they must be carefully formulated by professionals.
3. All metadata must be given by the map service itself, there is not possible to rely on information given by an administrator or any other person or service.
4. As been mentioned before, the system should be based on full-text search engine. Browsing trees or categories are not effective in this case from reasons mentioned above.

4 GEOSPATIAL SEARCH SERVICE

The following section presents our solution of the geospatial search service. This solution has three main parts: indexing tool, virtual mapserver (interface to indexed map services) and full-text search engine.

4.1 Indexing tool

Indexing tool is accepting an URL of WMS service. This URL should be given by some agent or manually. *Indexer* parses *GetCapabilities* file of the service and creates independent indices for every map layer. All information in the record is given by the *GetCapabilities* file. The structure of the record follows:

- *NickName* – unique identification string, string consisting of a name of the map layer (unique within the mapserver) and unique identification of a mapserver (it is chosen during indexing, usually it is part of URL – e. g. *roads@indica.mendelu.cz*), usage of this element will be explained later,
- *Name* – name of the layer (content of `name` element),
- *WMS* – version of WMS supported by the mapserver, taken from the head of *GetCapabilities* file,
- *Address* – URL of the mapserver where the layer is stored, hence also URL used for GetMap requests, again taken from the head of *GetCapabilities* file,
- *Access* – access mode to the layer, there are three options: *all* (everyone is able to access this layer), *black* (everyone except for users from IP addresses on the blacklist), *white* (users from IP addresses on the whitelist only), used for security reasons,
- *Descriptions* – contains contents of `Title` elements in `Layer` elements and usually also from the head of *GetCapabilities* file,
- *Abstracts* – list of `Abstracts` taken from the head of *GetCapabilities* file and instances of `Layer` element,
- *SRSs* – list of supported coordinate systems,
- *BoundingBoxes* and *LatLonBoundingBox* – define the bounding box of the recorded layer,
- *MinScale* and *MaxScale* – maximal and minimal scale of the layer, taken from the lowest instance of `Layer` element (could be replaced or extended by `ScaleHint` element),
- *Formats* – list of supported output formats, taken from the head of *GetCapabilities* file,
- *Opaque* and *Queriable* – their meaning is the same as in *GetCapabilities* file, values are taken from the lowest instance of *Layer* element,
- *Styles* – list of Styles defined for a layer.

This record could be stored in some relational database, XML form or any other desired format. In our project we used an XML form and currently we are experimenting relational databases with an XML interface (*Oracle 11*, etc.).

4.2 Virtual mapserver

Interface to these indexed map layers is created by virtual mapserver. This virtual mapserver has completely different architecture from virtual mapservers used in GIDB project. Our mapserver is merging layers from all indexed real mapservers into one service. This approach has many significant advantages:

- We are able to merge layers from different real mapservers on the level of WMS request.
- All map layers are on one server. There is not necessary to browse many mapservers.
- Our virtual mapserver is supporting full-text search (will be described in section 4.2).

The gist of the virtualization is quite simple. Virtual mapserver (called *Moebius*) receives request on two layers from different real mapservers. *Moebius* generates two separate requests and sends them to real mapservers. Results – images with map layers – are merged together using *ImageMagick* tools (http://www.imagemagick.org) and GDAL library (http://www.gdal.org). Final result – single image file – is returned to the client (see Fig. 2).

This approach is working. There are just two problems. The first one is inaccurate information in indices (concretely some layers are supported just in some scales, but this information is not given by the *GetCapabilities* file). The second problem is incompatibility of coordinate systems. This should be partially solved by GDAL library, but there is not possible to transform all coordinate systems without errors. And precision is one of the key issues in GIS. Therefore we are currently supporting only WGS 1984. This problem is more serious just for users in Europe and small countries like Czech Republic. For “global” or American applications this restriction is not significant.

4.3 Search engine

The described virtual mapserver *Moebius* could contain a huge number of map layers. For an easier access to the layers we designed a new request – *FindMap*. *FindMap* is based on this thought: If *GetCapabilities* means in fact “return description of all layers”, *FindMap* means “return list of all layers which fulfill these conditions”. Therefore the return format of the response could be the same –

GetCapabilities file. This is a very interesting issue: Every search result is in fact an independent virtual mapserver,

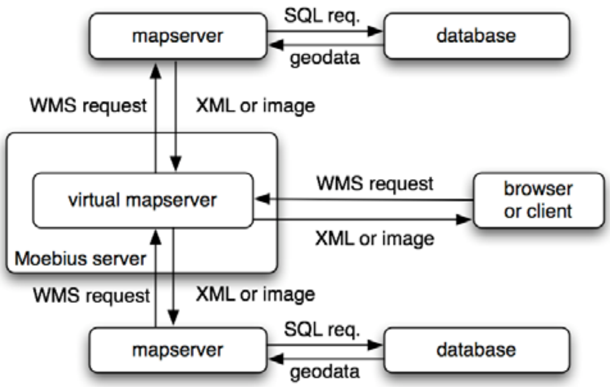

Figure 2: *Communication scheme used in our project. Client is sending requests to single virtual mapserver with all indexed map layers.*

hence it could be loaded directly in every common GIS. This approach brings great advantage – there is not necessary to process some web pages with results and then load appropriate layers in GIS nor browse a huge mapserver. It is possible to open specific layers directly in GIS. Moreover *GetCapabilities* is a standard XML file which could be transformed into XHTML, KML or any other XML format.

Calculation of relevance is based on a method similar to *inverted index* – we are calculating number of instances of keywords in index and proximity of keywords.

It is obvious, that *FindMap* request has a similar structure as *GetMap* or *GetCapabilities*. The list of parameters follows:

- `request=FindMap` – identification of the request, should be mandatory or optional (depend on implementation of the service),
- `words=keyword,keyword,…` – list of keywords which are searched in the indices, mandatory,
- `bbox=minx,miny,maxx,maxy` – bounding box for searching, mandatory,
- `operator={and,or}` – defines relation between keywords, optional (default value is “or”),
- `version=1.0.0` – version of request, currently not used, but in the future will be mandatory,
- `exceptions=exception_format` – defines format of exceptions, optional,
- `abstract=0..n` – number from 0 to *n* which represents the significance of instances of keywords in this part of the index (0 – abstract is not used in the calculation, n – abstract has the highest significance),
- `descriptions`, `keywords`, `name` – they have the same meaning as `abstract`.

Example of such a request is:

```
http://echo.mendelu.cz/cgi-bin/moebius/
search.py?words=Three,Gorges&operator=
and&bbox=-180,-90,180,90
```

Response will be an appropriate part of the *GetCapabilities* file from *Moebius* with layers from a given part of China.

5 CONCLUSION

This article has presented our innovative approach to development of geodata search engine. The core part of the solution – virtual mapserver *Moebius* – creates WMS compliant interface to many different map services. Key innovations of our approach are the method of virtualization and the *FindMap* request. This request returns *GetCapabilities* file with selected map layers. This file could be used in any GIS supporting WMS services or transformed into another format. Currently we are testing a service for translation into KML format.

The proposed concept was successfully tested in experimental implementation in the Python language. There is possible to say that this approach is viable and suitable for production implementation and further research. The mentioned results as well as the source code of the experimental implementation and further information are available on address: http://echo.mendelu.cz.

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RESPONSIBILITIES UNDER DATA PROTECTION DIRECTIVE (95/46/EC) FOR SEARCH ENGINES PROVIDERS AS CONTROLLERS OF USER DATA

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ABSTRACT

As the search engines become even more powerful, there has been concern on what this could mean for privacy issues. The paper discusses the legal framework, purposes for legitimate processing, the obligations on search engines. EU law provides that any information regarding an identified or identifiable natural person is to be considered as personal data. Consequently the Working Party 29 in its Opinion on data protection issues related to search engines concludes that personal data must only be processed for legitimate purpose.

1. INTRODUCTION

As the information age becomes a reality for increasing numbers of people around the world, the technologies that underpin it are getting more sophisticated and useful. The opportunities are therefore immense. For individuals, a great leap forward in their ability to communicate and create, speak and be heard; for economies, innovation and accelerated growth. However this kind of technological advances sometimes make it feel as if our lives are an open book. Mobile phones track our every movement; credit cards record where we shop and what we buy. The latest internet trends – blogs, social networks – make it possible to share almost anything whit anyone.

As the use of search engines becomes a daily routine, the protection of the users` privacy and the guaranteeing of the individuals rights, such as the right to access to their data and the right to information as provided for by the applicable data protection regulations, remain the core issues of the ongoing debate. Search engines have become an essential part of the way in which digital information is made easily accessible and »Googling«[1] has become autonomous concept. »To exist is to be index by search engine«.[2] Google`s storage and access to vast amounts of personal data create a serious privacy problem, one that Princeton computer scientist Felton E. recently called "perhaps the most difficult privacy problem in all human history."[3]
There are different types of privacy problems raised by search engines. On one hand is the privacy of search targets, the privacy rights of the people you search for on Google. On the other there is the problem of search engine users' privacy, rising by collection of search queries. Today information has become available instantly and costlessly. So that's way there is privacy interest of the person conducting the search. Search engines maintain comprehensive logs detailing users` search history. As such, they are private and highly personal in nature.[4]
Online search companies like Google, Microsoft could be forced to tighten further their privacy controls after an privacy working group found that the existing safeguards did not sufficiently protect users` personal information. The opinion clarified that the search engines companies »have so far insufficiently explained the nature and purpose of their data collecting operations to the users of their services«.

2. SEARCH ENGINES AND ONLINE PRIVACY

Search engines (hereinafter SE) operate by gathering[5] information and responding to search queries that are specified by user.[6] The results that are returned in response to the search queries are a result of proprietary algorithm develop by the search engine, with supposedly no human[7] interaction.[8] As researches have shown the rankings of search results are extremely important because the users are more influenced by the order in which results are being presented than the abstracts that accompany the links.[9]
Google (and other search engines) has officially stated that's its mission "is to organize the world`s information and make it universally accessible and useful." In order to organize all of the information in the world one must first collect the information.[10] Search engines are compiling a massive amount of data about each users, especially since the search engines have branched into popular e-mail services, for example Gmail, online calendar services… The fact that the users personal data could be entered or "read" also by using software algorithms of anyone using Gmail (or any other corresponding with Gmail user) in order to place direct advertising on the Gmail page could led to slippery slope.[11]
Search engine operations can be understood in terms of the information flows: 1. indexing, by witch SE learns what content providers are making available; 2. user queries to the SE for information about particular topics; 3. the results returned by the SE to the users, and 4. the content that providers send to users who have found them through search. Effective search requires that users disclose

information about their interests or intentions. The very fact that they are curious about something will be evident in their query. If there are repeat users the SE may be able to construct history of their queries. Many of this data are personal – AOL posted in August 2006 a list of 20 million search queries entered by 658.000 users over a period of three months. Even though the search logs identified users only by pseudonymous numbers, reports showed that it was possible to take a list of searches and identify the searcher; people actually have a tendency to search on their own names and other identifying detail.[12] Even where the information cannot be linked to an individual, it can still be used in ways that cause privacy harms.[13]

EU law provides that any information regarding an identified or identifiable natural person (data subject) is to be considered as personal data. An identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one factor specific to his physical, physiological, mental, economic, cultural or social identity.[14] We can note several types of data processed by SE that are to be consider as personal data: log files, search queries, IP addresses and cookies.

2.1 Types of data being processed

Privacy problems relate to any personally identifiable information that is information which can be used to uniquely identify, contact or locate a specific individual person.

The question related is whether data may be linked to a specific person. Public awareness to the extent of data retention by SE is minimal. A survey reveals that internet searchers are confident, satisfied and trusting, but they are also unaware and naïve.[15]

The log files of specific individuals` use of the SE are the most important personal data that are processed by SE. Each search creates a new entry in the log[16], populated with elements or different categories: IP address for user, data and time of search, URL revealing search term and engine, browser and operating system, user`s cookie.[17] The question whether the IP address constitutes "personal data" has been much debated in EU. The answer depends on whether the address might be linked to an "identified or identifiable natural person" through reasonable means. An IP address may be dynamic (different address is assigned to user every time he logs on) or static (permanent internet address assigned by internet provider). The Article 29 Working party[18] opined that even dynamic IP address constitute personal data. Also an individual`s search history is personal data if the individual to witch it relates, is identifiable. If the IP address is linked to user unique ID cookie distributed by SE, identification can be improved.[19] Similarly a cookie could be personal data, but only if a cookie is related to search log because it acts as a unique identifier in the on-line world allowing the computer upon which is placed to be distinguished from others.[20]

Effective search requires that users disclose information about their interest and intention. A collection of search terms can indicate a connection to a particular individual but that will only be in inexact connection and may lack the specificity to be data that relate to "an identified or identifiable natural person".[21]

International case law dealing with collection of personal information online suggests that users for now will not enjoy legal recourses against SE for the misuse of their queries.

But on the other hand, SE have internationally shown a willingness to comply with government demands for identifying data, even when the consequences for the identified users are sever. [22]

2.2 Purpose for which search engines collect personal data

The investigation launched by Article 29 Working Party into Google`s privacy and data retention practices (Article 29 Working Party Letter) stimulated Google to publicly explain its need to maintain user search logs.

In accordance with article 6 of the Data Protection Directive, personal data must be processed fairly and lawfully. Moreover, the processed data must be adequate, relevant and not excessive in relation to the purpose for witch they are collected and /or processed. For any person data processing to be lawful, it needs to satisfy one or more of the six grounds for legitimate processing set out in Article 7 of the Directive. They could be summarized a as follows: either the data subject has consented to such processing, or the processing is necessary for the vital interests of data subject, or the processing is necessary for prevailing legitimate interests of the controller or third parties, including society and the state.[23]

SE have generally stated the following grounds for using and storing personal data in their role as controllers of user data: 1. Improving the service; 2. Securing the system; 3. Fraud prevention; 4. Accounting requirements; 5. Personalized advertising; 6. Statistics; 7. Law enforcement.

2.3 Are the privacy policies of SE providing the right balance between privacy and security?

Privacy policies[24] are incorporated by reference into SE terms of use, which are service agreements "agreed" to by users by mere use of the companies services. For example: "2.1 In order to use the Services, you must firstly agree to the Terms. You may not use the Services if you do not accept the Terms. 2.2 You can accept the Terms by: (A) clicking to accept or agree to the Terms….., or (B) by actually using the Services. In this case, you understand and agree that Google will treat your use of the Services as acceptance of the Terms from that point onwards." Thus, users are held to have read and consented to privacy policy. In addition certain SE also reserve the right to modify and amend their agreements at any time and without notice.

As privacy policies of different SE are concerned, we can conclude that even if a user finds a satisfactory privacy

policy, he should be wary of relying on the SE providers promise to protect his rights. The fact that privacy policies and terms of use do not appear on SE`s homepage it casts a shadow over their enforceability. As a broader contractual issues related we can establish that the user acceptance of terms of use is inferred from use of the site.
To be complete and detailed as possible the privacy policies should include fundamental principles of data protection legislation. One of the fundamental elements of the protection of privacy of individuals are data subjects rights of access or deletion included in Articles 12 (Right of Access), 13 (Exceptions and Restrictions) and 14 (The data subject`s right to object) of the Data Protection Directive.

3. APLICABILITY OF EU DATA PROTECTION LEGISLATION

With the growing role of SE, the question arises as to where to position them in law. We can say that SE are still largely "lost in law". The European media regulation or the European regulatory framework for the communication sector have not been written with the phenomenon of the SE in mind and the applicability of legal concepts needs further testing. In the context of the Directive on Electronic Commerce (2000/31/EC) SE have been marked as a type of information society services[25], namely information location tools[26].
Data Retention Directive (2006/24/EC) does not apply to the SE because search queries are considered to be content information, not the traffic one.
SE fall under EU Data Protection Directive if there are controlling users IP addresses or search history information, and therefore have to comply with relevant provisions. Provisions also apply to controllers who have their headquarters outside the EU, but only establishment in one of the EU Member States, or who use automated equipment based in one of the Member State for the purpose of processing personal data. So essentially the only way for SE to avoid compliance with the EU provisions is to have neither offices nor hardware in EU. Which national law applies in certain case, is a matter of further analysis of the facts of the case.

3.1 Legal framework

According to Recital 2 of Data Protection Directive, "data – processing system" are design to serve man; whereas they must, whatever the nationality or residence of natural persons, respect their fundamental rights and freedoms, notably the right to privacy. SE play a crucial role as a first point of contact to access information freely on internet.
The right to privacy enjoys constitutional protection under Article 8 of the European Convention on Human Rights and under Articles 7 and 8 of the EU Charter. In general terms European privacy rules are based upon the principle that a minimum of personal data should be stored and processed and that there must exist a direct relationship between what is done with data and the reason why it has been collected. Moreover permission is required to gather data and the person involved must be able to verify and correct the information held.
One of the fundamental principles of data protection law in EU[27] is the principle of purpose specification. Under the purpose specification principle, personal data obtained for one purpose must not be used or made available for another purpose without the data subject` consent. In the EU, the purpose specification principle is based on the belief that personal data "belongs" to the data subject and may be collected and used by the user of the data (data controller), strictly for those purposes consented to by the data subject or prescribed by law.

3.2 SE as an controller of user data

On April 4., 2008 the Working Party 29, that is the EU advisory body on data protection issues, issued opinion[28] on data protection related to search engines. Mentioned opinion was long anticipated, namely the EU parliament and Working Party have openly investigated the data protection aspects of SE. The opinion sets out new specific requirements on the relationship between search engines and EU data protection legislation.

The EU Data Protection Directive regulates the processing of personal data, weather are automated or not.
"Controllers" (natural or legal person, which determine the means and purposes for processing of personal data) are responsible for compliance of this processing with the Directive. The Directive sets the criteria for making data processing legitimate. It means that the Directive specifies conditions that must be met in order to process the data legally.
Although SE typically will not collect information that directly identifies search engine users (e.g., their name and address), most SE will process search history data such as log files, IP addresses, and web cookies in the context of a particular search.
According to the Art. 29 WP, IP addresses and persistent cookies with a unique user ID constitute personal data, as they allow tracking – and hence potential identification – of search engine users. SE that process user data, including IP addresses and/or persistent cookies containing a unique identifier, therefore fall within the material scope of EU data privacy rules.

3.3 Possible legal grounds for processing personal data

The possible legal grounds for lawfully processing data are:

- prior consent of the user,
- need to execute a contract with the data subject or
- Legitimate interest of the SE.

A significant part of data processing operation undertaken by SE can be based only on the third ground (legitimate interest), which involves a trade-off between the interest of SE and the rights of data subject connected. Applied to the different purpose for which SE process personal data (service improvement, system security, fraud prevention, accounting requirements, advertising, law enforcement, statistics) the amount and extant of the personal data being processed should be as limited as possible for each of these purposes.

Although SE usually comply with law enforcement requests, these requests can not be used in advance as a reason to store massive amounts of personal data. According to the Art. 29 WP, storing large amounts of personal data may trigger authorities to submit even more access requests.

SE should also respect the rights of data subjects to access and if appropriate to correct or delete information held about them. In this relation, according to Article 12 of Data Protection Directive users must have the right to access any personal data stored about them including their past queries. The obligation to inform individuals about the processing of their data is one of the fundamental principles of the Data Protection Directive. Article 10 regulates the provision of this information where data are obtained directly from data subject. Data controllers are obliged to provide the data subject with following information:

1. the identity of controller;
2. the purpose of the processing for which the data are intended;
3. Any further information such as: the recipients of the data, whether replies to the questions are obligatory or voluntary and possible consequences of failure to reply, the existence of the right of access to and the right to rectify the data concerning him.

More important SE should make clear to users what information is collected about them and what is used for. Mainly a basic description of the use of personal information should be provided whenever it is collected.

Under art. 14(a), a data subject has a general right to object processing of their personal data weather there are compelling legitimate grounds if the basis for the processing is that it is carried out either (i) by an official authority or in the public interest or (ii) in the legitimate interests of the data controller and without overriding the fundamental rights and freedoms of the data subject. The general right to object may be excluded or extended to apply in other circumstance, by national legislation.

As data controllers, SE are obliged to ensure compliance with applicable data privacy laws. To facilitate compliance, the SE must consider guidelines, which include the following:

- the Art. 29 WP does not consider service improvement to be a legitimate ground for processing personal data that have not been anonymized;
- Compliance with law enforcement requests to hand over user data does not justify the storage of large amounts of data for that purpose only;
- Users must be informed about the processing of their data, as well as their privacy rights under applicable law. SE should provide privacy policies that are easily accessible, complete and as detailed as possible, and that mention the fundamental data protection principles;
- SE should provide the necessary means to allow users to exercise their right to access, and where appropriate, to correct or delete information held about them.

3.4 Responsibilities Under EU Data Privacy Rules

SE will be viewed as “data controllers,” responsible for ensuring compliance with EU data privacy rules, to the extent that they determine the purposes and the means of the data processing. The report from the Art. 29 WP said SE had “insufficiently explained” why they were storing and processing personal data to their users.

As a basic principle of EU data protection legislation, personal data should not be stored longer than necessary for the specific purpose for witch it is being processed. After this period it should be deleted or irreversibly anonymized. Although some of the SE reduce their retention periods in 2007 to 18 months in order to mitigate the concerns of WP, the mentioned body now considers that retention period should not generally amount to more then six months. In case SE would like to retain personal data longer then six months, they must demonstrate comprehensively that such is strictly necessary.

SE must delete or anonymise personal once they are no longer necessary for the purpose for witch they were collected.

SE must give users clear and intelligible information about their identity and location and about the data they intend to collect, store or transmit, as well as the purpose for witch they are collected.

The consent of the users is expected in the case of enrichment of user profiles with data not provided by users.

4. CONCLUSION

Although opinions of the Art. 29 WP are not legally binding, they often become the “EU standard,” and therefore are highly influential in shaping EU policy as well as Member State implementation in the privacy field. As the general principles of EU data protection legislation are merely applied to the specific situation of SE, there are several new specific requirements that need to be taken into account by SE. As SE gain much attention from EU data protection authorities, we can expect that fundamental questions will also be solved in a user protective way.

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[28] Article 29 Data Protection Working Party, Opinion on data protection issues related to search engines, 4.4.2008, http://ec.europa.eu/justice_home/fsj/privacy/ındex_en.htm

[1] Google or Googling will be used as a methaphor. After all, »googling« is synonymous with searching on the Internet. In fact, Google is a global search engine indexes over 8 bilion web pages and 2 bilion images. In March 2007 alone, it processed over 3.8 bilion queries a second, making it marked leader with almost 54% of all searches conducted in that period. See http://www.nielsen-netratings.com/pr/pr_070423.pdf.

[2] L. Introna& H. Nissenbaum, Shaping the Web: Why the Politics of Search Engines Matters, The Information Society, 1 July 2000, vol. 16. No. 3., p. 169-185, http://www.nyu.edu/projects/nissenbaum/papers/searchengines.pdf.

[3] Economist Special Briefing, Inside the Googleplex, Economist, http://www.economist.com/displaystory.cfm?storyid=9719610 .

[4] O. Tene, What Google Knows: Privacy and Internet Search Engines, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1021490.

[5] SE generate income mainley from advertising. If we take Google as an example, it generates 96% of its income from advertising. Google reveails that in its business model there is no direct link between the search result and advertisement. But in order to place relevant advertisements the results of search requests have to be linked to them. See S. Nikoltchev, Search Engines: Seek and Ye Shall Find? The Position of Search Engines in Law, availabe at: http://www.obs.coe.int/oea_publ/iris/iris_plus/iplus2_2006.pdf.en.

[6] D. Sullivan, Search Engine Watch, comScore Media Metrix Search Engines Ratings, 2006, available at http://searchenginewatch.com/showPage.html?page=2156431.

[7] But there have been sevaral instances of Google interfirence with search results – see Search King, Inc. V. Google Tech., Inc., 2003; finding that Google as defendant purposely decreased web side ranking of Search King by driving the actual Search King web site to the bottom of the ranking for a quary of »Search King«.«.

[8] Google claims that »There is no human involment or manipulation of results, witch is way users have came to trust Google as source of objective inforation untained by paid placement,« available at http://www.google.com/corporate/tech.html.

[9] iProspect Search Engine User Behavior Study key findings have shown that 62% of search engine users click on results within the first page of search results.

[10] »Increasingly, people are exposing personal inforamtion about themselves and others online... These fragments of inforamtion won`t fade away with time, and they can readily be located by any curious individual.« see, Daniel J. Solove, The Virtues of Knowing Less: Justifying Privacy protections Against Disclousure.

[11] See, What is Googles reputation score? A Method for Modified Self-Regulation of Search, J.M.Mercadante, availabe at http://ssrn.com/abstract=1118557.

[12] As demonstrated by the New York Times in the AOL case (see Michael Barbaro & Tom Zeller, *A Face Is Exposed for AOL Searcher No. 4417749*, NY TIMES, Aug. 9, 2006) even thoroughly anonymized search logs can be traced back to their originating user. This can be done by combing search queries for personal identifiers, such as a social security numbers or credit card details. It becomes simpler yet by the tendency of users to run "ego searches" (also known as "vanity searches" or "egosurfing"), the practice of searching for one's own name on Google (once, twice, or many times per day) – see Egosurfing, WIKIPEDIA, available at http://en.wikipedia.org/wiki/Egosurfing.

[13] A SE could harm a user through disclosure, breach of cofidentiality , exposure, identification, secondary use, aggreegation, surveillance. See J. Grimmelmann, The structure of Search Engine Law, Iova Law Review, vol. 93, no. 1, p. 18.

[14] Article 2(a) of Directive 95/46/EC of the Europen Parliament and the Council of 24 October 1995 on the protection on individuals with regard to the processing of personal data and on the free movment on such data, 1995 O.J. (L 281) 31, (herainafter Data Protection Directive).

[15] 57% of internet users in a survery conducted in US are not wary about their privacy and the prospect that SE might track searchers` moves. D. Fallows, Search engine users, PEW Internet&American life project, 2005, available at: http://www.pewinternet.org/pdfs/PIP_Searchengine_users.pdf

[16] Web transaction logs follow standard format and usually contain at least following fields: 1. time of the day (hours, minutes,seconds), 2. User identification (IP), 3. Query: terms entered by the user, 4. Result page: a code represanting a set of URLs and result abstracts returned by Web-search engine in response to a query. See B.J. Jansen, A. Spink, How are we searcinh the World Wide Web? A comparison of nine search engine transaction logs, Inforamtion Processing and Management 42 (2006), p. 254.

[17] P. Church, G. Kon, Google at the hart of data protection storm, Computer Law&Security Report, No. 23 (2007), p. 462.

[18] Article 29 of the EU Directive establishes a "Working Party on the Protection of Individuals with regard to the processing of Personal Data". It is generally known as the "Article 29 Working Party". It is made up of a representative from the data protection authority of each EU Member State (including the Irish Data Protection Commissioner), the European Data Protection Supervisor and the EU Commission. The Working Party is independent and acts in an advisory capacity. The Working Party seeks to harmonise the application of data protection rules throughout the EU.

[19] The Google privacy policy states: » When you visit Google, we send one or more cookies – a small file containing a string of characters – to your computer that uniquely identifies your browser. We use cookies to improve the quality of our service by storing user preferences and tracking user trends, such as how people search. Google also uses cookies in its advertising services to help advertisers and publishers serve and manage ads across the web. We may set a cookie in your browser when you visit a website and view or click on an ad supported by Google's advertising services.

[20] This is certainly the view of the Slovenian Information Commissioner.

[21] Google at the heart of data protection storm,ibid, p. 464; S. Buresh, Personalized Search - All's Well or Orwell?, available at: http://www.isedb.com/db/articles/1694/1/Personalized-Search---Alls-Well-or-Orwell/Page1.html; J. Engle Buyer Beware, eBay Security Chief Turns Website Into Arm of the Law, available at: http://www.thenation.com/doc/20030707/engle.

[22] See A. Broach, Google to hand over Brazilian user data, CNET News, 2006, http://news.cnet.com/8301-10784_3-6112176-7.html.

[23] A. Büllesbach, Y. Poullet,C. Prins: Concise European IT Law, Kluwer Law International, 2006, p. 47.

[24] See Google Privacy Policy; Yahoo!Privacy policy; Microsoft Online Privacy Statement.

[25] SE are in Europen legislation considered on Information society services, defined in article 2 of Directive 2000/31/EC.

[26] See Article 21.2 in connection with Recital 18 of Directive on Electronic Commerec (2000/31/EC).

[27] Article 6(1)(B) of the EU Data Protection Directive, which provides that personl data must be »collected for specified, explicit and legitimate purposes and not further processed in a way incompatible with those purpose.«

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TOWARDS SEAMLESS COLLABORATION IN DISTRIBUTED DISASTER KNOWLEDGE MANAGEMENT

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ABSTRACT

Despite technological advances, the interoperability of the information and decision support systems of the various parties of the emergency and crisis management community remains a difficult task. In order to develop a service-oriented architecture framework and advanced process modeling and simulation procedures for the Finnish emergency management community, a two-year project called SSMC/DDKM (Seamless Services and Mobile Connectivity in Distributed Disaster Knowledge Management) was established by the Pori unit of the Tampere University of Technology at the beginning of 2008. This paper describes the project consortium, the target group and results from the first interviews arranged in early 2008. The preliminary results show that the challenges and issues can be related to current practices, the availability or quality of data, Finnish law or attitudes and to technical issues related to the transfer of information.

1 INTRODUCTION

Several different authorities take part in the management of accident and disaster situations. Their ability to utilize existing knowledge concerning disasters – historical data, status information at the time of the incident, received knowledge relating to similar incidents – is of great importance for the effective management of disaster situations. In particular, major accidents and natural disasters demand seamless collaboration between the authorities and the opportunity to utilize the available data on both the incident itself and on other similar accidents. In disaster situations, where often human lives are at stake, the appropriate information must be in the right place, at the right time and with the right person. The data required in the information age is scattered in different databases, registers and public data sources, so there is a need to generate a comprehensive incident awareness through combining data retrieval and technologies. Even in smaller and local accidents, the information available from one source would be helpful in solving a problem in another context [1]. Some related research projects in these topics include REACT (Reaction to Emergency Alerts using voice and Clustering Technologies) [2], ORC (Orchestra) [3] and WIN (Wide Information Network) [4] Integrated Project (EU FP6 Call 2 DG IST).

However, in practice, the information is in many cases bound to the context, which makes the effective use of the information difficult Moreover, some other issues have also been observed such as the low level of interoperability between the systems managing the available information, and also the constraints for safety reasons on the distribution and availability of the information concerned. One main assumption was that problems in this case are more organizational (interfaces between authorities) than technical (interfaces between information systems). Previous studies have shown that successful networking and collaboration with other organizations demands great openness, which is not necessarily easy for every organization [5],[6], especially if it concerns the power of an authority. It is well known that trust and openness are some of the most important elements when it is a matter of information or knowledge sharing between individuals as well as organizations [7]. Previous research has shown that people do not share knowledge with those they do not trust and if people do not trust each other, they do not give their best efforts to the collaboration [8]. This same phenomenon is also recognized at organizational level. This is important to know when examining the issues and problems related to information transfer across organizational borders.

This paper investigates the factors that may cause the problems in interoperability in information transfer between authorities. The context is information transfer related to disaster situations and here we present and analyze the results from interviews, concentrating on the information captured related to the needs, challenges and problems recognized in this sector from the sample of Finnish authorities.

2 BACKGROUND

2.1 SSMC/DDKM – the project

The starting point of this study is the ongoing SSMC/DDKM (Seamless Services and Mobile Connectivity in Distributed Disaster Knowledge Management) research project, coordinated by the Tampere University of

Technology (TUT) [9]. The general goal of this two-year research project is to study and develop the methods, processes and technologies to support improved knowledge management in disasters and accidents. The ability to build a reliable situational model based on the history and current knowledge of the situation, and good practices concerning comparable accidents/disasters are important in minimizing the consequences of the accident. In addition, the synthesis of knowledge collected from different sources provides an opportunity to support proactivity: pre-accident warning systems can be activated and the relevant information distributed to the people in the disaster area. It is also possible to prepare an organization (the police, army, fire brigade, etc.) to be able to react in the correct way and with a short response time in the case that the expected disaster does occur. Related research has been carried out by e.g. Zettsu & Kiyoki [10], Zettsu et al. [11] and Jaakkola [12].

However, several problems can be recognized in practice. First of all, the incompatibility of the legacy systems of the authorities, as well as the low level of interoperability between them does not support the beneficial use of existing data, which is scattered in different information systems. Even when technically separate systems are networked with each other, their ability to benefit from the data in other systems is deficient. In addition to the knowledge in the legacy systems, there is a lot of publicly available "communal" data, which would be beneficial to support proactivity and reactivity in the case of disasters. These issues described above form the research issues that we are trying to examine and solve with this research project. The project is funded 70% by Tekes (the Finnish Funding Agency for Technology and Innovation) [13] and 30% by a consortium consisting of two Finnish ICT companies and the Finnish Emergency Response Centre Agency.

2.2 Scope of the project and participating organizations

The SSMC/DDKM project includes two dimensions: *international* and *national*. The project is based on international research co-operation between several organizations. The leading forces are NICT (National Research Institute on Information and Communication Technology) and Keio University (SFC) in Japan. The Japanese project has been given government financing for a 5-year period. The goal of this international part is to develop a distributed disaster knowledge management system, which supports the connectivity of separate knowledge sources [14],[15]. The platform is a GRID-based system with a central knowledge node analyzing the situational data and finding "solutions" from the distributed disaster knowledge base. NICT and Keio have activated co-operation with some European partners: the Tampere University of Technology (Pori), the VSB Technical University in Ostrava (Czech Republic) and the Christian Albrechts University in Kiel (Germany). All the research partners are co-operating and have their own sub-projects, like SSMC/DDKM in TUT, working towards the common goal.

At national level the participant organizations can be divided into three separate groups:

Realizer organizations are: the Tampere University of Technology (TUT) and the Emergency Services College (ESC) [16] (which are also part of the authority group).

Authority organizations are: the Ministry of the Interior (emergency management), the Prime Minister's Office (coordination of status reports), the Ministry of Justice (Accident Investigation Board), the Ministry for Foreign Affairs (consular unit), the Emergency Response Centre Agency and the Police College of Finland.

Corporate partners are: Nokia Corporation, DNA Ltd, Lociga Ltd and Birdstep Technology Ltd.

In the national dimension the project focuses on investigating current collaboration – taking into account both technical and social aspects – in accident and disaster situations between the Finnish authorities who are responsible for producing, disseminating and utilizing information in these situations. More specific objectives in the research at national level are:

- to investigate possibilities for developing a flexible and open *reference architecture* (based on Service Oriented Architecture) for Finnish authorities to enhance collaboration between their current information management systems
- to investigate and develop *methods and models* which enable the description of information related to accidents and disasters and also disaster situations
- to investigate and expand the possibilities for utilizing *mobile technology* to supply disaster information

At the beginning of the project, in the preliminary study phase a series of interviews were carried out in a sample consisting of the participating *authority organizations*. The target group selected within these organizations was made up of persons who had experience, knowledge and understanding of information transmission during a disaster situation and those responsible for information transfer operations in practice. These activities generally come under the job description of senior managers or senior experts in the government authorities, and these are precisely the people who were interviewed in this project. The aim of these interviews was firstly to ensure the relevance of the research theme, secondly to test the validity of the hypothesis - that there are problems in interoperability between the authorities and their current information systems - and thirdly to get opinions and viewpoints from the authorities as to the direction the research should take in future. The next section highlights some general observations on the results of the interviews made during the preliminary study.

3 THE AUTHORITIES INTERVIEWED AND CHALLENGES IDENTIFIED IN RELATION TO INFORMATION SHARING

The challenges identified in this chapter are based on the interviews made for the preliminary study phase of the SSMC/DDKM project. The interviews with the authority organizations were arranged at the beginning of the project, in early 2008. The next section briefly describes the operating environment of the organization in question and the main observations related to the research theme which came up during the interviews.

3.1 Participating authority organizations and their viewpoints on collaborative information transfer

Emergency Services College

The *Emergency Services College* (ESC) arranges basic and advanced education and training in fire and rescue work, civil defence training and other training in emergency operations in Finland. The ESC is involved in the research and development functions in the field. The College is also responsible for maintaining the assignment register of the rescue services (PRONTO) and the central library of the rescue field Emergency Services [17].

According to the research manager (Interview 30.01.2008), there have sometimes been problems with the delegation of power. The problems are usually related to the quantity and quality of the information to be transferred. One particularly challenging area is the delegation of power from rescue and/or police authorities to environmental authorities. An illustrative sentence from an ESC officer: "During emergency situations, some signals and events announce changes in the situation that may create unexpected difficulties if they are not detected, analysed and processed in due time. Detection of such weak signals is a key factor in turning emergency situations into crises" [17].

Emergency Response Centre Administration

The *Emergency Response Centre Administration* (ERCAd), managed and directed by the Ministry of the Interior in co-operation with the Ministry of Social Affairs and Health, was set up at the beginning of 2001 to handle emergency response centre activities in Finland. The Emergency Response Centre Administration consists of the administrative unit, the *Emergency Response Centre Agency* (ERCAg), and 15 *Emergency Response Centres* (ERCs). The Emergency Response Centre Agency creates the preconditions for the successful operation of the ERC administration, enhancing and developing ERC operations. The nationwide ERC reform implemented in Finland from 2001 to 2005 involved combining the municipal emergency response centres of the rescue services and the emergency call centres of the police, which used to function as separate units, into a state-run organisation of 15 ERCs. In addition to this, the ERC Administration works in co-operation with the emergency centre of the Åland islands.

Finnish citizens and visitors to Finland can now obtain help using a single emergency number, 112, whether they need urgent assistance from the police, rescue, ambulance or social services. This operating model differs from the operating models in most countries, in that the ERC operators can directly alert all the necessary authorities. This means that the call no longer has to be forwarded, which saves time in case of emergency - e.g. in major accidents and other tasks requiring help from several authorities, they are all alerted at the same time from the same location. The one emergency number principle is still rare in ERCs elsewhere around the world. [18]

According to the officers in ERC (Interview 07.02.2008), one of the biggest problems during the management of an incident or disaster is to get enough information to the ERC. The concepts may differ among authorities and it is crucial to have a common positioning system in incidents requiring a location service. They are also very interested in getting good information on the processes in the field. Furthermore, the description of processes should be made in close co-operation with other authorities. The laws of privacy protection also hinder ERC officers from passing private information about e.g. criminal behaviour or mental disorder to rescuers.

Police College of Finland

The *Police College of Finland* (PCoF) is responsible for recruitment for police training, student selection, diploma and advanced studies, leadership training, further training, and research and development in the police field. [19]

According to the PCoF, there are problems in information-sharing among authorities (Interview 13.02.2008). The performance of the Terrestrial Trunked Radio (TETRA) - based digital authority network (VIRVE) - which is commonly used by Finnish authorities – is currently unsuitable for appropriate data relay. The current situational view of an emergency is formulated on the basis of only voice and fax mails, so there is a window of opportunity here for a new system based on e.g. service oriented architecture (SOA). They also saw a need for harmonising concepts among authorities. The police authorities must also be able to use many different systems so they also have to learn many different systems. Usability and the easiness-to-learn of a system are thus very important factors for them.

Prime Minister's Office

The *Prime Minister's Office* (PMO) is one of the twelve ministries that form the Finnish Government. It is responsible for the planning of social policy legislation that does not fall within the competence of any other ministry. The PMO is charged with Government security services, compilation of a security-related situation picture (i.e. situational awareness) and provision for emergency situations within the ministries. A prognostic and real-time situation picture is compiled by the PMO to support Government decision-making and communications. The situation picture is developed by taking into account and utilizing the authorities' other pre-existing or future IT environments. Cooperation and planning that serves the compilation of the situation picture is being improved among the different sectors of administration. Cooperation between the gathering of information, the compiling of the situation picture and communications is being intensified and tested. The Government's 24-hour on-call and alert system has been developed. The range of instruments for gathering information has been widened by, for instance, developing the monitoring of open information sources. National structures may tap into the cooperation with the EU's Situation Centre (SitCen). [20].

According to the PMO officers, they are currently well prepared to manage predefined incidents. They have over 60 predefined processes for special situations. The PMO is moving from a "what has happened" phase to a "rapid analysis" phase. They regard the main challenge of information management in crisis and emergencies as being often the local domain. On the other hand, the information flows between ministries have not yet been described or modeled (Interview 26.02.2008).

Consular Services

The *Consular Services* is part of the Ministry for Foreign Affairs. One of its duties is to provide quick, efficient and professional assistance to Finns in distress abroad and foreign people living in Finland permanently. Among other things it has an updated crisis centre and consular Rapid Deployment teams, missions abroad, contingency plans, improved dialogue with interest groups (travel branch), EU cooperation, increased cooperation between capitals and missions in third countries, Nordic and crisis cooperation. All operations are based on a crisis management model and the "Strategy for Securing Functions Vital to Society". [17],[21].

According to Consular Services, their situational awareness system lacks an overall view. They also have a lot of guidelines and instructions which stresses heavily the officers in the crisis centre, in the Rapid Deployment teams and in missions abroad. The use of information from the civil register is often difficult due to the laws of privacy protection (Interview 26.02.2008).

Accident Investigation Board

In Finland the *Accident Investigation Board* (AIB) investigates all major accidents regardless of their nature as well as all aviation, maritime and rail accidents and incidents. The purpose of the investigation of accidents is to improve safety and prevent future accidents. The flow of events during the accident, its causes and results as well as the rescue operation are dealt with in the investigation and a report is prepared based on the results. The report also presents recommendations, which are based on the conclusions of the investigation. All reports are written in Finnish with English summaries. An English version is prepared of important reports. In addition, the AIB takes care of the readiness to conduct investigations and of the development of accident investigation methods. The training of investigators, the preparation of guidelines for the process of investigation, publication of the reports and international cooperation are handled by the Board. In Finland the Accident Investigation Board is located within the Ministry of Justice. [22].

According to the AIB, the formulation of situational awareness has in some cases been too slow. It is typical in such cases that there have been insufficient rescue resources. There have also been problems with communication to hospitals and sometimes to the media (Interview 03.03.2008).

3.2. Summary of the interviews

Most of the interviewed authorities had seen problems related to situational awareness. Some aspects of situational awareness were either lacking or were formulated too slowly. Some of the inter-organizational communication problems related to differences between the organizational processes and some related to semantic differences between concepts (slightly different meanings). In brief

- Issues related to current practices (processes)
- Issues related to data (availability, amount, quality)
- Issues related to Finnish law or attitudes (e.g. openness)
- Technical issues related to transfer of information

One reason for these information transfer-related problems may be the change in the disaster management life cycle from response phase to recovery phase. It may be because the nature of the work to be done in the recovery phase [23] is mainly very different to those activities needed in the acute and often extremely hectic response phase. The response phase is usually the most imposing phase in emergency management and may thus obscure the more routine-like functions located in the recovery, prevention, mitigation and preparation phases [23]. We hope to be able to elaborate on this phenomenon more deeply later in our research project.

4 CONCLUSION

This paper deals with information management between authority organizations in disaster situations. The basis of this study is an ongoing research project (SSMC/DDKM) with the aim of studying and developing the methods, processes and technologies to support improved knowledge management in disasters and accidents. The focus here was to investigate the authorities' opinions on the current status of interoperability between the organizations in question in disaster situations. Interviews were used to find out and identify the potential challenges and problems in current practice. From the results of the preliminary study we are able to see that there are indeed various problems of interoperability in this context. To summarize, the challenges and issues are related to current practices in information sharing, the availability or quality of the data, the Finnish law or attitudes and also technical issues with regard to the transfer of information. The observations made in this study point to the issues on which the investigation needs to be directed in the rest of the research project. Ongoing research work is focusing on examining the utilization of business process models for describing information transfer and standardizing the concepts used in disaster information in authority organizations.

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DISTRIBUTED MOBILE AGENT WORKFLOW - ACTIVITY COORDINATION CONSTRUCTS IN WORKFLOW PROCESS GRAPHS

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ABSTRACT

Workers, Inc., a workflow management system implemented using Java technology and mobile agents, is especially suited for highly distributed and heterogeneous environments. In this paper, potentially problematic substructures of agents' itineraries will be discussed. Some of them are known to be common problems in the workflow domain, while others are specific to our system.

1 INTRODUCTION

The usage of mobile agents [3] in modeling and implementation of a workflow [5] simplifies the workflow management. The proposed system consists of individual agents with autonomous behavior. Mobile agents carrying out workflow instances (the so-called workers) are able to move to different users, where they can interact with them locally, and to autonomously take care of their current position, state, and further itinerary. In order to achieve the flow of work, workers split the work in logical parts, cooperate together, and synchronize themselves.

However, in the proposed system, new agent classes describing brand-new workflows had to be hard-coded manually. In order to employ the workflow system in a real working environment, end-users of the workflow system should be enabled to create brand-new worker classes.

This goal could be achieved by the means of a declarative language, which can be used for describing workflow definitions. Moreover, a software tool, which would enable the visual definition of a new worker, could be used for process modeling while extracting the necessary data. Without these facilities, the usage of the system by end-users would require substantial support from programmers.

The Workflow Management Coalition (WfMC) developed and proposed XML Process Definition Language (XPDL) [6] with the intention for it to become a common language in the workflow domain considering the definition and exchange of process definitions. The language allows for the import and export of process definitions between a variety of tools ranging from workflow management systems to modeling and simulation tools.

By adopting the proposed standardized language (XPDL), our system becomes capable not only to use a number of existing graphical workflow editors, but also to exchange process definitions with various other workflow products.

In order to comply with XPDL, the system had to be modified to conform to the basic constructs of XPDL and the underlying meta-model. The structure of workers' itineraries (previously supporting only sequential routing) was adapted to support more refined control-flow patterns, like parallel routing, alternative paths, or iterations. The system which developed in such a way has been named Workers, Inc. to emphasize the collaborative nature of agents.

Moreover, a system-specific import layer had to be provided to allow the translation of process definitions, generated using a visual modeling tool, into worker execution contexts, their internal system representations.

2 SYSTEM ARCHITECTURE

Workers, Inc. is envisioned as a community of cooperative agents, its main characteristics being full decentralization and distribution of workflow functions. The current architecture is essentially two-part, consisting of work-agents (workers) and host-agents (worker hosts).

2.1 Workers

A worker is the key system component encapsulating both the process definition and the execution state of a workflow. While performing a workflow, a worker itinerates among distributed resources carrying process-specific information and autonomously taking care of its execution state. In that way, workers manage not only to perform workflow activities locally with respect to assigned resources, but to avoid the need to consult a central server or the originating machine at every step.

A worker's behavior is entirely defined by its execution context. A worker context is an executable process definition, a worker being just a medium through which its context is transmitted and accomplished. When a worker migrates, its entire execution context as an object net is being encompassed by object serialization, and then transported and reconstructed at the target location.

The most important part of a context is the worker itinerary, which represents a flow of a worker through a network. By representing itineraries with directed graphs we are able to represent complex flow patterns that could be needed by workflow applications.

To allow concurrent activity execution, agent social abilities are employed. When a single thread of control needs to split into two or more threads, which can be executed in parallel, the worker context is cloned and multiple worker instances are allowed to be executed simultaneously. On the other hand, when multiple parallel threads of execution need to converge into a single thread, agent coordination mechanisms and synchronization techniques are employed.

To strengthen security of the system, Mole mobile agents and thus workers are forbidden to access any system resources directly. Critical resources can be accessed only by communicating with system agents, i.e. worker-hosts.

2.2 Worker Hosts

Every node in the network contains a worker host, which is implemented as a stationary system agent, having special privileges for the access to host system resources. A worker host is a passive entity, which spends most of its lifetime receiving requests from workers or users and coordinating their actions. There are three main subcomponents of a worker host: an application manager, a participant manager, and a user interface.

3 EXECUTION CONTEXTS

The design of an execution context is done so as to comply with the workflow meta-model specification [6]. From the control-flow perspective, the itinerary is the most important part of a context.

3.1 Itinerary

The itinerary has the structure of an arbitrary complex directed graph, where vertices of the graph represent process activities, and edges of the graph correspond to process transitions.

An activity is the smallest, atomic unit of work in a business process. The three main properties of an activity specification, which can be seen as answers to the accompanied questions, are:

- Performer assignment (Where?) – It specifies the performer of the activity. In the process of workflow participant resolution, the actual location of a participant is determined. By evaluating a performer expression, a worker knows where its activity needs to be carried out, and will transfer itself over the network accordingly.
- Implementation specification (What?) – It specifies what the concrete realization of the activity is. It can be a call to a declared application, another workflow process, or an embedded activity set. Also, the activity may have no implementation at all, in which case it supports complex flow transitions or manually performed activities.
- Automation modes (How?) – Information on whether the activity is to be started / finished manually by the user or automatically by the worker itself.

Transitions connect individual activities. A transition may contain a condition which must be fulfilled for the worker to start performing the target activity. If the performer assigned to the target activity is different than the one of the source activity, the worker will first transfer itself to the appropriate node in the network, before it actually starts the activity.

3.2 Transition Restrictions

Transition restrictions of an activity specify how a worker should operate when encountered with multiple incoming or outgoing transitions of the activity. When faced with multiple outgoing transitions, a worker can take one, several, or all of the encountered paths, depending on the split type of the activity and the conditions associated with the outgoing transitions. On the other hand, when an activity has multiple incoming transitions, worker should know whether to start the activity immediately or to wait for the other active flows to complete, depending on the join type of the activity.

Any transition restriction, whether split or join, may be of one of the three differed types:

1) XOR – alternative paths (only one path is taken)
2) AND – concurrent paths (all paths are taken)
3) OR – alternative paths with the potential of concurrency (several paths are taken, ranging from one to all)

Split points generating multiple concurrent threads are achieved by cloning a worker context into the appropriate number of copies, and by creating the same number of separate workers to carry and interpret those copies.

On the other hand, join points that involve convergence of multiple threads are achieved with the mediation of a worker host. A worker host keeps a collection of synchronizing objects of all concurrent joins currently occurring at its node. When encountered with such a join activity, a worker asks the local worker host for a synchronizing object. If no appropriate synchronizing object is found at the host, the new one is created containing a reference to the requesting worker. When the synchronizing object is returned to the worker, it will know (based on the reference) that it is the first one arrived in its group, and it will block itself and wait. Every other worker from the same group arriving at the node will get the synchronizing object that is already created and that references the firstly arrived worker. The subsequently arrived worker will hand over its context for the data consolidation to the worker referenced from the synchronizing object, and afterwards it will dispose itself of. When the last worker (counted by the number of incoming transitions of the activity) is over, the firstly arrived continues by executing the activity.

The identifier of the synchronizing object is composed of the process instance identifier plus the join activity identifier. In that way it is guaranteed that at the same time

another concurrent join of the same process instance is allowed to take effect at the same node.
Supporting concurrent join points has a necessary precondition: all merging workers must meet at the same node. This subject is directly related to the mechanism used for participant resolution. When participant locations are resolved in process initialization phase (as is the case in the current implementation), it is not an issue. If participant locations were evaluated dynamically during run time, it would become an issue raised by the same concurrency problems that apply to process relevant data consolidation.

4 XPDL COMPILER

XPDL Compiler for Workers, Inc. takes an XPDL source code as its input, and produces appropriate context classes needed by workers to carry out defined processes.
Once the system has been made compliant to the workflow meta-model, the translation itself becomes a routine. Every XPDL element is translated into a block of Java code, in which the corresponding context member is constructed and associated with the appropriate context.
The compiler works through three phases:

- Parsing the XPDL document using Java API for XML Processing (JAXP). The XPDL source is validated against the XPDL schema for well-formedness, and a DOM tree is built.
- Code generating for appropriate context classes. By traversing the DOM tree, the Java source code for the adequate number of context classes is generated: one class for the package and one for every process within the package. Process graphs are checked for correctness, and local methods are incorporated in the appropriate context classes.
- Running Java compiler to produce Java bytecode.

The use of the XPDL compiler is required as the intermediate step between the modeling tool, which provides the XPDL process definition, and the actual process invocation in Workers, Inc.

4.1 Checking Graph Structure

According to the workflow meta-model of the XPDL specification 1.0, there are three conformance classes restricting the activity-transition net of a workflow process:

- NON-BLOCKED – No restrictions are imposed on the graph structure.
- LOOP-BLOCKED – The activities and transitions of a process definition form an acyclic graph.
- FULL-BLOCKED – For each join (or respectively split) there is exactly one corresponding split (or respectively join) of the same kind. In an AND split no conditions are permitted (OR-split semantics is disabled). Loops are not allowed.

Process graphs of the full-blocked conformance class are fully compliant with the mechanisms used for workers' coordination and synchronization. However, with such a definition, the full-blocked class does not provide enough expressive power, while a number of graphs belonging to wider conformance classes may impose unexpected behavior during run time.
The main purpose of the introduced Graph Structure Checker component is to analyze the process graph during compile time, so that potentially problematic points in the process graph can be detected prior to run time. A process definition containing problematic constructs may be rejected and asked for a revision, or the suspicious points may be marked and treated accordingly at run time.

4.2 OR-Joins (Join Points of Conditional AND-Splits)

The number of threads to be synchronized at the OR-join is dependent on the result of the transition condition evaluation of preceding OR-split(s). The fact that the system should wait for the completion of only active paths leading to the activity generally makes an OR-join the construct of the problematic semantics [7].
Some workflow management systems [5] have solved problems related to the OR-join using syntactical restrictions. It usually comprises imposing restrictions on the graph structure, requiring e.g. the workflow to be acyclic, i.e. the only way to introduce loops is by executing the entire (sub)process. Other systems [2] seem to apply a non-local semantics of an OR-join at run time. For a more complete discussion on OR-join semantics, we refer to [1, 4].
OR-constructs are currently not supported by Workers, Inc. Moreover, XPDL 1.0 does not explicitly differ them from AND-constructs (the same transition restriction attribute value is used). The only distinction is the presence of transition conditions associated with outgoing transitions of an AND-split. If we wanted to allow OR-constructs in the future, we would be faced with the following two situations.
If there is a matching OR-split, the OR-join semantics is taken to be "wait for the completion of all paths activated by the matching split". In these situations, it would be possible to incorporate the information about the number of threads created at the split point into spawned workers, and to use that information for the synchronization at the join point. However, the OR-segment would have to be full-blocked in order to provide the correct interpretation of the incorporated information.
The other situation refers to the case when a matching OR-split cannot be found in the process graph. This situation is impossible in XPDL 1.0 because OR-join cannot be explicitly specified. However, XPDL 2.0 provides explicit distinction of the two transition restriction types. If there is no matching split, there could be at least three derived interpretations of an OR-join:

- wait-for-all (treated as an unconditional AND-join),
- first-come (the first thread to arrive at the join point proceeds, while every subsequent thread is blocked – possible XOR-join semantics), and
- every-time (every thread that arrives at the join point proceeds – XOR-join semantics).

None of the above interpretations match the exact definition of an OR-join. By implementing such a behavior, the process will almost certainly not be carried out the way it supposed to. The detection of a non-blocked OR-join may lead to a process definition rejection, or alternatively it may be accepted having one of the above interpretations. One of them may be declared as the default interpretation, while other alternative interpretations may be indicated explicitly in the process graph using extended attributes.

4.3 AND-Joins without Matching Splits

In the AND-join point without a matching AND-split, an arbitrary number of threads may arrive. If there are not enough incoming threads, it may lead to the complete blocking of the graph segment following the join point. Alternatively, it may cause some threads to wait forever if the number of incoming threads is greater than but not dividable by the number of incoming transitions.

AND-joins without their matching splits represent a common problem, and are usually considered as the responsibility of a workflow modeler. As such, these constructs are allowed in Workers, Inc, and they are not detected by the graph checker.

4.4 AND-Joins with Matching Splits

Even if they have matching splits, AND-joins may produce unexpected behavior in cases when more than one collection of workers is allowed to arrive at the join point. The problem is specific to Workers, Inc., and pertains to the synchronization mechanism used at AND-join activities.

If a blocked AND-segment is to be itinerated by multiple threads, every incoming thread will spawn one collection of workers to carry out concurrent activities. Since the identifier of the synchronizing object is composed of the process instance identifier plus the AND-join activity identifier, at the join point, workers cannot determine if they all belong to the same collection, i.e. if they all originate from the same parent. This phenomenon may occur in blocked AND-segments following:

- non-blocked XOR-joins that may be itinerated by concurrent threads, or
- conditional or unconditional AND-splits figuring inside a loop with outgoing transitions that lead outside of the loop.

Coping with the problem, we can disable this possibility by rejecting problematic graph substructures, or we can assign an additional thread counter to all the workers originating from a single incoming thread of control. Whichever solution taken, it will require the detection of the problematic subgraphs using some standard techniques that can be found in elementary graph theory.

The detection of the problematic graph substructures is performed by traversing the process graph using the Depth-First Search algorithm and by classifying all of its edges.

- Non-blocked XOR-joins with incoming forward or cross edges are easily detected. Incoming back edges do not impose a treat in this case because they indicate loops.
- Every loop that potentially contains problematic AND-splits (with transitions that point outside of the loop) also has to be checked. Loops are detected by finding all the back edges and strongly connected components of the process graph.

5 CONCLUSION AND FUTURE WORK

XPDL 2.0 redefines graph conformance classes:

- NON-BLOCKED – There is no restriction on the network structure.
- LOOP-BLOCKED – The network structure is restricted to proper nesting of loops.
- FULL-BLOCKED – The network structure is restricted to proper nesting of splits/joins and loops.

Using the above definitions we could declare conformance only for process graphs containing properly nested splits/joins and loops.

XPDL 2.0 also introduces the notion of "loop activities" allowing the activity to be repeated several times. There are even two types of loop activities: Standard (having a boolean expression that is evaluated after each iteration of the loop) and Multi-Instance (having a numeric expression evaluated only once before the activity is performed).

By using loop activities, the graph checker may even force process graphs to be acyclic. Such an approach may be justified by the analogy with the experience gained in structured programming: there is no need for a GOTO command as long as there are IF-THEN-ELSE and DO-UNTIL constructs (equating, at that, the concept of a back-edge transition with the GOTO command).

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USER TRACKING FOR INDIVIDUALIZING PERSONAL LEARNING ENVIRONMENTS

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ABSTRACT

Tracking user data is a central basis for an automated user-centric personalization of IT-based learning environments. This paper explores the eligibility of already existing user tracking facilities of moodle and how these data can be used for personalization purposes.

During the last years eLearning initiatives were established in universities and enterprises as well. There was a shift towards personal learning and thus personal learning environments had to be provided. But existing personal learning environments are not aware of the specific needs of a user regarding the individual learning or working style.

The first part of the paper provides the necessary theoretical background of system supported personalization in eLearning environments. It is argued that tracking the user's activities is the central basis for personalization.

The already integrated user tracking facilities of moodle, a widely used eLearning platform, were examined in order to analyze their possibility to be used as a basis for an automated user-centric personalization. The results are presented in the second part of this paper. At the end a conclusion and an outlook are given.

1 INTRODUCTION

ELearning focuses on the transfer of existing knowledge that has been produced according to educational principles and goals. This content provided in eLearning management systems is usually static and it can hardly be adapted to current requirements.

From a constructivist point of view learning focuses on the learning process by looking at the construction of knowledge by an individual. Learning is not seen as a transmission of content and knowledge to a passive learner. Constructivism views learning as an active and constructive process which is based on the current understanding of the learner. Learning is embedded in a social context and a certain situation.

Due to the importance of personal learning for organizational learning, personal learning environments have been developed in order to cope with the specific needs of learners. For the further improvement these IT-based learning environments some efforts have been taken to personalize the learning environment to the specific needs and working styles of the user

Tracking the user's activities, when using the system, is the basis for an automated personalization. The learning platform moodle, one of the most widely used systems, has been selected to examine the usage of the available user data for personalization.

2 THEORETICAL BACKGROUNDS

This section describes the theoretical background required for the following empirical study, especially the areas of personal learning environments and user tracking are discussed.

2.1 Personal Learning as a Basis for Organizational Learning

Kim [3] states that "the importance of individual learning for organizational learning is at once obvious and subtle – obvious because all organizations are composed of individuals; subtle because organizations can learn independent of any specific individual but not independent of all individuals."

He defines individual learning "as increasing one's capacity to take effective action" [3]. Hence, theories of individual learning are crucial to understanding organizational learning.

There are a lot of theories on organizational learning that are based on individual learning [5, 9, 2]. “However, if a distinction between organization and individual is not made explicit, a model for organizational learning will either obscure the actual learning process by ignoring the role of the individual (and anthropomorphizing organizations) or become a simplistic extension of individual learning by glossing over organizational complexities” [4].

Also Siemens [10, 11], who coined the term “connectivism” argues that organizational and personal learning are integrated tasks. Personal knowledge is comprised of a network, which feeds into organizations and institutions, which in turn feed back into the network und continue to provide learning for the individual. Connectivism attempts to provide an understanding of how both learners and organizations learn.

Thus it is important to provide systems that offer all possibilities of setting up a personal learning environment in order to enable people to work and learn according to their individual learning style, regardless of time and space. This leads to the idea of a personal learning environment.

2.2 Personal Learning Environments

Attwell [1] writes: “The idea of a Personal Learning Environment [PLE] recognizes that learning is continuing and seeks to provide tools to support that learning. It also recognizes the role of the individual in organizing their own learning. Moreover, the pressures for a PLE are based on the idea that learning will take place in different contexts and situations and will not be provided by a single learning provider. Linked to this is an increasing recognition of the importance of informal learning.”

PLEs are personal and open learning environments and they are suitable for cross-linking contents and people. Ideally they are available for life-long-learning and integrated in the workplace. Learners can use PLEs to manage individual learning progress.
Within personal learning environments individuals have the means and capabilities to construct and maintain their personal landscapes of tools and services. They make use of networked tools and services to establish new relationships and to construct extended social networks to support their own educational projects. They take responsibility for all necessary instructional functions such as selecting and acquiring of material resources, pacing and monitoring themselves, establishing criteria of evaluation, generating feedback, and so forth.

2.3 User Tracking and Monitoring

Learning management system can be used to track and record the student’s progress through each course and assessment. User tracking involves creating a space for each user to track their involvement and usage. This would include all watched pages and edits made by the user as well as any discussions or communication by the user.

According to Schulmeister [8] two different types of tracking can be distinguished, active and passive tracking. Passive tracking summarizes all data that the user “leaves” in the learning management system just by using the system, like working with contents and tools.

The following classes of information can usually be gathered by passive tracking:

Course progress: The system provides information about the progress of different learning materials, courses, chapters, etc. of a specific user. Data about the used time and used tools, annotations, etc. can be derived. Frequencies of repetitions of the same contents may give interesting hints about the user. Additionally, these data can be used to get a notion about possible quality issues of the contents.

Learning Success: Results from quizzes, test, exercises, etc. give information about learning outcomes. Besides the results of tests or exercises data about the overall time spent, time spent on specific exercises or completeness are important for supporting learner optimally.

Communication: eLearning systems usually provide a variety of tools for synchronous and asynchronous communication and collaboration. The frequency of the usage of those tools and the contents of the communication may give some information about the knowledge and understanding of the learner with respect to a certain knowledge domain.

Active tracking comprises of data that the user provides intentionally, like data that are stored in a user profile, like name, nick-name, data of personal communication channels, etc. User profiles also contain data about the personal configuration of the eLearning platform, like preferred tools, individualized design (colors, background pictures, position of tools on the desktop, etc.) of the PLE.

2.4 Aims of user tracking and monitoring

A system that adapts to the user’s needs and learning style has the following advantages and applications:

Course content: Adaptive construction of course content from large organizational databases.

Personalized learning content: that adapts to personal requirements of the learners. Personal requirements are collected by the system over time and reflect the learners’ preferences and demands.

Learning style: Additionally, the system determines what individual learning styles or sets of learning styles are most closely related to the learners' preferred ways of knowledge acquisition and subsequently offers content accordingly.

Management of skills: Skills and competencies necessary for specific positions within an organization are clearly defined and transparently communicated to employees. Thus, employees are able to define learning paths that optimally close the gaps between their actual skills and the skills necessary for a desired position.

Support of HR processes: A comprehensive system supports the human resource processes of planning and recruiting. A system integrating e-learning and knowledge management on a strategic level automatically finds candidates best meeting the requirements for a given job and produces learning paths if necessary.

There is some literature [7; 12] on processes, architectures and prototypes that introduce possible solutions to provide methods to personalize and adapt the learning environment on basis of gathered user tracking data to the specific needs of a specific user.

According to Schmidt [6] the following subsystems to support and realize personalized eLearning environments are necessary:

Context Management: For managing the context, a generic User Context Manager has to be developed that can collect this information from various sources and support different services with a specific view.

Matching Service: This subsystem can compile personalized learning programs from the available learning material, the user's current context and the context's knowledge requirements.

Learning coordination: This subsystem decides, based on context changes, when to display suggestions about available personalized learning programs and communication or collaboration spaces. There can be several strategies to implement this behavior.

Presentation of Learning Content: This subsystem represents the component that displays recommendations to the user and captures context changes from the user's interactions with applications.

3 USER TRACKING IN MOODLE

Moodle is an open source software e-learning platform and it is one of the most widely used e-learning systems with a high market penetration and recognition. Moodle is designed to help educators create online courses with opportunities for rich interaction. Its open source license and modular design means that people can develop additional functionality.

Almost any module of moodle, like courses, wiki, chat, calendar, discussion forum, etc. provide tracking possibilities. The following tracking data can help to provide a basis for an automated user-centric adaption of the learning environment:

Login data: On every login of the user some login data like date, timestamp, ip-address of the user's computer, etc. are stored. This data can be used to get an impression about the favorite places or time a user usually uses the learning environment. If there are primarily static ip-addresses the place from where the user logs-in can be derived. If a user prefers to work outside the office or in his off time it can be difficult to offer contents that requires data from systems that are available only at the workplace.

Course enrolment: Before a user can attend a course an enrollment is necessary. This information can be used to remind user that should attend a course but have not yet started. This information can be used to make suggestions for preparatory courses that may help to understand certain content better.

Courses and lessons: User can enter a course or can work on exercises, tests or lessons. All data regarding these activities are stored and can be used to extract patterns of the working and learning style of the user. If a user should attend a course but does not, a reminder can be sent to the user.

Calendar entries: Every entry in the calendar can be monitored and is visible for tracking purposes. On basis of this data reminders can be sent to the user.

Recent activities: All activities of a specific user can be viewed in a chronological order. If a user works on a specific topic, this information can be used to offer the user all new contents or give the user a hint that there is nothing new regarding this topic.

Up- and downloads: Every file that is up- or downloaded by the user will be tracked. If a user uses this feature very often the corresponding tools can be offered whenever the user works with files where the user might have the intention to up- or download it.

Messages: The messaging system in moodle can be compared with a conventional e-mail-system. The frequency of the usage of this communication channel can be measured as well as the type of the usage, e.g. user-to-user-communication or user-to-all communication.

User can decide which other user can be part of personal contact lists. Rejecting a user can indicate that there are problems between two or user of the system. This information can be used to identify possible problems with specific user at a very early stage. If a user uses a specific way of sending messages some entry fields of the messaging system can be filled by the system.

Glossary and book: If reading a glossary or book is required to attend a course this information can be used to examine if a user has already done this If a user likes to use the glossary or book this way of content and knowledge preparation can be offered to the user frequently.

Chat and discussion forum: This information can be used to gather data about the usage of the various communication channels and the interpretation is similar to "messages".

Printing: If a user prints contents very often this could indicate that learning with the computer, for example reading from the screen, is not the preferred way for a user. The preparation and access of the content should then be provided in different ways.

Test, exam and quiz: The detailed analysis of the results of tests can gain in depth insights in the learning success of a user. Tests can be used for personal purposes but also for the assessment of the user by instructors. Personal assessments enable users to test their knowledge and review answers. This can be the basis for suggestions for further courses or the repetition of contents. Not only the results of tests can be analyzed but also the time spent on questions or test items. The type of question, like multiple choice, open ended questions, etc. as well as the used tools to find the answer can provide interesting information about the personal working style of a specific user.

4 CONCLUSION AND OUTLOOK

The analysis of the user tracking possibilities provided by moodle show that there is only a very small basis for an automated user-centric adoption of the content and tools in order to provide a personal learning environment.

More data, especially about the context of activities of a user must be gathered, because context is the basis for a useful personalization. Most tracking data are just a collection of user activities whereby it is difficult to extract context from these data.

Information ethics and privacy issues are a critical point in user tracking. User tracking requires the storage of all user activities in the related context, which is a major contrast to privacy and personal rights. Gathered data can be used for other purposes than the intended personalization issues. Thus, besides implementing learning systems with the related processes and architectures that support automated personalization of learning environments, the protection of privacy and information ethics must be considered.

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OPEN INNOVATION NETWORKING FOR REGIONAL DEVELOPMENT WITH SMES

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ABSTRACT

We suggest a conceptual framework for regional development and cooperation in HEIs (Higher Educational Institutes) and SMEs based on our previous project experiences. Globalization is challenging especially for SMEs due to their local focus, shortage of skilled working force, and further need for innovation and networking. We aim at improving the operational environment of the SMEs through networking.

1 INTRODUCTION

With our suggested framework we try to put forward existing best practices and technology related tools that can be readily applied, as soon as the knowledge and awareness of these approaches is delivered in a comprehensible manner to the SMEs through regionally operating HEIs. With this we hope to give an evolutionary and growing setup for SMEs and their expanding networking. We will use two regions, namely the Mecklenburg-Schwerin in Germany and the South-Ostrobothnia in Finland as examples, and reflect on how to foster innovation for SMEs in regions.

2 PROBLEMS OF REGIONAL DEVELOPMENT FOR HEIS AND SMES

The availability of knowledge and skills in applied ICT and business informatics has become as important as the existing ICT infrastructure. The local environment is having the same importance as the national macro economic situation in determining the ability of enterprises to compete in the global economy. Accordingly, universities are expected more than ever to actively engage in the development of their regions. A regionally engaged university can become a key asset and powerhouse for local economic development.

During years 2004 to 2006 we executed jointly a regional development project MODE (Management of Distributed Expertise) in the University of Vaasa together with its subunit in Seinäjoki (in South Ostrobothnia). In this project we developed methodologies and knowledge conceptualization tools for disseminating knowledge iteratively in a hierarchy of networked actors. The hierarchy is not so much organizational, but more operational- in the way that different actors come in with different needs and goals in a dynamic setting of mutually beneficial collaboration.

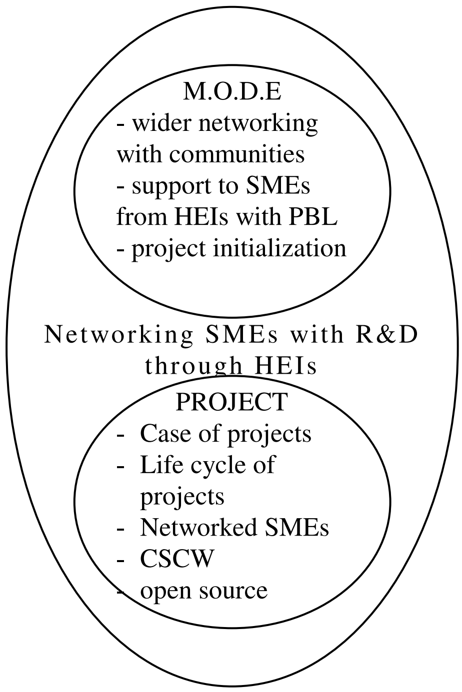

Figure 1: *Applied R&D for SMEs and HEIs in collaboration, [8]*

In this conceptualization the upper circle represents the organizational and methodological approaches that are used in the lower circle to incubate and host projects with SMEs and HEIs. The lower circle represents a generic, iterative project during its life cycle. MODE project improved the overall internationalization and coordination of already existing projects and introduced new regionally important technologies, but not yet addressing the role of the SMEs. As an example, the regional development project can be like is described next in chapter 3.

3 EXAMPLE PROJECT IN THE WESTMECKLENBURG REGION

Within the one work package of the BSR INTERREG IIIB NP project A.S.A.P. "Efficient Administrative Structures as a Prerequisite for Successful Economic and Social Development of Rural Areas in Demographic Transition" six universities from Finland, Russia, Estonia, Latvia and Germany were looking for measures and mechanisms to facilitate dialogue with different regional stakeholders and to strengthen universities role in regional development within the pilot areas. By using different empiric activities, like questionnaires, interviews and case studies, the partner universities have analysed universities´ success in managing regional development task and benchmarked models of the cooperation in different regions around the Baltic Sea. The idea is to elaborate effective and fruitful university-region cooperation models, which can promote rural development in practical and concrete way. In the following the example of Wismar University will be presented [1].

When it comes to international activities, Wismar University plays a key role as a regional competence centre due to its existing international collaborations and networking activities. Furthermore, the international oriented research and education is turning Wismar University into a regional innovator strengthening the regional business structures. In cooperation with the regional Research and Technology Centre in Wismar and Schwerin, the university is supporting the human capital within the regional knowledge clusters.

The main regional economic activities are concentrated on shipbuilding industry, wood processing industry and food industry where the economic clusters are concerned in the areas surrounding the towns of Wismar-Schwerin-Ludwigslust / Parchim. For the rural parts of the region, tourism and agriculture remain the most important economic sectors but with a growing importance for renewable energy and health tourism. Beyond that, potential innovations and their associated spin-offs, such as nanotechnology and plastic technology need active support.

Areas of competence and activities of Wismar University

The main competences of Wismar University are:

1. Education including lifelong learning and continuous professional learning
2. Social and cultural involvement
3. Internationalization of SME
4. Generation and transfer of knowledge
5. Logistics
6. Entrepreneurship
7. Sustainability

Based on this organizational setting, the Wismar University incubates international business opportunities for local SMEs and regional needs by disseminating knowledge in and out of the region together with its other HEI partners and networks around the Baltic Sea region [3].

4 SYNERGY AND DISTRIBUTED EXPERTISE FOR NETWORKED BUSINESS OF SMES

4.1 Technical approaches for SME and HEI knowledge enhancement

We will next describe the usage of open online communities, for disseminating knowledge towards the SMEs. Technically, we advocate the use of semantic or hierarchical portals. We use semantic web technologies, which will make the granularity and on-spotness of information more meaningful for SMEs and HEIs, staff and peers. The role of HEIs are taken into the framework both through education and R&D approaches stemming from the shared problems and their solutions either through applied business solutions either through applied CASE projects at SMEs, or more extensive research projects.

Collaboration between partners usually evolves iteratively as follows:

- Giving birth to a project
- Project task setup (negotiations and meetings)
- Covering the project environment (EU funds, units of interest, active persons, existing work and related projects)

Using the methodologies and descriptions of chapter 2, as many of these steps above should be made more analytical and measurable from each of the HEIs' point of view.

We will use here the preparation of the BSOU portal as an example, because this contains all the inside and outside steps necessary in a CASE project preparation. The BSOU portal was developed to ease the linkage between partners and content areas in the BSN network [2]. Using the general methodologies and approaches of semantic web [10] we developed an RDFS based ontology of the Bologna based educational units and their educational (course) offerings. All the different partners of the BSN and their data were taken up from their web sites. Based on this semantically organized information we set up a portal for the BSN, that can be accessed both by humans and machines- due to its inherent RDF nature. This work will still be developed further internally in the partner organizations in other CASE projects in the future[9].

4.2 Knowledge Management via Knowledge Networks

Within the last years a new approach for managing information has been developed: Knowledge Networks. Wismar University realised a research project called "ToMaHS" using the knowledge network approach in order to solve the matching problem between the existing knowledge inside the university and the demands from outside the universities. In general SME or other groups of interest are search for existing research results or special expertise inside the university. A concept of how to solve these matching problems with the help of knowledge networks was tackled with the ToMaHS project [6].

Once a knowledge network has been built it can be searched using a common web browser. We then have a search mechanism using a semantic search. An important feature of a knowledge map is its graphical representation as a map. A topic map shows the nodes and edges of a knowledge network like spots and roads on a map. The distance between two locations represents the semantic distance of the concepts. Current topic map viewers are able to draw the focus onto the most important concept and show its relations to other concepts. Thus we get a more complex answer to a certain search task. But a profit of a knowledge network will be seen only if a lot of up to date information is available. Thus a knowledge network needs permanent maintenance.

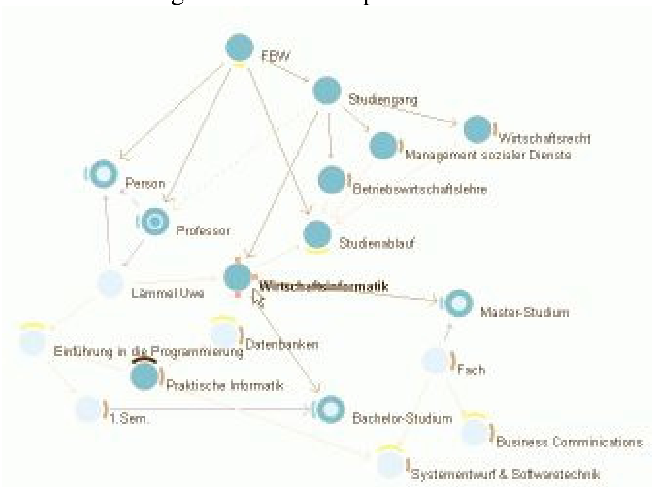

Figure 2: *Example of knowledge network for HSW, [4,7]*

A knowledge network could be used for improving a technology transfer between university and industry or among enterprises. We can start to build such a knowledge network by mapping the university expert knowledge into a network.

This is a first information system which gives an overview of the university power in technology and can show the relationship among the research groups of the university as well like was described in section 4.1.

In a second step the network can be enriched by co-operation information: co-operation between researchers, university teachers and enterprises. Later on enterprises can put in their contacts as well, so that a powerful information system enabling a semantic search is available. It should be possible to develop different knowledge networks for certain regions. Of course these local networks have to be connected in some way so that a more powerful system can be launched.

4.3 Supported decision making and actions in an organizational unit

In this part we propose a step by step approach for utilizing the previously described unit and project metadata in a systematic manner. This scheme has given a way of testing the above generic MODE metadata approach towards some real life case projects in the previous chapter.

Here the necessary outcomes has been both a general plan for a Management of distributed expertise MODE PROJECT CASING pilot system and a metadata description, recording and knowledge network visualization with software tools. Here the already existing web and database technologies, knowledge presentation and other ICT software tools should be used. This work will continue in the Seinäjoki unit of Uwasa by a new research proposal UNISEMA. This project coordinates the information presented in the five different units of the University Center Seinäjoki UCS [11] with a unified information portal similar to figure 2.

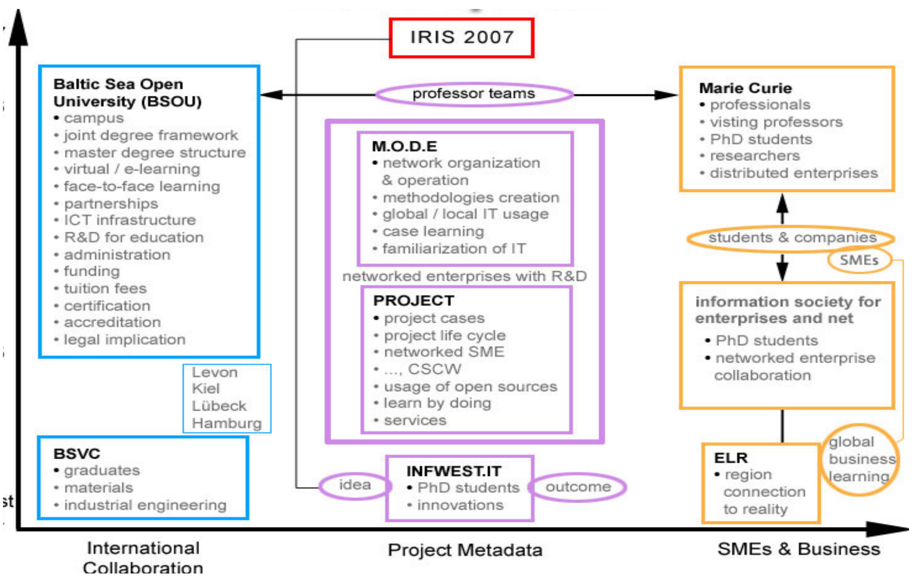

Figure 3. Aplied R& D towards SMEs, [8]

The original goal of the MODE project was to create a unified action plan for technology oriented development projects in the Ostrobothnia region. Towards this end, we will improve the hierarchical models and methodologies of chapter 2, through which different actors can find each others in the various collaboration networks.
In the end of the project the following strategic map for the various collaboration networks and their interrelations was established in the University of Vaasa:

On the international side, Laurea Polytechnic together with Kiel University of Applied Sciences and Wismar Universityin Germany will host several students working in these issues during the next academic years.

5 CONCLUSION

Based on the common project and unit metadata descriptions, a unified environment and knowledge source for project related information should be established. In the future this can be used in the strategical planning and management of old and new individual projects. This is a knowledge tool that allows prototyping with structural and visual project data management like in figure 2.
The methodologies developed will be used further in the Knowledge Management in Organizations KMO research collaboration [5] and related conferences. The KMO network consists of shared R&D efforts in the Universities of Vaasa, Maribor, Staffordshire in Finland, Slovenia and UK in EU together with some universities from Taiwan and China. In 2009, a related international conference KMO'2008 will be held in Taiwan to advocate this collaboration further, see [5].

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DEVELOPMENT OF TEACHER'S E-PORTFOLIO

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ABSTRACT

Selection of the LMS (Learning Management System) has a long term effect. Once it is chosen, it is usually extremely difficult to switch to another LMS. Development of a new LMS is possible, but software upgrades of the existing LMS are more practical. In the latter choice, especially when upgrades are developed using the educational institution's own resources, source code is needed and therefore the best choices are open-source LMSs.

This is what has happened at the University of Maribor and is happening at the University of Ljubljana. The goal of our institutions is teaching and training future teachers; consequently, our task was to prepare software modules for teacher training. Very recently, more functions have been introduced into Moodle, but even with them, our goal cannot be entirely met. We still had to develop student teachers' e-portfolio modules.

The results of our development were used for different purposes. The primary goal was to create a teacher training system and the secondary goal was to develop educational material for software development. Our students of computer science gained insight into all steps of software development, had excellent opportunities for development practice, and still can develop alternative approaches.

1 INTRODUCTION

(E-) portfolios control our lives [4]. Our society is hooked on the internet and would find it difficult to cope without e-mail, instant messaging, and web-browsers. Businesses are now employing e-portfolios for their employees to detect the seller of the month. Banks use them to detect knowledge shortages and schedule educational seminars. Even primary education institutions use computer programs to store the grades of their pupils. E-portfolios have been used for years at universities and other educational institutions. They suit their initial purpose, but don't well suit the purpose of educating and training teachers. Faculties where future teachers are studying solve their problems differently using various systems. Portfolios are kept in paper format, scheduling is done by custom made computer programs, arrangements are sometimes made by telephone, and reports are written using text processors. The necessity of central systems for scheduling, making arrangements, progress tracking and reporting on teacher training is obvious. In addition, it is important to consider, together with usage of e-portfolios, protection of the data stored on the web.

In teacher education, an elaborate system of practical teacher training is needed. Learning theory is not enough for students to become teachers. The main principles are practically the same all around the world. Moreover, recent changes in the EU require development of new educational systems according to the Bologna declaration [1]. Our hope is that changes will bring positive results and boost student mobility [11]. Nevertheless, for teacher training we need a support system [10] that performs the tasks of providing student assignments, storing information office, data gathering, cataloging, and final analysis.

At present each student has a portfolio which is filled with documents and records until the training is complete. Traditionally, this was all done on paper and it sometimes happened that during transportation and processing, some papers were lost or needed to be resent. It was especially annoying when papers were delayed en route and deadlines were missed.

In teacher training, there are three different types of participants: students, mentors and didactics specialists (professors in the Faculty of Education). By providing mentors with access to the learning materials, we created a vertical virtual community and improved the bonds [7].

At first we wanted to design the project as a standalone application. Later the decision was made to incorporate the project (a web application) into LMS (Learning Management System) as a module [5]. This gave us broader functionality and better incorporation with other types of TSL (Teaching Study Learning) processes. In our case, we used the open-source LMS Moodle [12] which enabled us to use previously developed learning materials and to incorporate our earlier findings [8]. The policy to "use open-source software wherever it is suitable" saves a lot of money and enables us to share Open Learning Objects [6]. Since Moodle is subject to continuous development, we also needed to assure that we could use new versions of Moodle with our application. By using Moodle's user authentication function, changing Moodle's database structure with additional tables, and physically separating the application's code from Moodle's code, we solved that problem.

Although the development of the e-portfolio module seems to be a small problem, it is not. During the preparation of the software specification, we found out how big it really is. Communication between different participants in the project was difficult because of their lack of knowledge when expressing their needs. Too much effort was spent on solving needless problems caused by grammatical errors in the user interface. We believe that only a win-win situation will make participants enjoy using the software, so we used theory-W. Theory-W project management is based on research into different software engineering projects. Projects ended with different outcomes. It the end, two involved parties (customer and developer) can have four different positions but only one is favorable for both. This is the win-win position. Any win-lose or even lose-lose result means financial and human loss and must be avoided at all costs. Success is much more likely when following the four steps of theory-W [2]:

1. Separate the people from the problem.
2. Focus on interests, not positions.
3. Invent options for mutual gain.
4. Insist on using objective criteria.

Software developers discovered a new dimension when they found that some win positions were totally opposite from the established practice of visual software design. Writing documentation about software development is also a very good learning experience for computer science students.

2 REQUIREMENTS SPECIFICATION

Every software developer knows that preparing requirement specifications is the most important task in software development. For our project, we had to do this with a team of advisors from different educational disciplines. Their views on special didactics in general were different. They did not even agree on what the portfolio should consist of. Therefore, the first problem was to unify the procedures of teacher training.

Teacher training in our country begins in the third year of post-secondary studies. It is in the domain of special didactic subjects according to the students' study discipline. Students can study a single discipline or two disciplines. Students who decide to study a single study discipline will become teachers in secondary schools, while those with two study disciplines will be teachers in primary schools. Whichever program they take, in the 3rd year all students have two weeks of teaching observation and practice in primary schools and in the 4th year they all have two weeks practice in secondary schools.

Different study disciplines mean differences between didactic specialists. By preparing scenarios of how a common e-portfolio would ease their work and give them a better overview of progress in teacher training in their discipline, we managed to find a common interest.

Despite the differences in preparation for training and the amount of ICT used in the training, the general idea was the same: students work under the supervision of didactics specialists. First they have practice among their colleagues and then in schools. There they start with observation of the mentor, an experienced teacher with a teaching certificate. The mentor prepares a lecture for his or her students (primary or secondary education students) and our students (university level teacher trainees) observe the mentor's behavior and skills during his or her teaching. Later, students prepare their lectures and teach primary or secondary school students under the supervision of a mentor and didactics specialist. Other students observe their schoolmates and at the end, the didactics specialists conduct a didactical analysis of the students' performance. Each student needs to be present at three (3) observations and to prepare one (1) lecture.

Didactical analysis is done in three steps:

1. The first is by the student who teaches the class and then presents an observation of his or her teaching, including pluses and minuses in performance, what he or she would change if allowed to teach the same lecture again, and which topics were not included in the preparation of the lecture but should have been.
2. The second is by the student who was assigned to observe the lecture and present his or her view about the performance of the teaching student. This student also describes what he or she would do in the same situation.
3. The last is by the didactics specialist who makes the final assessment of the student's performance and explains to the attending students what they might have missed during the observation. He or she also encourages students to make creative suggestions about unforeseen situations that occurred in the classroom during the lecture.

In the web application, students can insert information about the observation of the teaching done by the mentor or by their fellow students. When students teach, the special advisor is the one who enters data into the web application because he or she is the one who assesses the student's performance.

The second stage in the student training program is practical work for two weeks per year. Students are assigned to different schools and they work with their mentors. The two week practice is divided for students studying two disciplines; one week is intended for each study discipline.

During the second stage the didactics specialist's role is to observe the training process. Only students and mentors are active in the second stage. The mentor assigns different tasks to the students, and the student needs to fulfill these tasks in order to attain a positive training assessment. Students therefore need to observe others teaching, and to teach and participate in other educational activities at school. At the end of the teaching practice, the mentor prepares a final assessment the of student's performance in the classroom.

Training is concluded when the didactics specialist provides the combined assessment of the student. The training report is signed by the mentor and didactics specialist and deposited in the student's portfolio.

All of this is just a short description of the procedures that need to be followed in teacher training. A description of these procedures was the basis of our software development. As mentioned in the introduction, the first aim of the software development was to encourage ease of communication between students, mentors and didactics specialists. At present, all these things are done with paper forms which are sent by regular post or carried by students in their portfolios. Sometimes some of these documents get lost and replacements are needed. In such cases, web based software would speed up the process and would even assure better security than paper versions.

We also have pedagogical students of computer science. We observed that during their study, they have problems in understanding the object software development process. By developing our project, we also got some ideas how to prepare them for real-life software development projects. As we progressed through the phases, we showed them the progress and results of development steps. In our discussions with them, we found that they participated much more eagerly than in the hypothetical projects they were used to. The discussion of solutions also proved to be a good validation and verification process because they discovered some possible scenarios neither we nor they had foreseen.

3 SOFTWARE ANALYSIS

Requirements analysis is a good starting point for conducting real software system analysis. Armed with new found knowledge about developing technical information systems for industries, we chose the object oriented approach [9]. We identified all of the classes involved in the system. There are three classes of users involved in the process: didactics specialists, mentors, and students. We also identified the attributes needed for each of them and prepared the object diagram in UML notation (Figure 1).
From Fig. 1 we can see that there are some reasonable constraints. The didactics specialists (**did_spec**) can cover only one study discipline (**subject**). The same applies to the mentor, while students can have two different study disciplines (**subject1**, **subject2**).

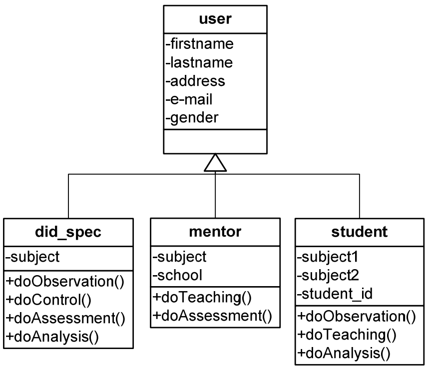

Figure 1: Object diagram - participants

As described in Section 2, student training consists of two stages. The first stage is general observation under supervision of the didactics specialist, and the second is practical training in schools.
During the practical training in the schools, students need to perform different tasks under supervision of mentors (see Figure 3). With the help of the interviews, we reached the consensus that practical training starts with the initial meeting where the mentor prepares the plan for the student. From our perspective we need only the date of this event. Also, didactics specialists suggested that they do not need additional information. The mentor's only task is therefore to select a student and confirm the date when they had a meeting (see Figure 2). The student's training is completed on the date when he or she has the final meeting with the mentor. At that date the mentor confirms the event and prepares the analysis of student progress.

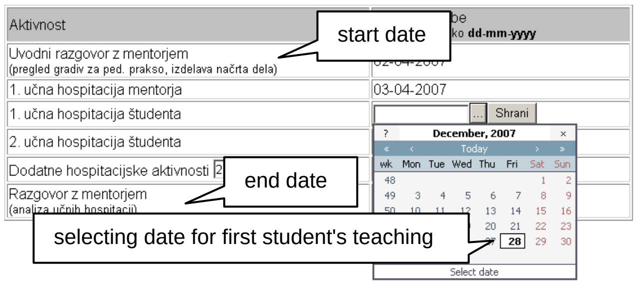

Figure 2: Mentor's view of Observations (see Figure 3)

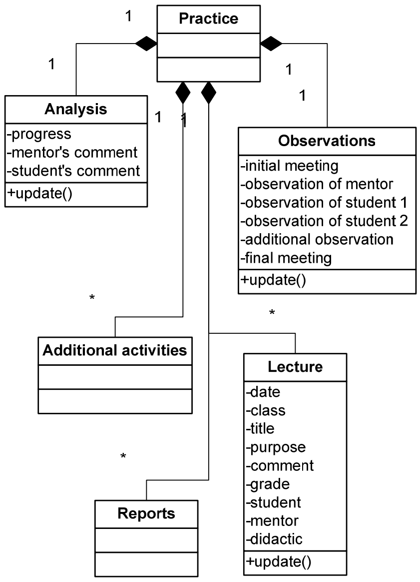

Figure 3: Pedagogical practice

Each student needs three (3) observations during his or her training in the school and a minimum of four (4) and up to six (6) lectures. The lecture resembles the structure of the lectures in the first stage of teacher training. The difference is that the mentor grades the student. In the analysis the mentor assesses the student's progress with values (*yes*, *partially* or *no*). In the field comment the mentor prepares a short text commentary about the student's overall performance and gives some guidelines for the student's future work. The student also has the option to comment on his or her performance. In addition, the "additional activities" are grouped into different segments where students need to fulfill at least five (5) additional activities (see Figure 4).
The dynamics of the application can be best shown with a **sequence diagram**. In this paper, not all sequence diagrams are presented.
In the second stage - practice training in school - all parties are involved while most of the work is done by the mentor. To reduce the work load of the mentor, only necessary data are to be entered. Studying the sequence diagram for a lecture (see Figure 5) it can be seen that the mentor should enter data for each of the student's lectures.

Figure 4: Additional activities of student teachers

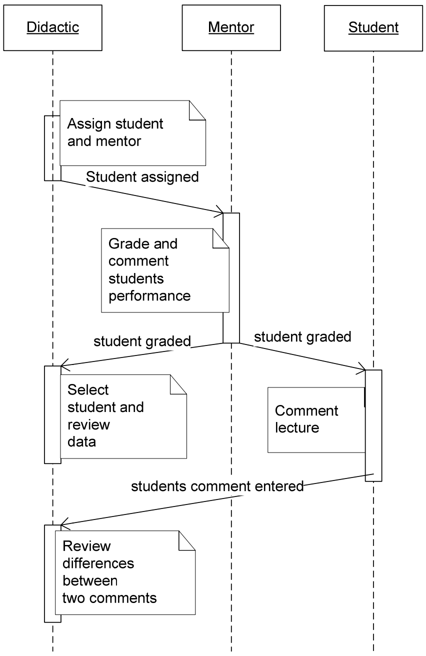

Figure 5: Sequence diagram for lectures

4 CONCLUSION

Software development can be expensive but it sometimes can not be avoided. To reduce software development costs, open-source LMSs, with access to their source code, are very suitable.

The primary goal of our institutions is training future teachers. This is an extremely complex process which requires extensive use of ICT. Unfortunately, at present all of the administrative tasks of teacher training are still done in traditional ways, using paper portfolios. The open-source Moodle LMS does not support teacher training but because we use Moodle for other activities in education the next logical step was to use it and develop modules that would support teacher training.

We developed a teacher training e-portfolio module in our pilot project. It is useful in many ways: it provides better understanding between involved participants (didactics specialists, mentors, and students); it verifies and standardizes the procedures which previously existed only on paper; it speeds up communication; it improves the security of personal documents and personal data; and developing it provided a good learning experience for prospective computer science teachers.

The pilot project was very well accepted by all of the participating students and by ICT aware teacher - mentors. Even those mentors who did not participate in the project saw its effectiveness and have expressed their desire to use it in the future.

Acknowledgement

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FORMALIZING DESIGN PATTERNS WITH ONTOLOGIES

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ABSTRACT

Design patterns are a high level approach for reuse in software engineering area. One of the most valuable design pattern characteristics enable developers to produce high quality software in less time.
However, design pattern usage has never really taken off, and the application of patterns in practice is very limited. By years design patterns number is increasing and issue is more and more obvious. It is out belief, introducing new approaches and tools for managing and selecting design patterns can bridge presented obstacle. This is why we have prepared an experiment prototype of a new design pattern repository, based on semantic web technologies. New Ontology-Based Design Pattern Repository is currently a work in progress. This is why we point out its potentials for improving design pattern adoption and foundations in formal design patterns representation.

1 INTRODUCTION

In all engineering disciplines it is important to develop new systems from existing, already proven reusable elements. As such, reuse has become an essential and important strategy in the software development area also. In software engineering several levels of reuse are established. The lowest ones - reuse of concrete software elements such as functions, classes and components- are already well established and practiced on a daily basis. However, if we observe reuse at higher levels of abstraction i.e. design patterns, the reuse is still not well established.
A pattern is a form of knowledge for capturing a recurring successful practice [10]. Design patterns capture the best practices for solving recurring software design problems and are proven way to build high quality software [5]. They capture knowledge that experienced developers understand implicitly and facilitate training and knowledge transfer to new developers [17]. A survey [13] indicated a low adoption of design patterns among practitioners – respondents estimated that no more than half of the developers and architects in their organization know or use design patterns. Therefore bridging the gap between the pattern expert communities and the typical pattern user is critical for achieving the full benefits of design patterns [4].
Design patterns improve software design productivity and quality for the following reasons [22]:

- They capture previous design experiences, and make it available to other designers - designers do not need to discover solutions for every problem from scratch.
- They form a more flexible foundation for reuse, as they can be reused in many ways.
- They can be used as a tool for communication among software designers.
- We can consider patterns as micro architectures, from which bigger software architectures can be built.

Although design patterns could help a lot in producing high quality software, developers experience more and more problems finding patterns that match their design problems. Useful patterns might therefore easily be overlooked. We want to fill a gap between unmanageable number of design patterns and developers searching for a suitable pattern in their current design problems. Since we have many positive experiences in initiating developers to use design patterns we decided to develop an integral web-based tool for selecting design patterns. The tool (Ontology-Based Design Pattern Repository – OBDPR) presented in this paper is a basis for automatic and intelligent services, used to help in selecting appropriate design patterns. Based on formal design patterns representation it introduces capabilities known from artificial intelligence area to improve the efficiency of design pattern selection used in the software development. When OBDPR is fully functional we are planning to perform several experiments to indicate if and how much our effort helps software engineers, especially inexperienced ones.

2 FORMALIZING DESIGN PATTERNS

Design patterns are traditionally represented with informal loosely structured documents. They help developers to understand patterns, but there is quite obvious issue regarding knowledge management possibilities. We can also find several semiformal representations, most of them are based on UML [6][8][3][12]. Those representations are efficient for a basic understanding of patterns since they cover their structural elements. But they do not provide information and knowledge on high level aspects such as intent, usability and consequences. For enabling sophisticated services on design patterns we need fully formal representations. The main goals of formalizing design patterns are [22]:

- Better understanding patterns and their composition. It helps to know when and how to use patterns properly in order to take full advantage of them.
- Resolving issues regarding relationships between patterns.
- Allow the development of tool support in activities related to patterns.

There are several attempts to introduce formal representations in design patterns area. Some of them are based on pure mathematics such as first-order logic, temporal logic, object-calculus, ρ-calculus and others [22].
On the other hand some authors [7][8] are trying to formalize design patterns and keep them understandable to humans at the same time. They take a standpoint similar to the semantic web (to keep data semantically understandable both to human and machine). Their representation is mostly based on ontologies. It is used primarily to describe structure of source code, which is done according to particular design pattern. One of those used in "Web of Patterns" (WoP) project [1] has addressed the area of describing knowledge on design patterns.
In general, at the moment researchers are trying to develop formal representation of design patterns mostly for [22]:

- searching patterns in existing solutions,
- automatic code generation,
- formal solution validation.

Goal of our attempt to formalize design patterns is to address the issues of finding appropriate design patterns.
Authors are trying to formalize several aspects of design patterns. They can be divided in several areas[21]:

- pattern structure (classes, methods, relationships etc.),
- pattern behavior (e.g. method call sequence),
- pattern implementation,
- context prerequisites for using design pattern,
- verifying design and implementation based on patterns,
- pattern compositions.

It depends on formal representation goal which area of pattern will be formalized. Since our goal is to support the design pattern selection we do not cope with formalizing pattern implementation or verification for instance. As we are seeing in next chapters we can benefit of combining our solution with others.

3 ROLE OF ONTOLOGY IN OBDPR

After reviewing related work and benefits of using ontologies as explained below we also decided to use them in our work. Although there are some ontologies in the community, we did not use any existing one. We rather develop our own with interoperability in mind.
One could argue having a separate ontology is problematic. It is actually not a problem, since there is a possibility to connect ontologies in a quite straightforward way. Ontology from WoP project [1] is oriented towards supporting design pattern scanner, which does not help us a lot while being oriented towards design pattern selection.

One of the enabling approaches used in semantic web is ontology. Ontology describes the subject domain using notions of concepts, instances, attributes, relations and axioms. Concepts can be organized in taxonomies through which inheritance mechanisms can be used in ontology. Ontology adds semantics to the model representation. Their formal, explicit and shared nature makes them an ideal choice for design pattern repository.
With the presented facts we also justify our decision to use ontologies as well as other semantic web technologies to provide a basis, not only for design pattern description, but also for future intelligent services:

- Ontology-based design pattern descriptions are computer readable and therefore suitable for automated (computer) processing.
- Transforming OWL and RDF based design pattern representation into other kind of representations (textual or graphical form) is not an issue.
- Ontology and related technologies are well established, recognized, extendable and based on standards.
- They enable exchangeability of design pattern descriptions in straightforward way.
- Ontology supported knowledge base is distributed by default.
- Third-party ontology (OWL)–enabled tools are available and will be developed in future which can extend the use of ontology enabled knowledge base.

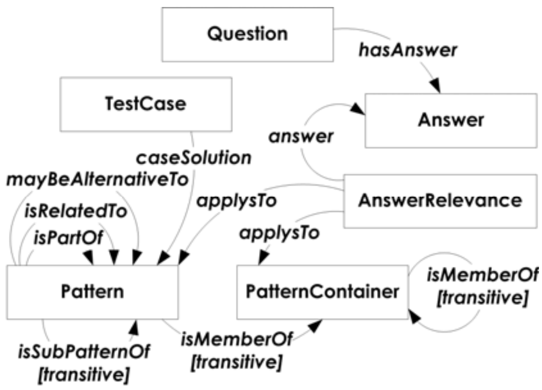

Figure 1. *Core of OBDPR ontology*

OBDPR underlying ontology is implemented using OWL. A core ontology fragment is shown in figure 1. We use hierarchical organization of pattern containers. Every pattern container may contain several pattern containers and patterns. This enables us to capture several divisions of design patterns, not only those found in fundamental literature. Every pattern can be included in several containers; the same is true for containers. Patterns themselves are connected in a more logical way in means of related, similar, composed patterns and pattern hierarchies. Not only patterns and pattern containers themselves are included in ontology, but there are also real-world examples using patterns to give more meaning to OBDPR user ("TestCase" class).

Design pattern experts can provide experiences in question-answer pairs, which enables them to capture their implicit knowledge on design patterns. Not only experts can give experiences to tell which design pattern is used in particular real-life situation (“Question” class), but they can also specify more possible solutions to real-life situation (“Answer”) with specified probability (“AnswerRelevance”). This is value in range from 0% to 100% and tells user how likely is that particular candidate (“Pattern” or “PatternContainer”) is used when answer to given question is confirmed positive. Answers and possible candidates can easily be updated or added to questions at any time with rich user-friendly web interface.

4 USING SEMANTIC WEB TECHNOLOGIES IN OBDPR

The idea of semantic web allows automatic, intelligent inferring on knowledge, represented using ontologies. The basic idea of semantic web is a different organization and storage of data and consequentially new possibilities to use this data [19]. The barrier that prevents more advanced usage of available data is believed to be the semantic poorness of today’s solutions. The vast majority of data is presented as a very simple, non-structured human readable and human understandable material. The result is the inability to make a real use of the enormous amount of “knowledge”. In order to overcome these difficulties the concept of meta-data is introduced in the core of the semantic web. Using meta-data, so called smart agents can be used to search for information by content and to infer on the gathered concepts. As a foundation, there has been a lot of work done about common formats for interchange of data and common understanding of common concepts. That allows a person to browse, understand and use data in a more straightforward way, and a machine to perform some intelligent tasks on the data automatically. Furthermore, the semantic web ideas can be used in an internal enterprise information system for knowledge management in a different way to introduce new intelligent services. In semantic web, knowledge is represented as graphs, written down in XML-based language called RDF (Resource Description Framework) [16]. RDF is dealing with URIs (another W3C standard for naming resources globally unique). Advanced use of semantically annotated data can only be accomplished by using ontologies represented as RDFS or OWL [14] documents. There is also a language for efficient querying the RDF-represented knowledge, SPARQL [18]. The whole stack of semantic web technologies is available and described in [20].

OBDPR is completely based on semantic web technologies. Furthermore it is not just design pattern repository. It is a platform for building intelligent services to improve design pattern adoption. As such includes several functionalities:

- It holds design patterns, containers and expert knowledge repository.
- Enables design patters experts to annotate patterns with additional knowledge.
- Integrate knowledge on particular design pattern from the web (Wikipedia, Sun Blueprints etc.) and additional data sources.
- User-friendly transformations of raw RDF data.
- Index all the integrated data for supporting full text search capabilities.
- Full access to RDF data to services built on platform including questions and answers, which will enable intelligent services to use expert system-like proposing or validating services.
- Set of real world examples and appropriate design patterns solutions in order to enable services to be used to train users or to show appropriate use of design patterns in real world examples.

Current OBDPR prototype implements all functionalities above. It offers also services built on top of them: full-text search service, design pattern proposing service and training service – all primarily intended to help design pattern novice to use them.

OBDPR prototype includes all design patterns found in GoF[5] and J2EE[2] design pattern catalogues. It is not limited to those since it is possible to include additional patterns – even those recognized in particular enterprise.

The implementation technology for OBDPR is Java EE with Jena [9] framework for accessing and performing core semantic operations on ontology. A simple user interface framework with basic functionalities like raw and user friendly view on repository is prepared. Framework is fully prepared to host additional services, developed in future.

5 FURTHER WORK

The main aim of OBDPR is to introduce formal methods of design patterns representation and keep patterns in human friendly form at the same time. Semantic web technologies were used therefore. However, to be confident in results some real life experiments should be performed. They might show if and how much does OBDPR help adopting design patterns. Some preliminary experiments have been already performed (with students and industry people). Since the results were promising (design patterns adoption rose significantly) we are quite confident we are on the right track. But as said previously: more rigorous experiments should be performed in the future.

There is another idea to expose OBDPR with simple interfaces. This would not only enable further integration but can also enable developing plug-ins for the most popular development tools such as Eclipse, NetBeans or Visual Studio. Having OBDPR always at hand during development sound like good idea to us.

Even existing services need some improvements before going production. For example, we are trying to personalize the proposing service. The proposing component could learn about user from past proposals and for instance ask personalized questions or ask more questions to verify possibly contradictory answering.

After performing research activities in means of experimenting with tool on industry developers we plan to develop a holistic methodology for design pattern selection. It will include both design pattern expert and user activities. OBDPR will be given a role of enabling tool for developed methodology.

6 CONCLUSIONS

It seems that in software engineering reuse based on design patterns has never really taken off. The potential of using appropriate design patterns is not yet fully realized and therefore the application of patterns in practice is very limited. It is our belief our work can contribute to using design patterns more by helping finding a suitable design pattern for a given situation. This issue represents a great challenge for a typical developer. OBDPR was therefore developed to capture design pattern explicit and implicit expert knowledge, to enable further development of intelligent services and to test our belief that we can improve design pattern adoption.

Introducing semantic web concepts and technologies into the design patterns field creates new possibilities for making design patterns more approachable to software engineers. During the development semantic web technologies showed to be the right solution. Especially when dealing with advanced requirements such as proposing design pattern for a given problem, and there are many more to come.

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IMPROVEMENTS OF SOFTWARE TESTING FOR LSP
The example in the case of internationalization and localization

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ABSTRACT

Software testing is an important part of the software engineering. As the complexity of software products has increased, the role of all parts in the software development process has been modified including with the role and importance of the testing process. In this paper an overview of scientific approaches to the software testing with application of the best tailored apporach is presented. A case study is presented with the implementation of scientific approaches in a real world situation, as a part of quality assurance for large software product. In presented example of the internationalization and localization testing is presented the high level testing design that is the basis for test cases definition. Presented is the general testing method for large software products applied on internationalization and localization testing.

1. INTRODUCTION

Development of software has initiated the new role of software testing. At the beginning of software products development the majority of the testing was performed by the developer himself due to the simplicity of the product. As the complexity of software products has increased, the role of all parts in the software development process has been modified including with the role and importance of the testing process.

The testing process has important position in the process of software product development, nowadays. As the consequence, the special concern is focused to the testing process. The testing itself, and methods of testing, have to be scientific based as much as possible. At the moment there are three different approaches to the scientific grounding of the software testing process.

To achieve reliable software product that satisfies customer demands, the software development process has to be well defined and well structured. Software testing as the part of the software development process is crucial and it has to be well structured [4]. There are three different scientific approaches to the software testing: (1) Development of software testing as a part of software engineering, (2) Generating of optimal test suites for test covering, and (3) Mathematical formalizations of software testing.

(1): The testing process is a component of software engineering. Cost estimations of development are critical issues in software engineering. The cost estimation of software product includes also cost estimation of testing [18].

(2): The software testing problem can be defined without direct correlation to other parts of software engineering. Faults of a system can be triggered by a combination of n or fewer parameters and testing of n-tuples of parameters is effectively equivalent to exhaustive testing [11]. It is important to generate appropriate test suites to assure test covering of software product demands. Testing coverage with test cases can be approved with interaction of the test suite generation and with random test suite generation [10]. The other approach to study testing coverage is a study of minimization of the test set of executed test cases [15]. This approach is based on a test suite prioritization with interaction coverage [8]. A test suite prioritization is based on seeding and constrains of test cases [9]. There are many algorithms for generating test suites - some of them are based on model-checkers [14] and some of them are based on pairwise interaction testing [5],[6],[7].

(3): Mathematical formalization of software testing is a formal testing model is realize in a formal testing model. The first formal testing model is a model checker. Model checking is the process of checking whether a given structure is a model of a given logical formula. Model checking methods for algorithmic verification of formal systems were developed by Edmund, Emerson [16] and by J. P. Queille and J. Sifakis [17] (Clarke, Emerson, and Sifakis got Turing Award 2007 for model checking). Further developed “Specification Based Mutation Testing” methods, based on the use of the model checker, are developed for propagation of defects in the form of the visible output [12]. “Specification Based Mutation Testing” is also used for generation of software tests with state machine mutation for reduction (abstraction) of the domain of a complete design [13].

2. IMPLEMENTATION OF SCIENTIFIC APPROACHES IN A REAL WORLD SITUATION

In a real world situation there is a software product that need to be tested to accordance to the goal of quality assurance. The presented approach use of all scientific findings. The most important and the only direction a real world testing process is to assure a quality software product, and the scientific based has to be of health.

2.1. Definitions

Def: The **Internationalization** is the process of designing a software product from the ground up so that it can be localized with no modifications to the executable code. Short term for internationalization is **i18n**.

Def: The **Localization** is the process of modifying a software product to conform to the expectations of a given user community. Short term for localization is **l10n**.

The difference between i18n and l10n is important. The i18n is the effort of the product developing process that can be localized easily. The l10n is adapting of the product for preferred market and country. This includes taking into account some cultural or linguistic issues, converting graphics, translation, etc. Another important term in testing is a *filename*.

Def: The **Filename** is a name of the object in the process of the product activity.

Def: The **LSP** is a name of the large software product that is studied in this article.

2.2 Scope of the testing

Scope of i18n/l10n testing is defined in three levels: (a) Groups, (b) Areas, and (c) Issues.

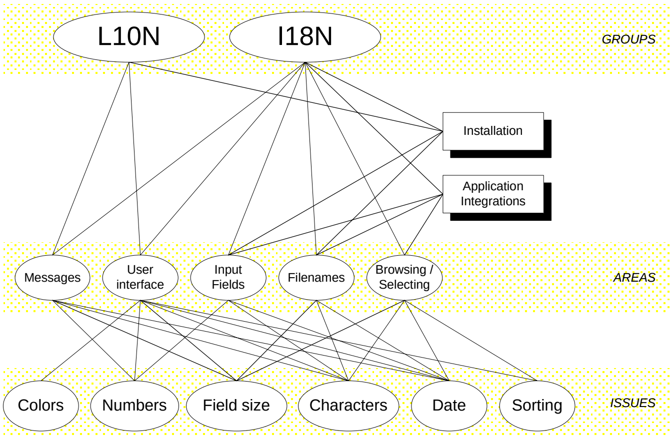

Figure 1 Testing configuration graph. Edges present communication channels - connections between all testing items.

The scope of testing is on the highest level grouped in **testing groups**: (1) i18n, and (2) l10n. On the middle level, there are **testing areas**: (a) *User interface.* Testing messages are displayed with user interfaces: GUI and CLI. In the **LSP** testing there is also testing of dynamic message – output messages, (b) *Browsing/Selecting.* For GUI and for CLI there have to be tested browsing/selecting filenames for all platforms on the local communication channels, (c) *Filenames.* During product activities, filenames have to stay in its original form. This has to be checked for all platforms. Filenames have to be checked on all different parts of the product, (d) *Input fields.* For each input field has to be checked allowance of localized characters, (e)*Messages.* There are some other special messages to test in l10n testing. Some of these are Event logs, Notifications, and Reports. Dynamic messages are tested during user interface i18n testing. The message testing has to assure: (1) *Localized OS generated messages.* It is enough to choose two different host locals with different date and number format. Number format in is not "i18n problem", because it can be explicitly switched of, (2) *Messages dependent on localized filenames.* There are some messages dependent on localized filenames. These cases are covered under i18n testing.

Some l10n tests acts as a kind of black box i18n testing. Special items added between testing groups and testing areas are (1) Installation and (2) Application Integrations. *Installation* and upgrade process has to be tested for all platforms and all languages. In the installation process, i18n testing will be performed as a part of *Input fields* testing. Installation input fields have to be tested for acceptance of localized characters. For the *Application Integration* item, some special i18n testing has to be done for proposed application integrations (e.g. Informix, Oracle, SAP ...).

On the bottom level, there are following **testing issues**: (1) *Character.s* Character set is related to local Language. Localized messages have to be presented in local character sets, (2) *Date.* Date format is has to be in appropriate local language, (3) *Field size.* Fields have to be formatted to fit all text sizes for all translated languages, (4) *Numbers.* Number format differ for some languages – meaning of comma and dot, (5) *Colors.* There are different meanings for some colors for different locals, and (6) *Sorting.* Text has to be sorted in accordance to local language.

2.3 Testing approaches

It is important to divide the testing process to cover both the i18n and the l10n testing. For this purpose distinction between l10n and i18n must be précised. To find out the quality of i18n and l10n of the **LSP**, there are some potential issues that the localized software must address. For each issue must be defined what should be tested under i18n testing and what should be tested under l10n testing.

Language. All messages have to be translated and displayed in local language (except log files). Messages have to be checked in (1) User interface, (2) On line help, (3) Manuals, (4) Man pages, (5) Web reports, and (6) Log files (not localized). In the test process the Language issue has to be tested as l10n.

Character set/ Some languages require special characters sets. Localized messages have to be presented in local character sets. Similar to the Language issue, defining of the character set is l10n process (development and testing). On the Microsoft Window there are Unicode character sets [1] while on the UNIX there are Multibyte Character Set (MBCS) ([2]).

Date format. There are two types of dates: (1) *Product's dates.* These dates have to be localized in appropriate corresponding local language. In the **LSP** these languages are English and Japan. This is l10n part., (2) *Filename's dates.* Examples of these dates are: Backup time/date, Restore time/date, etc. These dates have to be in corresponding local settings due to the host operating system and are not limited to the **LSP**'s "language version". Some locals require special date format. Order of {year, month, day} differ for different locals. When date is presented in "long format", names for days and names for months are local. This is one of the important matters in both processes: i18n and l10n.

Text Length. Lengths of messages differ for most of the locals. As stated in Language issue, local messages are presented in user interface. In the i18n process, appropriate space has to be achieved for different text lengths. In the l10n process message length in the language translation has to be achieved.

Numbers. There are different meanings for dot and comma for different locals. Numbers format have to be passed from the host operating system. This has to be done in i18n process.

Colors. Since the **LSP** is supposed to be provided for English, Slovene, and Japan for local colors there were not special requirement. Anyway, local meaning of the colors has to be checked. Red color is for instance unacceptable for some Arab locals. This has to be tested as i18n (support) and l10n (colors selection).

Sorting. There are many different sorting rules connected to local settings. Similar to "color issue", correct sorting rule have to be tested as i18n and l10n and it is **not** covered in this release.

Platforms. Let suppose that the **LSP** is provided to be implemented on 12 different platforms: 4 Microsoft Windows, 4 UNIX, and 4 other operating systems. Each issue has to be tested on all platforms. Testing process should cover i18n and l10n part of testing and it has to be performed on localized operating systems. Let suppose that the **LSP** is supported for 3 different languages: Slovene, English, and Japanese. It means that there are 3x12=36 different localized operating systems that have to be tested.

Internal communication channels. Important risk for loosing information about filenames can be some local communication channel. Internal communication channels should be tested for all platforms. To cover complete i18n testing it is important to check filename transferring through communication channels between different hosts.

2.4 Actions that need to be tested

Changing of contents of objects during actions is not subject of l10n testing and it is not part of this test plan. If content of the file is changed during an action, this is general "action" failure and is not l10n failure. In this subsection areas for test filenames in local character set are described. i18n and l10n problems have to be checked for GUI/CLI.

GUI. User interface have to be localized in selected language. Important testing action is testing of accepting locale text in the **LSP** input fields.

CLI. Similar to the GUI testing, date format have to be tested.

Browsing/Selecting with GUI. Objects in local character set have to be unambiguous presented in other local environment. Unambiguous selections in other local environment have to be enabled.

Browsing/Selecting with CLI. Similar to GUI testing, unambiguous presentation and selection of objects have to be tested.

2.5 Special items to be tested

To assure l10n quality it is important to act as high-level testing specialist. This testing is quite different to "automated" test procedure.

Possiblle Confusions. For the very widely used Latin1 (ISO-8859-1), the list of possible confusions is longer. Indeed, all non-ASCII characters of Latin1 expressed in UTF8 can be confused with a two-letter combination of such characters expressed in Latin1. This completeness is due to the fact that Latin1 is directly part of Unicode. But despite of these, the full list of possible confusions, is extremely low. Many of the two-letter combinations on the right side of the table look completely strange, and the probability that they ever appear in a resource name is extremely low. For this, the fact that Latin1 contains only special characters in the area of UTF8 trailing octets is partially responsible.

Other encodings (not Latin1) present similar situations. In the case of Latin2, there are some true letter combinations, and the probabilities are more difficult to assess in general.

List of all possible mistakes in transforming from Latin1 and Latin2 to UTF8 can be found in [3].

Input fields (i18n). Input field testing is testing of allowance of local characters entered in GUI input fields. Term *input field* is used to determine input entry in GUI, where user can enter some text string. Input fields testing assumes following steps: (1) Collecting input fields, (2) Defining strings with local characters, (3) Defining local platforms, (4) Determining allowance for each input field.

For each input field one of the following values has to be determined.

User Interface (l10n). The area for l10n testing is User interface and all *localized static messages* have to be tested. It is important to test static messages (messages from the localized catalogues) that are dynamic generated. There are many CLI output messages that are not read form the host Operating System and they are not filename related.

Browsing/Selecting (l10n). Browsing/Selecting filenames l10n testing is covered with i18n testing.

2.6 Special items not to be tested

At the end, here are some special l10n test items, which are not lab's test objectives.

Proofing. In the *proofing* the language specialist thoroughly checks the target local language for any errors, inconsistencies, etc.

Editing. The editing is similar as the proofing; but in the *editing* the language specialist also match the translated text to the English original text to ensure that the two match up equally for the particular context of the sentence.
Name Evaluation. The name evaluation is the process in which the **native** language specialist evaluates each **name** in the product to determine any potential cultural or linguistic issues that may arise with this **name** in a particular target country.

CONCLUSION

In the real world situation there is usually not enough space and time for pure scientific base approaches to solving problems. The final solutions are usually combinations of different approaches and different methods. Beside these, the final solution is closer to one or other method. The final test plan, the developed solution, depends on the theoretical knowledge of the test lead, and on the developing software product. Presented approach for testing of i18n/l10n features has all elements of the real world problem solving. It has some elements of optimization of the test suite for the test covering and it has cost estimation. The most important feature of presented approach is the formalization of the whole test for the i18n/l10n. Strict formalization offers possibility to develop the model which is the most adequate and reliable test plan assuring the high quality of the developing software product.
The final goal of the whole process is qualitative software product. The adequate and reliable test plan is a tool helping to achieve this goal.

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QUANTITY MEASUREMENTS OF INTERACTIVE WEB APPLICATION DEVELOPMENT TECHNOLOGIES

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ABSTRACT

This paper presents quantity measurements of interactive web application development technologies. We researched the common characteristics of AJAX, Silverlight and .NET Applet technologies and got quantitative results, which are the basis of ordinal technology classification.

1 INTRODUCTION

With the spread of interactive web content, formally known as Web 2.0, the number of technologies and approaches has increased. Because of the rapid technological growth, it is difficult to compare technologies with each other. If a company wants to select a suitable technology for each project, it has to have a wide specter of highly qualified and experienced workers. But major companies often do not have such employees and do not know the actual difference between technologies.

2 TECHNOLOGY OVERVIEW

2.1 Ajax

Ajax provides a new way of developing and using web applications. It abandons the “redraw-refresh” paradigm of traditional web pages, where they were loaded on every request. The Ajax approach allows quicker responds to inputs and makes the user interface more interactive. This advantage allows users to use web applications in the same way they use desktop applications.

The ability to send and receive a small amount of data is the primary benefit of Ajax. Traditional web applications were transferring data for a whole page and redundant data like navigation, page layout, side-bars and links were loaded and sent more than once. This kind of interaction can cause some performance issues. On the other hand, the Ajax approach can change and populate a precisely selected HTML element, which is presented in a DOM tree structure. The core object, which is responsible for the entire life cycle of the transmission, is *XmlHttpRequest*. It allows to receive data either in synchronous or asynchronous way[1]. When data is received, the specific JavaScript function is raised up, which reads data from the server.

2.2 Microsoft Silverlight

Silverlight is a cross-browser and a cross-platform plug-in for providing rich interactive applications (RIAs) for the web. It has its own programming model, which supports AJAX, Python, Ruby and .NET languages such as VB and C# and offers effective integration with existing web applications. Besides programming languages it is also responsible for providing high quality and cost effective video and audio content.

Microsoft realized its own programming model for application development and presented a principle for strict divisions between the user interface and business logic. They named it XAML and it must be written in XML syntax. Essentially it is a declarative language in which the designer can specify behaviors and a graphical user interface of the application. Such a model allows designers to join the application developing life cycle in earlier stages, because they can work completely independently.

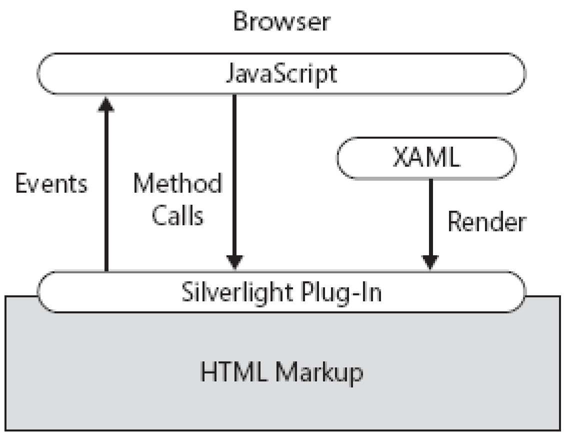

Figure 1: *Application architecture with Silverlight.*

When the Silverlight application runs within a browser, it is made up from specific HTML code[3]. With special calls it initiates the Silverlight plug-in, which reads the XAML content with graphical user interface specifications and defines the applications' behaviors (Figure 1).

2.3 .NET Applets

The term applet specifies a programming component, which runs within a larger program context (e.g. web browser). It is frequently used for definite tasks, which are completely independent from other components. We could say that they are small autonomous applications, which can also be found in any operating system. If they are made with the .NET framework, we call them .NET Applets.
Applets use Windows Forms controls, which are located inside the .NET framework. They are liable for drawing the graphical user interface and making it interactive. However, the primary purpose of Windows Forms technology is to develop desktop applications, but in some specific environments we need to apply them on the web. The only requirement for using .NET Applets is having a .NET framework installed on a client computer.

3 COMMON CHARACTERISTICS

To make a quantitive comparison between all three technologies for developing interactive web applications, we need to define common characteristics. When general characteristics are defined, it is necessary to form convenient measurement system.

3.1 Web page load time

Page load is a very important factor and it has a remarkable impact on the web applications' popularity. The research of the Akami company has shown [7] that web pages that do not load within four seconds are rarely visited.
The major search engines (e.g. Google) help users with slower bandwidth visit faster web sites by ranking them at higher positions. In this way, we could say that web pages with a lower page loading time have a better ranking, which is a company's main goal.

3.2 Required knowledge

All technologies contain some sub-technologies. So, if a developer wants to use Ajax, they must be familiar with JavaScript, XML, XmlHttpObject and the DOM tree structure. According to a developer's knowledge, some technologies will be more suitable for development than others. Although a company can send its developers to summer schools or provide additional instructions to learn new technologies, but there are few companies that can afford this kind of education. Because of this, it is critical to analyze workers' knowledge and make a list of sub-technologies that are eligible for the companies' project. With a detailed list of knowledge, the company can save some money and bring the project to the final stage (i.e. delivery of final information solution) with less effort.

3.3 Development tools

The existence of suitable tools (e.g. integrated development environment) is the key question before starting a new project. A developers group must check for tools that are available on the market and then choose the proper one or even a set of them. Some new integrated development environments contain a number of tools with a similar look, which are necessary for development through the whole project's life cycle. Imagine if a developer needs a set of programs for debugging, code editing, graphical interface designing. Such a confusing development environment will cause some additional problems and prevent projects from being realized quickly.

3.4 Maturity of technologies

Every application or operating system has its own life cycle. For technologies that are longer on the market and are still in use today, we could say that they serve their purpose. We can expect that these technologies will be in use in the future. Moreover, they will be extended and will get some new functionalities, which will even ease the developers' work and make the maintenance of applications easier. For technology maturity measurement, a company called Gartner, invented its own model for classifying maturity. It specifies five phases[8]:

- Technology Trigger
- Peak of Inflated Expectations
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity

Each phase defines a position (i.e. maturity) of technology in a life cycle.

3.5 Portability and web-standard support

To reach the same look and response of web applications, developers must respect web standards. Advantages of web standards are:

- To achieve a more stable web
- To reduce development and maintenance time
- To allow backward compatibility and validation
- To increase search engine success
- For graceful degradation now and in the future
- For common knowledge (set of rules that every developer can follow and understand)

Graceful degradation is designed with forward and backward compatibility. This means that web applications coded for older versions will be supported in new versions and web pages coded for new versions will be gracefully degraded to produce acceptable results in older browsers.

4 MEASUREMENT PROCEDURES AND RESULTS

To get quantitative results we must define the procedures, which make ordinal technology classification.

4.1 Page load

Page load was measured indirectly by implementing an ordinary registration form with all three technologies. Then we ran each web page inside Internet Explorer 7 and captured the transferred data (also an amount of data) between the server and the client. For capturing data we used a program named Fiddler2.

Technology	Transferred amount of data
Silverlight	145.206 B
ASP.NET Ajax	124.055 B
.NET Applet	20.764 B

Figure 2: Transferred amount of data after the first run.

Technology	Transferred amount of data
Silverlight	0 B
ASP.NET Ajax	9.187 B
.NET Applet	0 B

Figure 3: Transferred amount of data after the second run.

The results (Figures 2 and 3) show that Silverlight applications are the largest and .NET Applet applications are the smallest. However, .NET Applet and Silverlight applications can increase their size if they use dynamic libraries, which are not part of .NET framework. In this manner, we can say that Ajax applications are suitable for bigger solutions.

4.2 Required knowledge

To define the role of sub-technologies within our major three alternatives, we must split them into smaller pieces.

Knowledge/Technology		**Knowledge**		
		A	**B**	**C**
JavaScript	AJAX	*		
	Silverlight		*	
	Net applet			*
CSS	AJAX		*	
	Silverlight			*
	Net applet			*
XML	AJAX		*	
	Silverlight	*		
	Net applet			*
JSON	AJAX		*	
	Silverlight		*	
	Net applet		*	
Web service	AJAX	*		
	Silverlight	*		
	Net applet		*	
XAML	AJAX			*
	Silverlight	*		
	Net applet			*
C#	AJAX		*	
	Silverlight	*		
	Net applet	*		
Visual Basic	AJAX		*	
	Silverlight	*		
	Net applet	*		
PHP	AJAX		*	
	Silverlight			*
	Net applet			*
Java	AJAX		*	
	Silverlight			*
	Net applet			*
Ruby on Rails	AJAX		*	
	Silverlight		*	
	Net applet			*
LINQ	AJAX			*
	Silverlight	*		
	Net applet		*	

Figure 4: Sub technologies

In Figure 4, column A represents sub-technologies that are used very frequently. Column B represents technologies that are not used frequently and column C represents technologies that are used either rarely or never.

4.3 Development tools

The classification of tools was divided into three sections. The first section relates to developing a graphical user interface. We specified our own scale and mark tool with one point if a developer can use a design support for developing the user interface (e.g. drag and drop controls or elements), otherwise we gave no points.
Section 2 deals with business logic. If the tool has a class explorer, supports debugging options, intellisense we gave it one point. If it has only general text editing, we gave it zero points.
The third and final section deals with the collaboration of a developer and a designer. If the tool supports contemporaneous work on the same module or web page, we gave it 1 point, otherwise 0.

Development tool		**A**	**B**	**C**	**Mark**
Microsoft Visual Studio 2008 + Microsoft Expression Blend	AJAX	0.7	1	0.4	70%
	Silverlight	1	1	1	100%
	Net applet	1	1	0.5	83%
MonoDevelop	AJAX	0	1	0.2	40%
	Silverlight	0	1	1	67%
	Net applet	0.5	1	0.5	67%

SharpDevelop	AJAX	0	1	0.2	40%
	Silverlight	0	1	1	67%
	Net applet	0.8	1	0.5	77%

Figure 5: Development tools and marks

In figure 5 column A represents graphic user interface, column B represents business logic and column C represents collaboration between developer and designer. The results show that the best development tool is Microsoft Visual Studio 2008 with Expression Blend.

4.3 Maturity of technologies

Maturity measurements were made on Gartners basis[9]. We marked technologies according to the phase they belong to. We gave:

- 1 point for Technology trigger phase
- 2 points for Peak of inflated expectations phase
- 4 points for Trough of disillusionment phase
- 7 points for Slope of enlightenment phase
- 10 points for Plateau of productivity phase

For mainstream adoption we gave:

- 10 points for less then 2 years
- 8 points for 2 – 5 years
- 4 points for 5 – 10 years
- 2 points for more then 10 years
- 0 points for obsolete technology

Results are shown in figure 6.

Technology	**Phase**	**Mainstream adoption**	**Points**
AJAX	Trough of disillusionment	Less then 2 years	14/20
Silverlight	Peak of inflated expectations	2-5 years	10/20
.NET Applet	for Slope of enlightenment	2-5 years	15/20

Figure 6: Maturity of technologies

5 CONCLUSION

We made quantitive measurements of interactive web application development technologies. For making such an experiment we had to form a model, which consists of common characteristics. In addition, we had to define some procedures, which would return some quantitative results. We could say that the .NET Applet is a checked technology and is well supported by tools. Ajax and Silverlight are younger technologies and are competitive alternatives to .NET Applets. Moreover, they are suitable for larger solutions.

In this research, we did not include any specific Ajax and Silverlight features, which make them so popular today.

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METAMODEL FOR PRESENTATION LAYER

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ABSTRACT

This article is dealing with designing artifacts for modeling presentation layer of software. A model of presentation layer is defined by composite metamodel, which was created with use of the UML 2.0 profiles. The metamodel defines artifacts and rules for representation scopes like structure, functionality, view, presentation and navigation of graphical user interfaces (GUI). The metamodel covers these areas separately, which impacts modularity of the layer and brings benefits into phase of implementation. With respect to the nature of the metamodel, models can be read and processed by computers. Furthermore, models can be involved in the Model driven architecture on the level of platform independent model (PIM).

1 INTRODUCTION

The software presentation layer represents a complex issue, which begins during the design phase and continues over the phase of implementation and maintenance of the software product. The only way, how to make these phases easier, is to apply modeling.

Models bring another point of view of the reality and since their purpose is to abstract from detailed things, they enable better understanding of what is the reality about. Moreover, models can hide information, which is not necessary or depends on implementation, so they bring platform independence. Models are widely used especially in the case of modeling data layer or application layer, where entity relation diagrams and class diagrams are involved. In the case UML - compliant models, there is wide offer of modeling software, which enable developers to create models and to use additional functionalities, e.g. code generation for specific platform. Examples of use of such features are generating database tables or class skeletons.

In the present, there is no unified concept of providing support for modeling presentation layer. Models, which we can see in companies are just ad-hoc models, reflecting current specific needs of every customer or development team. The standard for modeling nowadays – UML, does nod define specific diagrams for presentation layer [4], so we can find only proprietary solutions in common modeling tools. For instance, the Enterprise Architect modeler provides User interface diagram dedicated to modeling structure of GUI. Unfortunately this model is not compatible with other modelers and such data can not be transferred across various software. There is general tendency to stick to standards as much as possible, to avoid incompatibility which can cause the fall of the software product.

2 CURRENT APPROACHES TO DEVELOPEMENT OF PRESENTATION LAYER

In the following paragraphs, we will take a closer look at different approaches, common in modeling and realization of GUI.

2.1 GUI Modeling

In the scope of the GUI modeling, the Use-case diagram is widely used. The intention of the diagram is to model relations between the system and the user. This modeling artifact also includes writing scenarios providing guidelines, how to control the application. The scenarios are documents of no formal form, so the description can not be extracted and processed for code generation. The Use-case model is mostly used for customers and developers as documentation. The Use-case model is defined in UML, thus plenty of modeling software provide support for its computer processing. The machine processing of the model is meaningful only in case, when we can get a list of functionalities and their relations to user roles in the system. As a result of such use of Use-case model, we can obtain products like functional catalog, or list of user rights. XXX

The next model, which is used for modeling of the layout and structure of GUI is wireframe [4]. This model is frequently used in the design phase. When meeting with customers, these can make an immediate decision on the form of GUI structure and view. The wireframe is not part of the UML diagrams, thus its definition and rules are missing. The lack of compatibility and minimal support of current modelers result in their rare usage.

For the purpose of navigation modeling, we can use the site map or Use-case storyboard [3]. This artifact is used to show connections and bindings between control items of GUI and views of the application. The typical use of this model is especially in the domain of web applications,

where the model is used for generation of help. It usually illustrates possible transitions from one view to another. The model is not a part of UML diagrams, thus the support of current modeling tools is very small, in spite of its great benefits.
All of the above mentioned models are frequently used, when dealing with development of presentation layer. They serve as documentation especially in the design phase, when collecting customer requests as well as during the phase of product maintenance. They capture functionality, structure and navigation aspects of GUI mostly in visual form, but they are not integrated into any regular concept. It means that we can not take a complex use of them. This lack decreases popularity of GUI modeling as opposed, to class or data modeling.

2.2 GUI Realization

The realization of presentation layer depends on the architecture in the first place. We discern between web architecture, which is based on web browser and desktop architecture, which is based on an operating systems or on a widget library. The last type of architecture is represented by mobile applications. Building presentation layers for these architectures can vary one from another and have their own specifics.
In the fact, there are two basic ways, how to build GUI. The first one relies on manual coding, the second one uses GUI builders to achieve the same result. The common way used nowadays combines both these ways. One of the disadvantages of these approaches is code mixing (code pollution). The code pollution arises, when mixing areas of interests (we call them domains), which should be kept separately as much as possible. This means, that the code is composed of application logic and presentation logic. Let us have a look, how a window is created with the use of GUI builder:

1. Blank window creating
2. Filling the window with particular GUI elements
3. Setting the view features
4. Manual coding of logic, which has to be in presentation layer

Each step implies creating new code into the same location. This makes it worse to get oriented in the code and code maintenance is difficult because of this. Another drawback of this approach is decreasing the modularity, which makes it harder to keep a unique design. The situation is easier in the case of web applications, which use the concept of Cascading Style Sheets. Styles centralize information relevant to design in one or more separate locations, thus the design information does not interact with the code responsible for the logic or structure of presentation layer. The different situation is represented by desktop applications, which do not provide styles or similar mechanisms. This is the case of widget libraries for desktop applications, where design is defined exclusively for each GUI item. It makes it very hard to keep view-uniformity of the application.

2.2 Summary of disadvantages in common approaches

Lack of modeling presentation layer impacts the work efficiency in negative manner. For instance, when the target platform or the architecture is changed, the current code must be rewritten, because the present code is not yet compatible. Since the information of GUI is not stored in any model, we can not use features like code-generation and everything must be done manually.
Furthermore, many different logics are mixed inside one location during code writing. This code pollution is highlighted especially in web applications, where mechanisms like MVC are involved to avoid this phenomenon [2]. Accurate logic separation can increase the modularity of presentation layer and makes refactoring easier.
The unified view of desktop applications is hard to keep, with the respect to individual setting of view features for GUI elements (color, border, margin, etc.).
Another problem is difficult orientation in the source code in wide multi-layer applications. In the phase of maintenance, when a defect is reported, the code must be explored and defect located. When locating defect, the programmer must get oriented in the code after that can find the mistake and fix it.

3 CONCEPT OF DOMAIN MODELING FOR GUI

With the respect to all problems, which are brought by the current way of GUI realization, we propose a new approach on this issue called domain modeling for GUI. The use of this concept offers all necessary artifacts for modeling many aspects of GUI. It can possibly solve the issue of code pollution and it can increase the modularity. The modeling lies in identification of areas of interest (domains), which are not closely connected and capturing them into the model. We will take into account the following domains.
Functional domain represents connections between GUI elements and procedures in presentation layer, service layer and data layer.
Structural domain includes information about types of GUI elements and their spatial relationships.
Presentation domain makes connection between GUI elements and information resources, like labels, text bundles and media.
Navigation among views of application is saved inside navigation domain. It connects GUI elements like button or links to views of the application (windows, web pages, frames).
Features like graphic or styles are modeled in view domain.

3.1 Relations between domains

As mentioned above, the presentation layer will be perceived as a composition of five domains. These domains do not coexist absolutely separately, but they are overlapping and working together. Domain relations are depicted on the figure 1, where oriented edges illustrate the influence.

We can see, that functional domain impacts all other domains. Navigation domain impacts only structural domain, while structural domain impacts presentation domain. Graphic domain impacts structure and presentation domains.

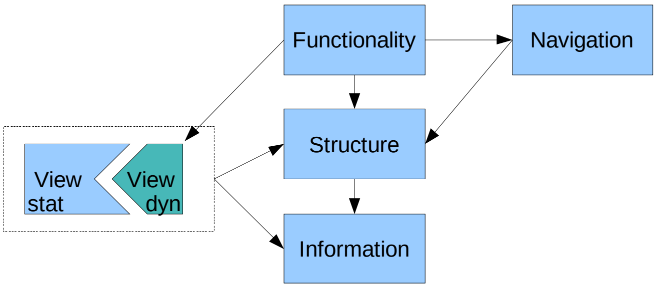

Figure 1: *Five domains of presentation layer*

3.2. Domain modeling realization

The object of our GUI domain modeling concept is its integration into UML. To achieve this, we can either modify the UML definition in UML metamodel, or to take use of UML 2.0 profile [1]. Editing of UML model implies change of UML itself, which become incompatible after and this is undesirable. The use of UML profiles is more like extending UML: the core remains unmodified, but new elements and connectors are added.

UML profile mechanism brings concrete resources like stereotypes, tagged values and constraints. The process of creating UML profile is to take an object from UML metamodel (typically the metaclass) and to inherit from it. After this, we will obtain a new class – stereotype, which can be associated to any class in the model. Furthermore, the stereotype can be specified by constraints (in formal way – i.e. OCL can be applied), by notes (non formal way) or by tagged values. The tagged value represents a pair of the name and value, belonging to a stereotype. The new stereotype can be associated to a class that gets new properties and new semantics. The classes can carry more than one stereotype.

For the purpose of presentation layer modeling, the GuiModelProfileB profile was created, that contains five packages with five metamodels, defining rules for the domains. GuiModelProfileB represents a metamodel of simple GUI. In the following, we will introduce each package of the metamodel. The profile does not cover all possible features, which are offered by common user-interfaces. We have defined this Beta profile with the respect to the simplicity, to illustrate the concept. Of course, the profile can be populated by new classes and can increase its usability and complexity.

3.2.1 Structural domain

Metamodel for structural domain defines a hierarchy of GUI elements. There are three types of these elements. They can represent containers and elements for presentation or control. Particular implementation responds to all non-abstract stereotypes in the hierarchy. Structural domain offers image, text paragraph, button, select, simple input, text field, panel, panel, window and dialog window.

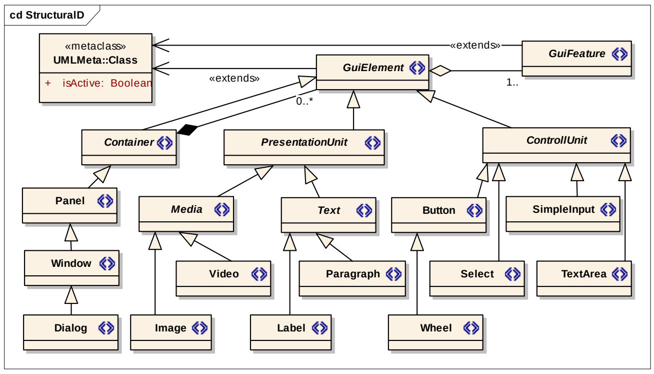

Figure 2: *Types for GUI items*

3.2.2 Functional domain

The functionality is illustrated partially in figure 3. We define four types of functionalities: ViewAction, InformationAction, StructuralAction and NavigationAction. These classes inherit from common functionality given by stereotype GuiAction. These four abstract stereotypes just serve for further inheritance.

The presentation layer usually carries some functionalities, typically in the form of procedures, which are triggered by using an arbitrary GUI control element (i.e. element of stereotype ControllUnit). This is modeled by the association Activate, which hangs together with particular functionality presented in presentation layer. Such functionality is modeled by the stereotype GuiProc and can run any operations – actions (stereotype GuiAction) on GUI elements. Classes having stereotype GuiProc, can also call procedures on a host (stereotype ExternalProc). These can be services (stereotype ServiceProc) or PL-SQL procedures (stereotype DataProc) in database. The information about connection of control element, GUI procedure and service can be read from model at that moment and brings better conditions for quick localization of a reported defect.

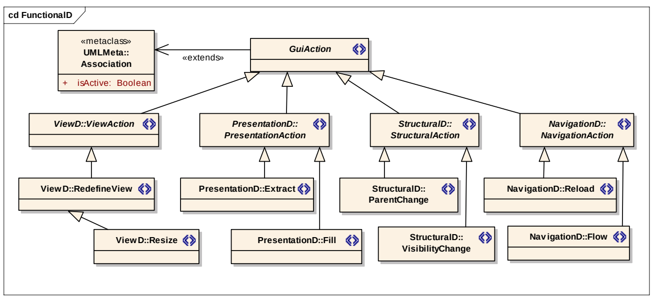

Figure 3: *Types for GUI actions*

Abstract stereotype GuiAction has its implementation (see fig.7, e.g. actions RedefineView or Resize). The GuiAction can handle arbitrary implementation of the stereotype GuiFeature, which can be set to participating GuiElement. The class with stereotype GuiFeature represents view definition (see graphics domain) or new resource (see the Resource in presentation domain).

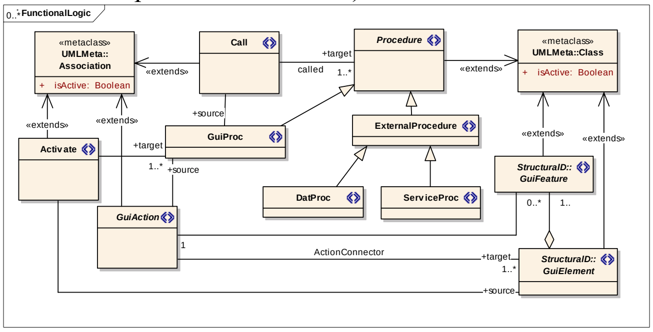

Figure 4: *Metamodel of functional domain*

3.2.3 Navigation domain

The central object of the navigation domain is stereotype Wheel, which serves for navigating between views (windows, web pages) or for reloading presentation units. Typical example in a web application is a button, which causes reload of particular in-line frame with new context, or button closing window in a desktop application. The process responsible for context reloading simply needs an information, what to load into the location. This information is provided by the stereotype Resource.

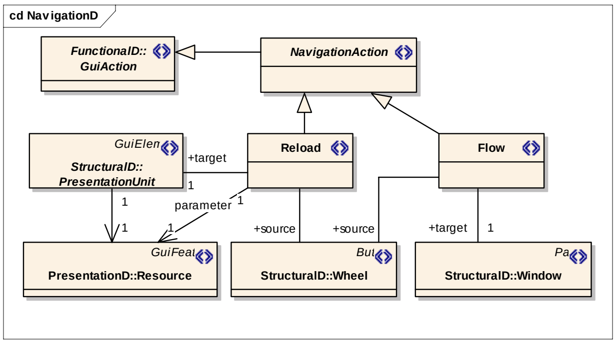

Figure 5: *Types for GUI actions*

3.2.4 Presentation domain

Presentation domain provides objects for user-oriented information. Particular information is represented typically by text or media and is modeled by abstract PresentationUnit. The implementation of that stereotype are stereotypes Image, Video, Label and Paragraph. Every class with stereotype PresentationUnit has dependency to stereotype Resource. The stereotype Resource models data sources, which will be loaded and displayed to the user via a PresentationUnit. It is typically a line from text file or a record in the relational database telling us the physical location of PresentationUnit. In the need of change, the current resource is replaced with a new one.

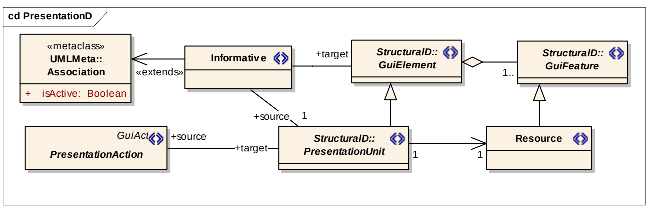

Figure 6: *Metamodel of presentation domain*

3.2.5 View domain

Modeling of element's view is provided by view domain. Particular information about view is stored in stereotype ViewDefinition. This includes features like font, background color, etc. When the view of an element is changed, the RedefineView action is involved. We can see in figure 7, that RedefineView action is equipped (indirectly) by ViewDefintion, which will be associated to a GuiElement during the RedefineView (or Resize) action. We can define as many particular view actions as we need: such action can be Resize, which is used quite often on web pages, providing picture scaling on button press. The associated ViewDefinition will apparently contain just simple information about new size of the element.

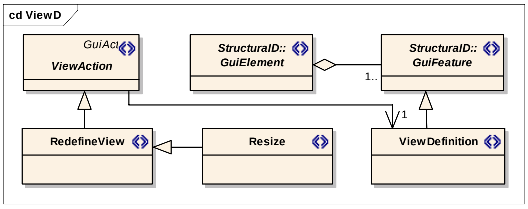

Figure 7: *Metamodel of view domain*

4 Conclusion and future work

In this article, we present new idea, how to deal with modeling complex aspects of presentation layer. The metamodel has been created, defining rules and semantics of GUI. Using this metamodel brings powerful artifact for capturing static and dynamic features. It is possible now to model even the functionality provided by the layer. When creating a model, the nature of metamodel is guide it, not to mix all information together, but to keep them separately instead. It prevents code pollution in the implementation phase and increases modularity. Such a created model is compatible with UML and can be edited in common modeling tools. Formal nature of such model also enables processing it and generating code for an arbitrary platform. Our future work is related with metamodel integration into mechanism of MDA and creating a framework for code generation. The target of the framework is widget libraries of .Net and Java platforms.

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COMPARISON OF TWO-PARTY ID-BASED AUTHENTICATED KEY AGREEMENT PROTOCOLS

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ABSTRACT

Authenticated key agreement protocols enable two or more entities establish a shared secret key which is subsequently used to achieve confidentiality through encryption. In the paper a comparative study of two-party identity-based authenticated key agreement protocols is conducted from the efficiency and security point of view. The intent of the comparison is to get an overview of the current research state and to clarify which protocol is the most efficient and most secure.

1 INTRODUCTION

The increase of application and information system's mobility, the use of the Internet and consequentially computer networks, makes it vital to assure confidentiality of data sent over such channels and authenticate participants in the communication process. Key agreement protocols enable two or more entities to establish a shared session key which can be later used to achieve a cryptographic goal such as encryption of data sent over an insecure network [9]. In addition, authenticated key agreement protocols assure authenticity of the participating entities. Different approaches can be used when developing authenticated key agreement protocols which effect their security and efficiency. Security of an authenticated key agreement protocol is defined using desirable security properties [2], [3]. The main goal is to develop a protocol which is secure and efficient at the same time.

The first key agreement protocol was proposed by Diffie and Hellman in 1976 [5]. It enables the establishment of a session key between two entities over an insecure channel. However, the protocol does not enable authentication of the two entities, hence makes it susceptible to man-in-the-middle attack.

In 1985, Shamir introduced identity-based cryptography [16]. In contrast to traditional public key infrastructure, the identity of the owner is embedded into to public key. This information can include any piece of information which uniquely identifies the entity, like e-mail address, name, physical address, physical description, identification numbers, and date of birth or combinations of these. In identity based cryptosystems the identification should not be a random number; therefore usually cryptographic hash functions are applied. Nevertheless, information which can be included in the hash can be far more extensive. An application of identity-based cryptosystems is identity-based authenticated key agreement protocols. In general such protocol include a number of entities (the usual settings include 2, 3 or *n* entities) and a trusted third party (TTP) often referred to as Private Key Generator (PKG).

In the paper we conduct a security and efficiency comparison of two-party identity-based authenticated key agreement protocols based on the RSA and Diffie-Hellman problems. The security comparison is conducted in regard to the fulfilment of desirable security properties and existence of attacks [2], [3]. When comparing protocols in regard to efficiency, we evaluate the computational and communication effort. Details on the efficiency and security criteria are defined in sections 2.2 and 2.3.

The rest of the paper is organized as follows: In chapter 2 preliminaries are given including relevant computations problems, security and efficiency properties which are used as criteria for the comparison. Chapter 3 very briefly discusses the protocols which are later compared in chapter 4. The comparison in chapter 4 is conducted in regard to efficiency, security including known attacks. A brief conclusion is given in chapter 5.

2 PRELIMINARIES

2.1 Computational problems

Most asymmetric cryptosystems rely on different computational problems, key agreement protocols not being an exception. That is why we introduce the computational problems which are fundamental for security for the protocols discussed later in the paper. The section is based on material from [5], [1], [6], [10].

2.1.1 The RSA Problem

First let us consider the RSA problem that forms the basis of the RSA encryption algorithm. The RSA algorithm which is based on the RSA problem was published by Rivest, Shamir and Adlemann in 1978 [13].

Definition 1**.** *Given a positive integer n as a product of two distinct odd primes p and q, a positive integer e such that gcd(e, (p - 1)(q - 1)) = 1, and an integer c, find an integer m such that* $m^e \equiv c \bmod n$.

If we look at the problem in a different way, we want to find e^{th} roots modulo a composite integer *n*. It is widely believed that the RSA and the integer factorization problems are computationally equivalent, although no proof of this is known. For completeness we give the basic definition of the factoring problem.

Definition 2**.** *The integer factorization problem (or factoring) is the following: given a positive integer n, find its prime factorization; that is, write* $n = p_1^{e_1} p_2^{e_2} \dots p_k^{e_k}$ *, where the* p_i *are pair wise distinct primes and each* $e_i \geq 1$.

However, most of the key agreement protocols discussed in the thesis are based on different computational problems.

2.1.2 Diffie-Hellman Problems

The foundations for the protocols which are subject of this paper are specific variations of the Diffie-Hellman problem, which will be covered in this section.

Definition 3. *Let G be a finite cyclic group of prime order q and let g be a generator of G. For elements* $a, b \in G$*, the (Computational) Diffie-Hellman Problem (CDHP) in G is given as: Given elements* g^a *and* g^b*, find* g^{ab}.

The other variant of the CDHP that we will describe is the Decisional Diffie- Hellman Problem (DDHP).

Definition 4. *Let G be a finite cyclic group of prime order q and let g be a generator of G. For elements* $a, b \in G$*, the Decisional Diffie-Hellman Problem (DDHP) in G is given as: Given elements* g^a*,* g^b*, and* g^c*, determine if* $g^c = g^{ab}$.

The set Z_p^* is usually used as *G* (the set of positive integers modulus *p* often denoted as *{1,2,...p})*.

2.2 Security properties

For a sound key agreement protocol, we need to define particular properties, which are described in detail in [1]. We assume A and B are two honest entities. It is desirable for authenticated key agreement protocols to possess the following security attributes [2], [3]:

- *Known-Key Secrecy:* In each round of key agreement protocol, A and B should generate a unique secret key. Each key generated in one protocol round is independent and should not be exposed if other secret keys are compromised, i.e. the compromise of one session key should not compromise other session keys.
- *Forward Secrecy:* If long-term private keys of one or more of the entities are compromised, the secrecy of previously established session keys should not be affected. We say that a system has *partial forward secrecy* if the compromise some but not all of the entities long-term keys can be corrupted without compromising previously established session keys, and we say that a system has *perfect forward secrecy* if the long-term keys of all the entities involved may be corrupted without compromising any session key previously established by these entities.
- *Key-Compromise Impersonation:* Assume that A and B are two principals. Suppose A's secret key is disclosed. Obviously, an adversary who knows this secret key can impersonate A to other entities (e.g. B). However, it is desired that this disclosure does not allow the adversary to impersonate other entities (e.g. B) to A.
- *Unknown Key-Share:* After the protocol, A ends up believing he shares a key with B, and B mistakenly believes that the key is instead shared with an adversary. Therefore, a sound authenticated key agreement protocol should prevent the unknown key-share situation.
- *Key Control:* The key should be determined jointly by both A and B. Neither A nor B can control the key alone.

2.3 Efficiency properties

The efficiency of protocols can be measured by computational and communication effort. To evaluate and later compare efficiency, we have to define criteria for both efficiency properties. Firstly we define the criteria for evaluating computational effort. It is measured by the number of computations performed by each participating entity. Computations are divided into two groups:

- Modular additions and hash operations are computationally less expensive.
- Modular multiplications and modular exponentiations are more expensive and thus have greater impact on the efficiency of the protocol.

Communication effort is measured by the number of passes and round of a protocol. The number of passes refers to the total number of messages exchanged in the protocol, whereas a round consist of all the messages that can be sent and received in parallel within a time unit (often referred to as protocol run). As all the reviewed protocols are one-round, we just compare the number of passes required for evaluating and comparing the protocols.

However, as we will discuss in the next section, in addition to performance, protocols have to conform to the security properties defined in section 2.2.

3 REVIEWED PROTOCOLS

In this section we compare the efficiency and security of the proposed improved protocols and other two-party identity-based authenticated key agreement protocols. The following protocols are included in the comparison:

- Okamoto's [12],
- Okamoto-Tanaka's [11],
- Saeednia et al.'s [14],
- Günther's [7],

- Günther's Extended [7],
- Saeednia's [15],
- Saeednia's Extended [15],
- Hsieh et al.'s [8],
- Tseng et al.'s [17] and
- Tseng's [18].

A detailed description of every protocol would exceed the boundaries of the paper. Therefore the reader is advised to look-up the appropriate reference. Nevertheless, we give the structure that is common to all protocols. An identity-based authenticated key agreement protocol is commonly specified by three phases: *System Setup, Private Key Extraction* and *Key Agreement*. The system setup, private key extraction phases set-up the environment and the needed parameters for the later key agreement. The key agreement phase in which the key is derived that is later used for securing the transmitted data. Based on the analysis of the structure of the protocol, published attacks and fulfilment of security properties, a comparison is conducted in the sequel section.

4 COMPARISON

In this section we perform a comparison of efficiency and security of the reviewed protocols that can be later used to develop attacks and new identity-based protocols.

4.1 Efficiency

An important factor when assessing a protocol is its efficiency. Identity-based authenticated key agreement protocols share different performance properties which we measure by counting computational operations per protocol run. Different operations require different computation effort. as discussed in chapter 2.3. Operations requiring less effort are modular additions and hash operations, while modular multiplications and modular exponentiations are far more expensive.

Table 1: *Computation Effort per User*

Protocols Based on the RSA Problem				
Protocol	*exp*	*mul*	*Add*	*hash*
Okamoto's	4	3	0	0
Okamoto-Tanaka's	6	3	0	1
Saeednia et al.'s	3	2	1	1
Protocols Based on the Diffie-Hellman Problem				
Protocol	*exp*	*mul*	*Add*	*hash*
Günther's	4	1	0	1
Günther's Extended	6	3	0	1
Saeednia's	5	2	0	1
Saeednia's Extended	6	3	0	1
Hsieh et al.'s	5	2	0	1
Tseng et al.'s	4	2	1	1
Tseng's	3	2	1	1

exp - modular exponentiation
mul - modular multiplication
add - modular addition
hash - hash operation

Table 2: *Communicational Effort per User*

Protocols Based on the RSA Problem	
Protocol	*No. of Passes*
Okamoto's	1
Okamoto-Tanaka's	2
Saeednia et al.'s	1
Protocols Based on the Diffie-Hellman Problem	
Protocol	*No. of Passes*
Günther's	1
Günther's Extended	2
Saeednia's	1
Saeednia's Extended	1
Hsieh et al.'s	1
Tseng et al.'s	1
Tseng's	1

From table 1 we can observe that the most efficient protocol from the group of protocols based on the RSA problem is Saeednia et al.'s protocol, whereas from the group of protocols based on the Diffie-Hellman problem is Tseng's protocol. In general the most efficient of all of the compared protocols are Saeednia et al.'s and Tseng's protocols as only 3 modular exponentiations and 2 modular multiplications are required per protocol run. The worst protocol based on the RSA problem is Okamoto-Tanaka's protocol and the worst protocols based on the Diffie-Hellman problem are Günther's Extended and Saeednia's Extended protocols. As can be observed the worst protocol in general are all of the three mentioned protocols since 6 modular exponentiations and 3 modular multiplications for each participant are needed per protocol run.
When the communicational effort of the protocols is compared, we can derive the following conclusions:

- regarding the number of passes the majority of protocols require 1 pass with exception of Okamoto-Tanaka's and Günther's Extended protocols.

Note that since all protocols are requiring 1 round, we do not list the data in table 2. However, as we will discuss in the next section, in addition to performance, protocols have to conform to the security properties.

4.2 Security

When dealing with security of authenticated key agreement protocols are two main criteria: fulfilment of security properties and known attack which influence how a protocol conforms to desirable security properties. We sum up the security properties in table 2 and published attacks in table 3. We do not list the property of key control since all discussed protocols in this paper hold this property at the same level. Later we give a list of published attacks for each protocol. Despite the fact that a protocol fulfils particular security properties it cannot be used, if it is susceptible to an attack.

Table 3: *Security properties*

Protocols Based on the RSA Problem					
Protocol	*KKS*	*PeFS*	*PaFS*	*KCI*	*UKS*
Okamoto's	+	-	+	-	+
Okamoto-Tanaka's	+	+	+	?	+
Saeednia et al.'s	+	?	?	?	?
Protocols Based on the Diffie-Hellman Problem					
Protocol	*KKS*	*PeFS*	*PaFS*	*KCI*	*UKS*
Günther's	+	-	-	+	+
Günther's Extended	+	-	+	+	+
Saeednia's	+	-	+	+	+
Saeednia's Extended	+	+	+	+	+
Hsieh et al.'s	+	+	+	-*	+
Tseng et al.'s	+	+	+	+	+
Tseng's	+	+	+	+	+

? - fulfilment of the security property unknown
* - does not provide key compromise impersonation resilience because of the attack by Tseng et al. [17]
KKS - Known-Key Secrecy
PeFS - Perfect Forward Secrecy
PaFS - Partial Forward Secrecy
KCI - Key-Compromise Impersonation
UKS - Unknown Key-Share

Most of newer protocols fulfil the desirable security properties. Since no security properties were defined at the time when specific (older) protocol was published, we can only estimate the security of these protocols. However it is not possible to estimate the security properties of specific protocols (e.g. Okamoto-Tanaka's and Saeednia et al.'s protocols). As can be observed the majority of newer protocols conform to the desirable security properties, i.e. Saeednia's extended protocol, Tseng et al.'s protocol, Tseng's protocol and our two proposed protocols. However, some protocols do not fulfil all of the properties, e.g. Hsieh et al.'s protocol (due to the attack by Tseng et al.) or Saeednia's protocol. Although authors of a particular protocol often claim that their protocol conforms to the security properties, it should be noted that attacks on a protocol deny such claims. An attack on both Günther protocol (the original and extended version) were presented by Burmester [4]. Due to the key compromise impersonation attack on Hsieh et al.'s protocol, it does not offer key compromise impersonation resilience.

When a protocol suffers from attacks that lowers the security level of a protocol since it does not conform to specific security properties.

Table 4: *Known attacks*

Protocols Based on the RSA Problem	
Protocol	*Attacks*
Okamoto's	/
Okamoto-Tanaka's	/
Saeednia et al.'s	/
Protocols Based on the Diffie-Hellman Problem	
Protocol	
Günther's	Burmester's triangle attack [4]
Günther's Extended	Burmester's triangle attack [4]
Saeednia's	/
Saeednia's Extended	/
Hsieh et al.'s	Tseng et al.'s key-compromise attack [17]
Tseng et al.'s	/
Tseng's	/

5 CONCLUSION

We presented an up-to-date comparison of two-party identity-based authenticated key agreement protocol. The comparison was from the efficiency and security point of view. It can be observed that Tseng's protocol is the most efficient and at the same time secure from the security properties point of view and the attack's point of view (no attack are known for the protocol). Nevertheless, much more analysis and research has to be conducted in developing new protocols and analysis the existing ones.

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THE KEY CHALLENGES OF SERVICE SCIENCE

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ABSTRACT

In the paper, we deal with a new emerging discipline called service science. The service sector is becoming a leading sector in innovative business thinking and is therefore very important for the developing world. In response to the ever-increasing role of services and service systems, a new discipline has emerged, centered on IBM's service science initiative. We will discuss the importance of services in new service systems, as well as their purpose and the challenges that need to be overcome in order to realize the promise of service science. We will also learn about the key concepts and perspectives of service science.

1 INTRODUCTION

Services and service systems are at the core of information and business integration in today's ever-changing world. Service systems are dynamic configurations of people, technologies, organizations and shared information that create and deliver value to customers, providers and other stakeholders (1) (2). They form a growing proportion of the world economy and are becoming central to the way businesses, governments, families and individuals work. Innovation, a term applied almost exclusively to technologies in the past, is increasingly being used in relation to service systems (1) (2).
But when compared to the industry sector, the service sector seems to lack productivity and quality. The idea behind the term service is not new, but the complexity, scale and interdependence of today's service systems (3) has been driven to an unprecedented level, due to globalization, technology evolution and demographic changes. The rising significance of services means that service innovation is now a major challenge for business, government and academics (2). We need a better understanding of service systems.
In response to this, a new discipline has emerged to address the problems of services: their quality, interoperability and purpose. The discipline is based on IBM's initiative "services science", presently known as "Services Science, Management and Engineering".
This paper has been organized in the following manner. Section 2 describes the rise of the service science concept. Section 3 talks about the definition of services, mostly e-services in the concept of services science. Section 4 touches upon the key challenges and questions that arise from services science and the need to understand it. Section 5 deals with the people, jobs and knowledge necessary for realizing all the potential of services science. In section 6 we present different views on services in service systems, especially those that are necessary to fully utilize service science.

2 THE RISE OF THE SERVICE SCIENCE CONCEPT

As mentioned in the introduction, service science is a new emerging discipline, but what are the reasons and motivation behind it? The concept of service science grew because of the increasingly prominent role of services and the service sector in businesses in developing countries. The services sector is increasingly becoming the central industrial sector of developed countries from the perspective of both value added and number of employees (4). It has become possible to offer a plethora of services over the internet, due to the trend towards open platforms online.

The concept of services science provides an answer on how to solve the low productivity of services and to promote "service innovation" as a solution to productivity problems. At a basic level, services science tries to elaborate on:

- managing and controlling a larger number of service systems which are
- connected thru multi phase business processes and rules and
- uses ICT (Information Communication Technology) as a support technology.

In the past, we looked at the field of services science from a business administration perspective, marketing and operational research. The emphasis was on human intuition and experiences. The concept of service science tries to rise above that level. Its purpose is to research and analyze services from a scientific level.
The concept of service science was born in 2002, when UC Berkeley's professor Henry Chesbrough (4) decided to research services from a social engineering perspective. The team, based out of IBM's Alamaden research center, was established as a service research group within IBM research in December 2002 (4) (2).
The concept of services science became publicly known in December 2004, through an article published by IBM's CEO

and chairman, Samuel Palmisano, in the U.S. Council of Competitiveness journal Innovate America (5), in which he called for promoting research into service science (4). Later on, in July 2005, the term services science was replaced by Services Science, Management and Engineering. Service science is a fusion of scientific areas. These are:

- computer science and informatics,
- operational research,
- organizational science,
- decisions systems and
- social and cognitive systems.

In Palmisano's opinion, service science will restructure today's business organizations, spread innovation and connect the business and technological worlds (5). He also mentioned that service science is mature enough to become a new academic discipline, where industry and science will meet to produce new value with business services.

2.1 What is service science?

We will discuss the two most common definitions of service science. The definitions stem from different time periods, so they differ slightly, but still emphasize the main goal of services science.

Definition 1 (6)**:**
In the words of Paul Horn, head of IBM Research: service science is the interdisciplinary, application of science, engineering and management for the improving of services. Service science also contributes to systematic innovation and improved productivity, and is the guiding force for the improvement of services through improved predictability in productivity, quality, performance, compliance, development, reusability of knowledge and operational innovation in services.

Definition 2 (4):
Service science is a new discipline that encompasses the interdisciplinary study of computer science, operational research, mathematics, decision making theory, social and cognitive sciences, and other fields.
The purpose of this new discipline is to attack the key challenges of 21st century, among which are:

- How to restructure and prepare organizations for service science?
- How to manage and govern technological innovations?
- How to simulate complex service systems?

Service science seeks to develop a knowledge database that will help us solve the problems we encounter in the designing of business processes, as well as organizational issues, and to provide a foundation for the analysis of decision making and leadership (4). In service-dominant logic, value creation occurs when a potential resource is turned into a specific benefit, an activity known as resourcing (1).

2.2 Service science vision

Challenges that modern organizations face are a consequence of the poor understanding of the nature and behavior of service systems. The vision of service science is to discover the basic principles of complex service systems and their added value. Service science will provide a structure to build a widely accepted body of knowledge to support ongoing innovation in service systems.
The vision behind service science is all about discovering support mechanisms for the interconnectivity of complex service systems and establishing a common language and basic platform for service innovations (3).

2.1 Services in ICT networks

As information technology and the internet continue rapidly developing, and the internet moves towards more open platforms, there is a growing opportunity for various new services to arise from this progress (4).
There are quite a few examples of these new services. For instance, services like SaaS – Software as a Service, and PaaS – Platform as a Service, where organizations offer their existing business knowledge in the form of business services or as whole enterprise platform.
Offering services over the internet is still in its incubation phase, but is constantly evolving and growing. With the increasing number of services being offered over the internet, interoperability will become more and more difficult to manage and govern. That is also one of the major reasons why service science is a new discipline. A major shift is expected in business organizations, a shift from a product-oriented approach to a service-oriented business approach. In the past, ICT was considered to play a supporting role, but now ICT technologies are themselves a crucial part of organizations, encompassing decision making, consulting, lowering risk and increasing business results (7).

3 DEFINITIONS OF E-SERVICES WITHIN THE SERVICE SCIENCE CONCEPT

If we want to understand the concept of service within service science, then we should look at the basic definition of service, which is: "Service is a communication between provider and consumer, which produces added value." Producer and consumer work together (co-production) in a process and are trying to produce added value (transformation).
Generally speaking, the concept of services is somewhat "murky." A major reason for this is that the term service is an extremely broad term, covering a lot of different areas and services. As we move to the ICT world, services need an effective system for measuring quality and satisfaction of users. This measurement gets more and more complex and, as such, very difficult to measure. One of the key elements that enable us to measure service quality is the SLA – Service Level Agreement.
Services are primary dependent upon communications, and therefore it is very important to define communication

scenarios and to establish common expectations and responsibilities. There are a large number of services usages (10-50%), that don't correspond to consumer expectations (6) (8).

A question that is also often asked at conferences by people that don't understand the term service science is: "What are the services, which will be improved with service science concepts?" As mentioned in (4), we can divide services into three major groups:

- Intellectual and spiritual services
  - Ideas, principles and concepts
- Behavioral services
  - Expressions, gestures
- Business and operational services
  - Provision of intangible goods
  - Direct economic value creation

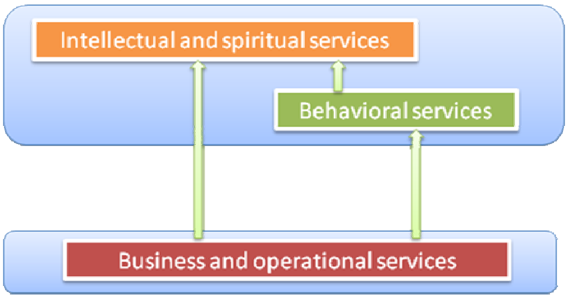

Figure 1 Service groups (4)

Business and operational services constitute the e-services that we know today. These include financial services and information services (gathering, processing, storage, transmission and production). Services cover a wide range, extending from those dealing purely with human/social capabilities to those related to commodity goods.

As seen in Figure 1, services cover many different areas, and therefore a lot of effort must be put into the establishment of multidisciplinary knowledge that is needed for service science realization. We will discuss more about that in sections 4 and 5.

4 KEY QUESTIONS AND THE CHALLENGES OF SERVICE SCIENCE

Even if there are a lot of differences among service science disciplines, it is very important to accept these differences and continue to search for the foundations of service science. Experts that are specialized in a single discipline are also needed, but to discover the full potential of service science we must develop knowledge about (9):

- How to invest in service systems for an effective growth of KPI?
- How to develop new service systems with added value (innovation)?

These two questions bring us to more issues:

- What are the architectures of service systems?
- Can we try to understand service systems as a large number of blocks that can be merged in many different ways to help realize the need for different services (interoperability)?
- Can architecture and blocks help us understand the basis of service science and their source?
- How can we optimize service systems for better communication and interaction, and subsequently higher added value?
- Why do interactions from within and between different services systems give us different results?

Service science is all about integration, optimization and maintenance. We have the necessary knowledge, but it is in pieces, and therefore not integrated into a combined single unit. Service science tries to provide us with methods, motivations and approaches for the integration of knowledge that is spread out among disciplines. Service science brings value to individuals, business organizations, government and academic institutions. In previous years, we witnessed the establishment of new disciplines, such as service marketing, service planning, services design and management, and others. All of these disciplines would bring much greater value, if they would be joined together under one common roof called service science.

5 KNOWLEDGE CREATION IN SERVICE SCIENCE

The need for knowledge, innovation and their management is present in all areas of services science. We can find it in agriculture, nanotechnology, biotechnology and all other areas that can deliver better services to their consumers. We need experts in all of these areas -- experts who have the necessary skills and knowledge for the realization of service science and innovation activities, experts with a broad knowledge specter. Industry refers to these people as T-shaped professionals, who are deep problem solvers in their home discipline, but also capable of interacting with and understanding specialists from a wide range of disciplines and functional areas (2). T-shaped professionals have just the right amount of knowledge and expertise, which gives them a bigger picture and the skills necessary to dig deeper in specific disciplines if needed.

T-shaped professionals are needed to fill in the gaps left by a discipline's specific education. Most universities still offer discipline-specific education programs, but there is always a greater need for service science students. Researchers, educators, and practitioners have shown tremendous interest in understanding service systems, and in the potential of establishing a new academic discipline: Services Sciences, Management and Engineering (SSME) (3). Some universities have already started with service-science specific programs (6) that will deliver both the new knowledge and experts necessary to realize service-science goals. Programs will teach students about the basic principles of service science, connectivity and reuse of other disciplines. A lot of organizations are hiring service scientists who will study, manage, and engineer service systems, solving problems and exploiting opportunities to create service innovations.

Widely recognized SSME programs would help ensure the availability of a large population of T-shaped professionals (from many home disciplines) with the ability to collaborate to create service innovations (2). These graduates could communicate with scientists, engineers, managers, designers, and many others involved in service systems. Graduates with SSME qualifications would be well prepared to become immediately productive and make significant contributions when joining a service innovation project (2).

6 PERSPECTIVES ON SERVICES IN SERVICE SCIENCE

The plurality of service understandings has been divided into five different categories to establish a common understanding of the term service in service science. The categories show different views of how we can understand the term service in the concept of service science. Figure 2 show views of service in service science. The views include the:

- service science sector,
- industrial science sector,
- transformation science sector,
- sector for specialized areas and
- service managing sector.

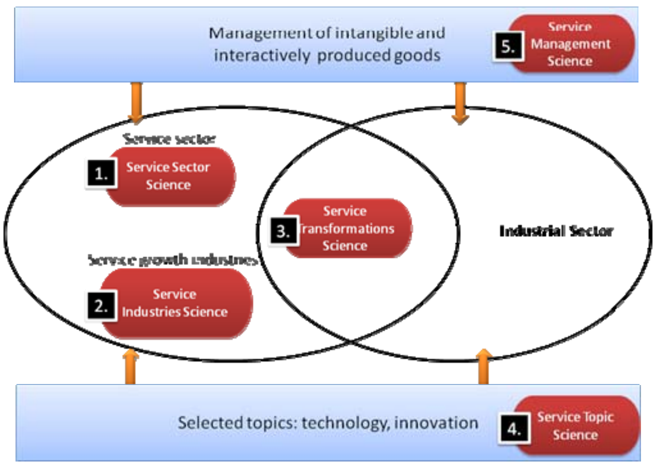

Figure 2 Perspectives on "services" in service science (10)

Service science sector help us understand service systems and service growth. For this understanding, we need a lot of research, in which the service industry sector plays a major role. Although the transformation science sector is mentioned the least of all, but it is one of the most important aspects of service science today. The transformation sector helps organizations move from gross dominant to service dominant business logic. Service-topic science helps us deal with specific topics, such as innovation, technology, business optimization, standardization, and so forth. Service management science researches services within the interaction process of co-value creation (producer-consumer). To understand service in service science, we need to understand service in all these different perspectives.

7 CONCLUSIONS

In this paper, we presented the key challenges of a new emerging discipline called "service science". We defined service science, and addressed its problems. Perhaps more importantly, we addressed its added value.
But there is still a long path ahead of service science and its establishment as a new scientific discipline. Service science will continue to grow with the rise of the service sector and the importance of services in today's globally challenged world. A lot of work still needs to be done, so that the term "service science" will not just be an abstract definition, but a concrete example of how service science can help us solve globalization issues that we are facing today. Organizations need to accept the relevance of services and reorient their research activity, which means that they need to shift their budgets from products to services. We can say with certainty that service science will become a vital player in the innovative-services sector, but it will only succeed if it is a collaborative effort of various different disciplines.

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STEPWISE INTRODUCTION OF SERVICES SCIENCE INTO UNIVERSITY CURRICULA

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ABSTRACT

A new academic discipline known as Services Science is a relatively new research area aimed at studying, improving and teaching service innovation. As business focuses more and more on service innovation, it is imperative that universities develop graduates who understand services and are able to integrate knowledge across disciplines to support the innovation process. The paper presents the activities of the KMO Group aimed at introducing services science into curricula at universities in two European countries, namely Slovenia and UK.

1 INTRODUCTION

Global economies have evolved from agriculture to manufacturing to services. Today's economy is dominated by a services landscape. The services sector overwhelms all other sectors [1]. About 80% of jobs in the US are mainly made up of service jobs as a source of economic leadership and the foundation for competitiveness in the global economy. The services sector also provides the majority of the European workforce with employment [2]. As our economies have developed in terms of higher skills and higher wages, the role of the services sector as a driver of economic growth has increased. Over the last five years, 60% of the jobs created in Europe were highly skilled, and the increase of "high-knowledge" employment was three times faster than the average growth in more traditional sectors. Services thus provide the growth engine and innovation base for the knowledge economy which is of critical importance for European competitiveness. However, higher education curriculum hasn't evolved sufficiently to develop skills to support long-term innovation within a changing global economy. As we moved to a service-driven economy, it becomes apparent that there is a lack of formal programmes to provide employees and students with the education and skills they need to be valuable members of the services marketplace.

A new academic discipline known as Services Science is a relatively new research area aimed at studying, improving and teaching service innovation. It is imperative that we make service innovation a priority – gross domestic product (GDP) growth depends on it. From the business perspective, a systematic approach to service innovation is a priority because revenue and profit growth depend on it. As academics we also need to bridge discipline silos – service innovation is multidisciplinary – students' futures depend on it.

According to IBM, Services Science, Management and Engineering is a new multi-disciplinary research and academic effort that integrates aspects of established fields such as computer science, operations research, engineering, management sciences, business strategy, social and cognitive sciences, and legal sciences [3]. Preparing students for this emerging workforce is the primary reason a services science discipline should take root, but another key benefit of creating this field is the potential for groundbreaking academic research in the burgeoning world of services.

As business focuses more and more on service innovation, it is imperative that universities develop graduates who understand services and are able to integrate knowledge across disciplines to support the innovation process. The aim of our work, as well as of the SLO-UK project [1], is to develop a set of modules to teach services science at our universities. These modules will be incorporated to extend existing curricula at Staffordshire University and the University of Maribor.

The paper is organized as follows: the importance of services science is discussed in the second section. The third section presents the activities of the KMO group related to the discussed topics. Section four gives a general description of the approaches that will be taken by two participating universities. Finally, we evaluate our activities with regard to the objectives of the KMO group.

2 THE IMPORTANCE OF SERVICES SCIENCE

The importance of services science has been recognized by all European actors, including European Technology Platforms (ETPs). ETPs are industry-driven initiatives that address technological challenges that can potentially contribute to Europe's future competitiveness and sustainable development as well as to the well-being of citizens. ETPs should ensure that knowledge generated

[1] RNP 05/2008 Introducing Services Science in Higher Education Curriculum is a project supported by the Slovenian Research Agency and British Council

through research is transformed into technologies and processes, and ultimately into marketable products and services.

NESSI is the European Technology Platform dedicated to Software and Services. Its name stands for the Networked European Software and Services Initiative. The main focus of NESSI is that of service. There are many definitions of service used in different contexts. However, all are based on the same principle: a service consumer does not own the service and therefore need not be concerned with all the aspects generally associated with ownership such as infrastructure, technology, integration and maintenance. Instead he/she has only to choose a service which meets his business needs. Businesses are increasingly concentrating on activities where they can gain a competitive advantage. Supporting capabilities can be obtained as services from specialist providers. In this context NESSI is about transforming the EU economy through Service-Oriented business models [2]. In the scope of NESSI - a Working Group on Services Sciences and Systems Engineering was established. It is beginning to address what it means to be in a services-driven world in which harnessing services in the right way can be complex, delicate, and critical to the achievement of societal and business objectives. The working group envisages a multi-disciplinary (e.g., economics, computational and mathematical sciences, management sciences, social-policy sciences, and others) effort for tackling some of the challenges in understanding services and deriving principles for harnessing services for providing appropriate value [4]. There is another NESSI working group, named Service Engineering that also addresses some additional issues related to the service economy. On the other hand, Living Labs are a crucial way to explore different aspects of services science, not only from the technological perspective, but also business aspects, as well as social implications of introducing innovative services and products.

Thus, the priority in the software and services sector, including research and academic communities, is to drive innovation. The ultimate goal of our collaboration is to develop modules and teaching approaches aimed at providing skilled and knowledgeable human resources that are crucial for achieving the objectives and goals defined not only by Lisbon and i2010 strategies but also by some national strategic documents such as Strategic Research Agenda of Slovenian TP for Software and Services[2] [5], priority research topics [6] and initiatives such as Innovation for Life Quality – Slovenia Living Lab initiative[3]. The importance and the key challenges of services science are discussed also in [7].

[2]Slovenian Technology Platform for Software and Services http://www.nessi-slovenia.com/

[3] Innovation for Life Quality – Slovenia Living Lab initiative http://slovenialivinglab.si/en/initiative/

3 SERVICES SCIENCE AT UNIVERSITIES - JOINT KMO GROUP PROJECT

In 2008 members of the KMO Group started a project aimed at developing a set of modules[4] to teach services science at our universities. These modules will be incorporated to extend existing curricula at University of Maribor and Staffordshire University.

The students of these modules will:

- Learn about problems in service, such as measuring performance, increasing quality, and creating innovation.
- Study service from a variety of different perspectives – including social sciences, cognitive science, management, engineering, and others – to address these problems.
- Understand how interdisciplinary research might be effective in studying and understanding service.
- Have an informed and intelligent conversation about the nature of service, how to think about measurement in service, and how to increase innovation in service.
- Learn how to establish, maintain, manage and participate in the LivingLabs that represent test-bed environments for evaluating new innovative services, products and solutions.
- Learn about novel business models and new ways of collaboration enabled by advanced services and solutions.

A joint project was proposed to and approved by British Council and Slovenian Research Agency because each of the partners has different, but complementary expertise required to contribute to a multidisciplinary subject such as services science. Knowledge and expertise at UM FERI, Slovenia include advanced technologies and approaches related to software engineering, information systems, communication, computer science, quality systems, security, privacy, trust, IS Auditing and semantic web. Knowledge and expertise at Staffordshire University, UK cover areas such as social issues, management sciences, cognitive sciences, organisational theory, business strategy, social theory and organisational chage and learning. Both partners are also familiar with areas such as Business Process Modeling, Innovations and Economics. Other members of the KMO Group are expected to contribute mainly in the field of engineering innovation, SMEs ecosystems, growth and globalisation of companies. We want to combine all these topics into a set of Services Science modules. These modules will be defined in 2008 and evaluated through public presentations and discussion.

[4] In this paper we are using a term module as it used in UK – a module is an area of study within award whereas in Slovenia a synonim would be a course or a subject.

We will consider the collaboration as successful if:

1. A set of developed modules or an individual module will become a part of the official curricula (master and doctoral level) proposal to be approved by authorized boards in Slovenia and/or UK.

2. In 2008 seminars and workshops compliant to the defined set of module will be given to at a group of learners in Slovenia and/or UK.

The developed modules will include at least the following content:

- Overview of Services Science
- What are Services?
- Service Systems and Eco-Systems, Service Economy
- Service Infrastructures and Frameworks
- Considerations for the Management of Services
- Productivity and Service Innovation
- Methods in services lifecycle
- Services Science, Management and Engineering Challenges

For communication between project members we have been using electronic media, videoconferencing and web groupware environments. Face-to-face meetings have also been organized, especially at international conferences and workshops such as KMO, CSS and the SSME workshop in Manchester.

4 APPROACHES TO INTRODUCE SERVICES SCIENCE

4.1 Existing programmes

As a part of the first phase of collaboration we conducted a search and comparison of approaches that had already been taken to introduce services science topics to universities. A detailed analysis of existing approaches basically revealed four main options:

- Master level study programme on Services Science (and Management) e.g. at the Northern Illinois University
- Sets of modules on Services Sciences incubated to other modules e.g. at Ecole Polytechnique Federale de Lausane, University of Exeter.
- Individual modules on Services Science e.g. at UC Berkeley, School of Information.
- SSME certification e.g. also at UC Berkeley.

Based on the detailed analysis as well as experiences with stepwise introduction of other disciplines e.g. computer science, informatics or media comunication we decided to take a stepwise approach consisting of five phases. The first phase is aimed at raising awareness on a new academic discipline. In the second phase we plan to offer individual general modules related to services science. Then we plan to introduce a set modules that will cover different aspects of services science - business, technical, social, legal etc. Finnaly, standalone study programes might be introduced at Master as well as undergraduate level.

4.2 Activities at the University of Maribor

According to this approach we developed a plan of how to implement this stepwise approach at the University of Maribor, Faculty of electrical engineering and computer science:

Phase 1 (2008): guest lectures on Services Science (invited speaker at the OTS 2008 conference, invited lecturer for postgraduate students of Computer Science and Informatics)

Phase 2 (2008-2009): New modules/subjects at the doctoral level:

- “Service Enginering and Services Science” at the doctoral Level programme of Computer Science and Informatics
- “Services Science” at Doctoral Level at the programme of Media Communications

Phase 3 (2008-2010): In addition to some mandatory/core modules related to service engineering, business process optimization, IT management, information and SOA management (all at the Master Level Informatics and Technologies of Communications study programme) a new elective pathway on Services Science will be introduced with modules on:

- Services Science and Innovation
- Service Management
- Socio-technical systems
- Legal issues of service ecosystems

Phase 4: (Joint) Master Degree Study programme on Services Sciences

Phase 5: Undergraduate study programme on Services Science

Please note that especially phases 2 and 3 are dependent on the accreditation process. Although the content and programme will be finalized in 2008 it will take at least one year to start the programme based on the official accreditation. In addition to that, phases 4 and 5 will followed only if previous phases gives satisfactory results. Developed modules or at least certain parts of them will also be offered as seminars to Slovenian companies interested in improving/extending knowledge and expertise of their employees.

4.3 Activities at the Staffordshire University

The activities planned at Staffordshire University are as follows.

Phase 1 (2008): Development of three new services science modules for undergraduaates for Information Systems and Computing students at the faculty of Computing, Engineering and Technology (FCET). In addition, a master degree for services science is also being developed at FCET for Computing students.

Phase 2 (2008-2009): Teaching of the three new services science modules to IS and Computing students at FCET. These include: 'Learning and Innovation'; 'Service Management and Service Oriented Architecture' and 'Service Science'.
Students will also be recruited for the Master program for service science at FCET. There will also be recruitment of PhD students for services science study at FCET.

Phase 3 (2009-2010): Development of services science undergraduate program in services science at FCET.

Phases 4 and 5 are identical to those presented in the previous paragraph.

5 CONCLUSION

Services science is not only about developing services for the consumer, but also with users/consumers. Since education and research on service science is also a part of a service landscape, it is only reasonable that the introduction of services science into university take an incremental and stepwise approach that is based on the experience and results of previous phases and stakeholders' feedback.

We believe we will achieve our objectives in a way similar to that described for the KMO group as community of practice [8], i.e. by:

- developing a dynamic exchange of ideas on knowledge management research, practice and education - developing modules and services science curricula
- working with industry and other organisations to promote research and develop and promote good knowledge management practice – via collaboration and active involvement in NESSI, national technology platforms and Living Lab initiatives.
- establishing a test bed and/or living labs for evaluating new approaches, techniques, methods and tools for efficient KM – e.g. Living Lab Slovenia, Finland Open Test Bed.
- contributing to and implementing the triple-helix model of innovation – by providing graduates with interdisciplinary skills and knowledge.
- sharing knowledge and exchanging expertise between members of the group in order to save effort – joint development of modules' content, material and mobility of professors.
- reviewing existing and new ideas for research projects.
- contributing to the SRAs (Strategic Research Agendas) of European technology platforms and corresponding national and European R&D programmes in KM and Services science.
- promoting seminars, workshops and conferences associated with knowledge management and services science research.
- Publicising to the group members calls for proposals for research funding, journal articles and conferences.
- disseminating work in progress on current research projects related to services science.
- facilitating the formation of partnerships among researchers and the promotion of multi-disciplinary research.
- encouraging a forum on knowledge management and services science for research students.
- applying for additional joint research funding.
- promoting sustainable innovation.

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PLAGIARIZEM PROGRAMSKE KODE – KRAJA INTELEKTUALNE LASTNINE

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ABSTRACT

Plagiarizem je vedno bolj pereč problem današnjih generacij. Prisoten je na mnogih področjih, tudi v izobraževanju in v razvoju programske opreme. Izvorne kode programov se namensko ali nenamensko širijo med različnimi akterji (študenti, programerji, …) in se uporabijo, kakor da niso delo in intelektualna lastnina drugega avtorja. Akterjev in izvorne kode je mnogo, zaradi česar je težko ugotoviti, kdo so v resnici avtorji izvorne kode. Sistemi za detekcijo plagiatov izvorne kode so lahko pri tem v veliko pomoč.

Da bi zajezili problem plagiarizma na fakultetah in povečali spoštovanje intelektualne lastnine, smo na Peadagoški fakulteti Univerze v Ljubljani, v sodelovanju s Filozofsko fakulteto Univerze v Mariboru, pričeli s projektom študija plagiarizma, zakaj študenti goljufajo in osredotočili smo se na plagiarizem izvorne kode programov ter razvoj lastnega ogrodja za detekcijo plagitatov. V tem prispevku predstavljamo del prve faze projekta.

1 UVOD

Svet je prepravljen z infomacijsko komunikacijsko tehnologijo, na voljo so vedno novi komunikacijski kanali in mehanizmi zagotavljanja informacij in storitev. Na spletu so na voljo vse močnejši spletni iskalni stroji in omogočen je dostop do ogromne količine informacij. Na splet lahko gledamo kot na največje javno skladišče informacij. Ogromno istih ali podobnih informacij je na voljo celo na večih spletnih straneh. Ker je večina informacij že na voljo v elektronski obliki na spletu, se zdi, da je tradicionalno iskanje informacij iz knjig že skoraj preteklost.

Temelj delovanja informacijske družbe je učinkovito komuniciranje, kar splet in ostala IKT odlično podpirajo. Vendar vse ni tako rožnato; najrazličnejši komunikacijski kanali in dostop do skoraj kakršnekoli informacije, ima tudi negativno plat zgodbe. Ker ni dobrega načina, ki bi preprečil, da uporabniki spleta uporabljajo nekatere storitve in dobljene podatke ter informacije, uporaba spleta in spletnih virov lahko predstavlja resen problem uporabe intelektualne lastnine. Splet namreč žal ponuja tudi precej možnosti plagiarizma - nad kopiranimi viri obstaja le zelo omejen nadzor in težko je preveriti njihovo zanesljivost. Dodana vrednost informacijski družbi se obrača proti družbi in njenemu učin-kovitemu, poštenemu delovanju. Plagiarizem se je razširil na mnoga področja, v izobraževanje, v raziskovalno dejavnost in v razvoj programske opreme, s čimer je ogrozil upošte-vanje intelektualne lastnine.

S tovrstnim problemom se srečujejo tudi vse fakultete in veliko raziskovalcev poroča, da se stopnja plagiarizma celo povečuje, kar predstavlja resno težavo v izobraževanju. Pedagoška fakulteta Univerze v Ljubljani pri tem ni izjema, plagiatorstvo najrazličnejših virov je prisotno pri večih predmetih, kjer je poudarek na uporabi IKT. Še posebej je izrazito pri predmetih, ki vključujejo programiranje, razvoj programske opreme in poučevanje programiranja. Obstaja utemeljen strah, da se bo s prihajajočo Bolonjsko prenovo stanje še poslabšalo - zmanjšalo se bo število kontaktnih ur, manj bo možnosti za učitelje, da bi ugotovili, kateri študenti potrebujejo dodatno pomoč in "edini" indikator uspešnosti bodo rezultati (programerskih) nalog. Očitno je tudi, da se bo z večanjem števila študentov, energija vložena v posamezno nalogo zmanjšala. Študenti se tega že sedaj zavedajo in nekateri plagiirajo ravno zaradi tega. Posledično, če je naloga kopirana od nekoga drugega in učitelj tega ne zazna, študent lahko predmet zaključi s premalo znanja in bo morda kasneje v življenju imel težave zaradi tega. Čeprav podjetja, ki se ukvarjajo z razvojem programske opreme, velikokrat trdijo, da šele sami izobrazijo/oblikujejo programerje, si v svojem kadru ne želijo ljudi, ki iščejo bližnjice, niso navaje-ni odgovornega dela in imajo premalo znanja iz programiranja in programskih jezikov. Strah vzbujajoče dejstvo je tudi, da so študije pokazale, da študenti redno kopirajo in da se jim takšno početje ne zdi napačno. Poudariti je potrebno tudi, da čeprav priložnosti za plagiarizem v akademski sferi niso omejene le na študente, se bomo v nadaljevanju vseeno omejili le na njih.

Na prej omenjeni fakulteti smo v sodelovanju s Filozofsko fakulteto Univerze v Mariboru pričeli s projektom študije plagiarizma. V prvi fazi projekta smo se osredotočili zakaj študenti goljufajo in na plagiarizem izvorne kode programov. Za zmanjšanje tega pojava in povečanje spoštovanja intelektualne lastnine je namreč pomembno poznavanje problema v samem jedru. V ta namen razvijamo tudi svoje

ogrodje detekcije plagiatov, ki ga bodo profesorji in asistenti uporabljali pri ocenjevanju nalog študentov.
Organizacija prispevka je naslednja. Razdelek 2 na kratko predstavlja intelektualno lastnino in z njo povezan problem plagiarizma ter zakaj se ga nekateri poslužujejo. Kako je plagiarizem opazen pri predmetih, ki vključujejo razvoj programske opreme, je podano v razdelku 3. Naše ogrodje je in trenutno stranje projekta je na kratko predstavljeno v razdelku 4. V zadnjem razdelku sledi nekaj idej za prihodnost.

2 INTELEKTUALNA LASTNINA IN PLAGIARIZEM

Intelektualna lastnina je v svetu lepo definirana [10,11,13]: po definiciji Konvencije o ustanovitvi Svetovne organizacije za intelektualno lastnino WIPO [13] se delitev intelektualne lastnine nanaša na tri kategorije pravic: na industrijsko lastnino, avtorsko in sorodne pravice ter ostale pravice. Pravice intelektualne lastnine so izključne in temeljijo na nekaterih osnovnih načelih: imetnik pravice sme prepovedati komercialno izkoriščanje predmeta pravice, za katerega ni dal dovoljenja, varstvo teh pravic se nanaša izključno na gospodarsko dejavnost, pravice so teritorialne in tudi praviloma časovno omejene, razen blagovnih znamk, trgov-skih imen in geografskih označb, katerih varstvo lahko traja neomejeno dolgo. Po izteku zakonsko predpisane dobe postane predmet takšnega varstva javna dobrina in ga lahko vsakdo svobodno komercialno izkorišča.
Intelektualna lastnina je samostojno pravno področje, saj zakon določa vrsto in vsebino teh pravic, njihov obseg in način pridobitve, način uveljavljanja pravic v primeru njihove kršitve, vrste in dovoljene oblike gospodarskega izkoriščanja ipd. Zaradi izključne narave so pravice intelektualne lastnine izredno pomembne, saj vplivajo na povečanje konkurenčnosti subjektov na trgu, njihov dolgoročni razvoj, na raziskave, razvoj in investicije, na vzpostavljanje novih ali širjenje že obstoječih vej gospodarstva, na odpiranje novih delovnih mest in nenazadnje tudi na povečanje prihodkov države iz naslova davkov. V Sloveniji velja trenutno 23 mednarodnih pogodb s področja intelektualne lastnine. Poleg mednarodnih in evropskih predpisov urejajo pravice intelektualne lastnine v Sloveniji še trije zakoni [11].

Encyclopedia Britannica [3] definira plagiarizem kot *“the act of the writings of another person and passing them off as one’s own. The fraudulence is closely related to forgery and piracy - practices generally in violation of copyright laws.”* Podobno Webster’s dictionary [10] definira plagiarizem kot *“a piece of writing that has been copied from someone else and is presented as being your own work”*. Podobno definira plagiarizem tudi SSKJ kot “*tisto, kar je prepisano, prevzeto od drugod in objavljeno, prikazano kot lastno«*. V vseh treh primerih gre torej za delo nekoga drugega, ki ga plagiator predstavi kot svoje lastno delo.

Poudariti velja, da v kontekstu visokošolskega izobraževanja plagiarizem nima le enoznačen pomen in lahko varira od citiranja nekaj stavkov brez reference avtorjem, do kopiranja celotnega dela. Obstaja namreč več načinov, kako lahko študenti s pomočjo IKT »neprimerno« opravijo svoje naloge. Najpogostejši pristop je uporaba dokumentov (člankov, raziskav, seminarjev), ki jih bodisi kupijo ali le preprosto prenesejo iz spleta. Študenti lahko preprosto pridejo do teh virov, že kar s tipkanjem ključnih besed na večih spletnih iskalnikih.
Schiller [9] poroča o treh različnih oblikah plagiarizma:

- Prva oblika temelji na preprostem kopiranju »beseda-za-besedo« iz knjige, revije ali spletne strani, ne da bi prekopiran material dali vsaj med narekovaje ali zapisali avtorja (zahvala, referenca). Tudi oddaja seminarske naloge, ki jo je napisal nekdo drug in je bila kupljena šteje za to obliko plagiarizma.
- Druga oblika plagiarizma je preoblikovanje (npr. nekoliko drugače zapisani stavki) prvotnega vira ali prevod v drug jezik, brez zahvale avtorju. Tudi če pisec spremeni nekaj besed, izpusti nekaj stavkov ali reorganizira vsebino, zahteva zahvalo avtorju.
- Tretja oblika plagiarizma temelji na uporabi idej drugih avtorjev. Delo je prav tako mišljeno kot plagiat, ker pisec ni predložil originalne misli in se pri tem zahvalil avtorju.

Lahkota, s katero lahko študenti prenašajo najrazličnejše vire, med sabo in institucijami, ima torej potencial, da spodkoplje tradicionalne oblike izobraževanja, podajanja nalog in kar je še huje, tudi intelektualno lastnino. Čeprav običajno predmetnik študente posvari, da je plagiarizem prepovedan, trud ki ga učitelj investira, da preganja primere plagiarizma skoraj zagotovo garantira, da ne bo preganjanja plagiarizma. Zato je pomembno je, da odgovorni poudarijo problem plagiarizma, kljub dodatnemu času in emocijah, ki so potrebni ko se soočijo s toženimi in s tem izničijo nekatere dvome, da fakultete zaradi obvez študentov spodbujajo krajo intelektualne lastnine.

2.1 Plagiarizem izvorne kode programov

Plagiarizem je pogost problem tudi pri računalniških predmetih. Pri veliko predmetih so implementirane programerske naloge običajno del zahtev predmeta. V veliko primerih te naloge celo znatno prispevajo h končni oceni. Posledično se pričakuje, da vsak študent nalogo reši individualno, čeprav je včasih zahtevano tudi timsko delo. Vendar je praksa, da veliko študentov sodeluje drug z drugimi in rešitve programerskih nalog se kopirajo in transformirajo z relativno malo napora. Posledično je natančna definicija, ugotavljanje in preganjanje plagiarizma zaradi mehkih mej med dovoljenim sodelovanjem in plagiarizmom težko dosegljivo. Ne nekaterih univerzah so v ta namen celo organizirali »antiplagiatorske skupine«, kot npr. na Carnegie-Mellon University [6].
Skoraj vsak učitelj in asistent pri predmetih iz programiranja se je srečal s plagiarizmom v programih, ki so jih oddali

študenti. Primerki goljufanja so najdeni, vendar običajno na ad-hoc nivoju. Učitelj npr. lahko opazi, da imata dva programa podobno napako v uporabniškem vmesniku ali pa podoben vzorec napak v testnih primerih. Ko takšno sumničenje naraste, učitelj običajno temeljiteje pregleda program in morda ugotovi plagiarizem. Na žalost je pri tem preveč prepuščeno naključju. Večje kot je število študentov, več različnih ljudi je vpletenih v ocenjevanju in manj je možnosti, da bi lahko detektirali plagiat.
Parker in Hamblen [7] definirata plagiarizem programske opreme kot *"program, ki je bi narejen iz drugega programa z manjšim številom sprememb"*. Spremembe, da se se skrije plagiarizem programske kode so zelo različne - od spreminjanja komentarjev, spremenljivk, formatiranja, do sprememb v odločitveni logiki programa.
Detekcija plagiatov je tako problem analize vzorcev (angl. *pattern analyis problem*). Kopiran program je bodisi eksaktna kopija originala ali varianta, dobljena z uporabo transformacij teksta, kot te, ki sledijo v nadaljevanju. Faidhi in Robinson sta definirala šest nivojev sprememb programske kode [4]:

- nivo 1: vključuje spremembe komentarjev in zamikov;
- nivo 2: vključuje spremembe na prvem nivoju in spremembe identifikatorjev (plagiator spremeni ime programa, procedur, funkcij, definicij tipov, konstant, spremenljivk);
- nivo 3: vključuje spremembe na drugem nivoju in spremembe deklaracij (deklariranje dodatnih konstant in spremenljivk, spreminjanje vrstnega reda deklariranih spremenljivk, premešanje procedur in funkcij, …);
- nivo 4: vključuje spremembe na tretjem nivoju in spremembe v programskih modulih (npr. spreminjanje funkcije v proceduro, združevanje dveh procedur v eno, razbitje procedure na več procedur, ustvarjanje novih procedur in funkcij, …);
- nivo 5: vključuje spremembe na četrtem nivoju in spremembe programskih stavkov (npr. for spremeni v while, while spremeni v repeat, …);
- nivo 6: vključuje spremembe na petem nivoju in spremembe v odločitveni logiki (npr. spremembe v izrazih).

Takšno razvrščanje v nivoje je sicer uporabno, vendar dokaj poljubno. Prav zato so se v literaturi pojavile tudi številne druge razvrstitve [5,6].

3 SISTEMI ZA DETEKCIJO PLAGIATOV

Za študente, ki se spoznajo na različne variante goljufanja, katere variante se ugotovijo in katere ne, je plagiarizem zelo mamljiv. Standardni pristop goljufanja je, da se dobi kopija programa in potem se spremenijo presledki med ukazi, imena spremenljivk, izpisi in komentarji. Primerjava vseh parov rešitev drugega z drugim lahko reši problem detekcije goljufanja. Vendarle tudi ta metoda zahteva podrobno ročno primerjavo, ki pri velikem številu nalog preprosto postane neizvedljiva. Ker imamo pri predmetih kjer imamo programiranje, običajno več kakor le eno nalogo, je avtomatsko orodje, ki izvaja zanesljivo in objektivno detekcijo plagiarizma, skoraj nujno potrebno
Poskusi ocenjevanja plagiarizmov, iz tehničnega vidika, naletijo na težavo ko razločujejo razlike med teksti različnih tipov. V preteklosti je bilo veliko dela namenjenega ugotavljanju konkordance med teksti. Metoda detekcije plagiarizmov mora temeljiti na metriki, ki ovrednoti kako blizu sta izvorni kodi dveh programov. Očitno je, da so razen v primeru dobesedne kopije, sistemi, ki izvajajo neposredno primerjavo teksta šibki, ker ne obstaja dobra mera podobnosti. Tudi preprosti »diff« bi seveda ugotovil le najbolj očitne primere plagiatov.
Zato obstajajo različni elektronski sistemi detekcije plagiatov za predmete iz programiranja. Iz sredine 70tih do konca 80tih so prevladovali sistemi, ki so iskali podobnost na podlagi štetja in primerjave atributov programov. Tehnika se je imenovala štetje atributov (angl. *attribute counting*). Kasneje so predstavili sisteme za detekcijo plagiatov, ki so primerjali strukture programov. Standardne metrike programske opreme in preverjanje redundantne izvorne kode so se prav tako uporabljale. Danes obstajajo tudi strežniki na spletu, ki detektirajo plagiate. JPlag [8] na Karlsruhe University se trudi najti pare podobnih programov in MOSS strežnik na Berkeleyu [2] išče zaporedja podobne kode v množici programov. Vsak od teh sistemov kreira spletno stran, kjer učitelj in asistent lahko vidita, kateri programi so sumljivo podobni. Čeprav so nekateri sistemi razumljivo uspešni pri ugotavljanju, so vseeno omejeni v ugotavljanju, kdo je originalen avtor dela.

4 NAŠE OGRODJE

Eden od študijskih programov na Pedagoški fakulteti Univerze v Ljubljani je matematika in računalništvo, kjer se študenti učijo za učitelje matematike in računalništva. Med drugim imajo kar nekaj računalniških predmetov, kjer programirajo. Več let se asistenti in profesorji pri domačih in seminarskih nalogah ukvajajo s kopirano izvorno kodo programov, pri čemer se zavedajo, da veliko primerov plagiatov niti ne ugotovijo. Avtomatski sistemi za detekcijo plagiatov imajo zanje ves potencial.
Kot že rečeno, obstaja kar nekaj sistemov, čeprav v literaturi še vedno ni veliko poročanja o njihovi uporabi. Da bi ugotovili, kako študenti izvajajo plagiarizem in bi učiteljem pomagali glede tega, smo pričeli s projektom proučevanja znanih sistemov za detekcijo plagiatov in razvojem svojega ogrodja, ki bi izvajal detekcijo med različnimi tipi datotek. V prvi fazi smo se osredotočili na razloge plagiarizma in plagiarizem izvornih kod programov. V drugi fazi bo dodatana detekcija plagiatov kode, kot so LaTeX, Mathematica, Matlab, Linux skripte in kasneje še drugi tipi datotek. Pričakujemo, da bodo postopki iz detekcije plagiatov v programski kodi uporabni tudi za druge tipe datotek.
V pvi fazi, ki je trenutno ravno v teku, razvijamo tudi svoje ogrodje, ki bo omogočalo uporabo različnih sistemov detekcije plagiatov in primerjavo njihovih rezultatov. Profesorji

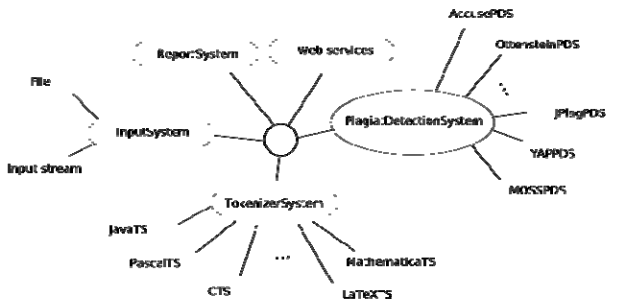
in asistenti bodo to ogrodje v naslednjem šolskem letu uporabili pri programskih nalogah iz Pascala, Cja, JavaScripta in PHPja. Ogrodje je napisano v jeziku Java, deluje kot samostojna aplikacija in kot spletna aplikacija. Njena ahitektura je prikazana sliki 1. Sestavljena je iz petih podsistemov:

1) »input system«, ki skrbi za različne tipe vhodnih virov (datotek in različnih vhodnih tokov);
2) »tokenizer system«, ki pregleda vhod in vrne zbirko nabranih podatkov, kot so npr. seznam atributov, števcev, ključnih besed, podprogramov itn.;
3) »plagiat detection system«, ki uporablja informacijo iz prejšnjega podsistema in izvede detekcijo na podlagi algoritmov različnih sistemov za detekcijo plagiatov;
4) »report system«, ki pripravi poročilo o primerjavi vhoda;
5) »web services«, ki omogočajo uporabo preko spleta.

Ogrodje je pripravljeno zelo splošno in omogoča preprosto dodajanje komponent podsistemom, kot so na primer dodatni »tokenizer-ji«, sistemi za detekcijo plagiatov ipd. Verjame-mo, da bo v prihodnosti vseboval tudi naš lastni sistem za detekcijo plagiatov in da bodo metode iz detekcije plagiatov programske kode uporabne tudi za druge zapise datotek.

Trenutno tudi intenzivno nabiramo programerske naloge iz dveh različnih študijskih predmetov:

1) "Računalniški praktikum", kjer študenti razvijajo osnovne programe v Pascalu. Iz 4 različnih nalog, smo do sedaj nabrali 105 nalog, od skupaj 38 študentov.



Slika 1: *Ogrodje našega sistema*

2) "Programiranje", kjer študenti razvijajo naprednejše programe v Pascalu, Cju in skripte v JavaScriptu in PHPju. Od 10 različnih nalog, smo nabrali 287 nalog, od skupaj 69 študentov. Dodatno temu so nekateri študentje (zaradi projekta) ob oddaji naloge anonimno poročali ali so kopirali svoje delo od koga drugega, od koga so kopirali, ali so nalogo reševali s kakršnokoli pomočjo in kakšna je bila ta pomoč.

Naloge se nabirajo do konca šolskega leta 2007/2008, v zadnjem mesecu pričakujemo večje število oddanih nalog in zatem bo narejena temeljita analiza oddanih nalog. Vsem oddanim nalogam se za kontrolo širjenja iste prvotne naloge med študenti beleži tudi čas oddaje.

4 ZAKLJUČEK

Nove tehnologije, novi komunikacijski kanali in vedno višji cilji posameznikov so zagotovo povzročili drugačno razmišljanje v našem mentalnem svetu. Istočasno na spletu nezadržno raste množica virov in spletni iskalniki ponujajo vedno več kvalitetnejših virov – intelektualne lastnine drugih avtorjev. Ker svet zahteva boljše in hitrejše rezultate, ne glede na področje, je zaradi plagiatorstva intelektualna lastnina nekaterih ogrožena.

V prispevku smo, kot prvo fazo projekta, obravnavali problem plagiarizma v splošnem in plagiarizma programske kode pri predmetih, kjer se pojavlja programiranje. V prihodnosti bo narejena primerjava na realnih programih, ki jih bodo oddali študenti smeri matematika in računalništvo Pedagoške fakultete Univerze v Ljubljani. V množici programov bodo programi letošnjih študentov, kakor tudi prejšnjih generacij. Novost na tem področju je, da bodo pri oddaji programov, študenti anonimno oddali komentar od koga in kaj so plagiirali. Na ta način bomo lahko realneje ugotovili ali in v kolikšni meri so ti sistemi natančni pri detekciji plagiatov. Prav tako bodo uporabljeni tudi umetni programi, s katerimi bomo poskusili sisteme zavesti.

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COMPARISON OF SOA GOVERNANCE AND ITIL

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ABSTRACT

Properly established SOA delivers several benefits to an organization. However, the procedure for establishing SOA is a complex and long term process. For this reason measurement and control methods are essential for context of SOA. Such methods are enabled with SOA governance and ITIL framework. This paper reviews and compares both governance approaches, which will give an insight into how adaptation of individual ITIL components benefits SOA governance and SOA overall.

1 INTRODUCTION

Introducing Service Oriented Architecture (SOA) into organization and realizing business goals with SOA is a complex and long term process. Consequently, in order to minimize complexity and to achieve SOA goals and benefits, the governing methods must be used [1, 3, 4]. Governing methods and activities enable control of established process, verify its consistency with business plan and take corrective actions if needed. Such methods are provided with SOA governance and Information Technology Infrastructure Library (ITIL) framework.

This paper will begin with SOA overview and description of how organizations can benefit from established SOA. Processes for establishing SOA are complex and it takes time before SOA investments can be returned [6]. For this reason, the challenges and issues of introducing SOA will be researched as well as the importance of SOA governance usage explained.

The following sections will provide description of SOA governance and ITIL framework. SOA governance and its processes will be explained through SOA governance life cycle. Furthermore, it will be explained how ITIL framework provides guidelines and best practices for Information Technology (IT) domain.

Every standard and framework has its strengths and its weaknesses. Therefore, SOA governance and ITIL will be compared. Through this comparison both life cycles will be researched as well as processes which can be adapted in purpose of SOA governance investigated.

2 SOA OVERVIEW

SOA is an architectural paradigm for dealing with business processes distributed over a large landscape of existing and new heterogeneous systems that are under the control of different owners.

- The key technical concepts of SOA are services, interoperability, and loose coupling.
- The key ingredients of SOA are infrastructure, architecture, and processes.
- The key success factors for SOA are understanding, governance, management support, and homework.
- SOA is neither a specific technology nor a silver bullet. There are places where SOA is appropriate and places where it is not.
- Web Services are one possible way of realizing the infrastructure aspects of SOA. Using Web Services is often recommended because it seems to be becoming established as the standard technology [3].

SOA is not a concrete architecture: it is an approach that leads to certain concrete decisions and has a set of common characteristics [3]. For example, SOA characteristics are:

- Loosely coupled: minimizes dependencies between services.
- Autonomous: control the business logic they encapsulate.
- Abstract: hide the business logic from the service consumers.
- Reusable: divide business logic into reusable services.
- Composable: facilitate the assembly of composite services.
- Discoverable: self-described so that services can be found and assessed.
- Promotes organizational agility: minimizing dependencies and increasing overall responsiveness to change [2].

2.1 Benefits and Goals of SOA

Properly established SOA brings organization several benefits and it can reduce business expenses over the long term. This is one of the main reasons why so many companies decide to implement SOA. In general SOA benefits are: improved integration, inherent reuse, leveraging the legacy investment, establishing standardized XML data representation, "Best-of-breed" alternatives and organizational agility. These benefits focus on tangible returns on investment, related primarily to how SOA leads to improvements in automated solution construction and how the proliferation of service-orientation ends up benefiting the enterprise as a whole [2].

SOA will benefit organizations in different ways, depending on their goals and the context in which SOA is applied. Previous list of common benefits is generalized and incomplete [2]. According to the Information Week Research Report [4] the most often stated benefit companies have experienced is increased flexibility in application development. Survey was taken in 2006 and it included 273 business technology experts in 200 firms. Other benefits are: ability to create services-oriented business applications more quickly, increased software modularity, better integration with business partners, lower costs, increased speed and simplicity, ability to order new products faster, less reliance on software suites, greater customization.

2.2 Establishing SOA

Establishing SOA is composed of several steps that define and develop services in the scope of service orientation. These services are then, in order to deliver organizational profit, composed into business processes.

There are different procedures to introduce and establish SOA. Procedures can vary from organization to organization and provide guidelines and best practices, which can be adapted to conform to organizational needs. Example of procedures that introduce and establish SOA are top-down and bottom-up approaches. Essence of different approaches for establishing SOA was summarized by Nicolai M. Josuttis as follows [3]:

- Establishing SOA proceeds step by step, in an iterative and incremental way.
- Need for management support.
- Importance of strong operational leadership when establishing a new strategy.
- Initial pilot projects have to be successful and have some business relevance, but they should not be mission-critical.
- Collaboration is a key factor for success.

Establishing SOA does not include the same approach in all cases. Thus organizations can adapt establishing process to their needs. Despite different solutions and proven procedures when establishing SOA organizations encounter several implementation challenges. IDC study [8] taken in 2006 conducted a survey asking 1000 business costumers about biggest implementation challenges in SOA. Results showed that number one challenge in SOA implementation most organizations encountered is exposing legacy applications as services. Other challenges are: appropriate security, complexity of integrating services, modelling business requirements and manage service metadata. Another concern in SOA context is return of investment. Nucleus Research report [6] discovered that only 37 percent of companies have achieved a positive return on their SOA investments.

Challenges and issues in establishing SOA indicate the usage of a mechanism to control processes of development and operation throughout the entire SOA life cycle. One of these mechanisms is SOA governance, which ensures effective resource allocation and achievement of the expected business results in SOA context.

3 SOA GOVERNANCE

Taking SOA business orientation into account shows significant importance of establishing governance processes into all SOA phases. Governance process provides a mechanism and activities to control whether SOA is delivering planned business aims and objectives. IBM [1] defines SOA governance as the establishment of:

- Chains of responsibility are the establishment and assignment of decision rights.
- Measurement is how to measure the effectiveness of the governance that is put in place.
- Policies are used to prescribe management direction, to guide an organization to meet its stated business needs and objectives.
- Control mechanisms are instruments that are put in place to make sure that everyone is doing what they are supposed to be doing.
- Communication is the glue of governance and a significant element. Parties must be informed to enable compliant behaviour, which drives the importance of communication [1].

3.1 Governance Relationship

From organizational aspect, in addition to SOA governance, there are also other important forms of governance such as corporate governance and IT governance. IBM [1] defines SOA governance relation to other forms of governance as shown in figure 1.

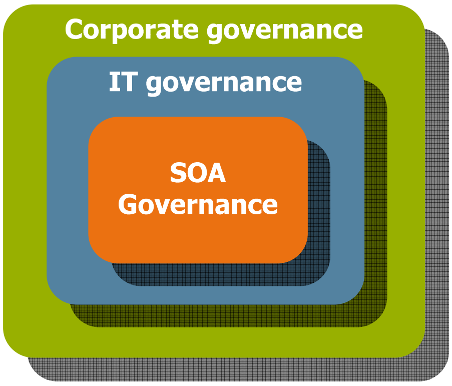

Figure 1: Relationship among the forms of governance [1].

Corporate governance

Corporate, or enterprise governance, establishes the rules and the manner in which an enterprise conducts business, based upon its strategy, marketplace, and principles of doing business. It defines for employees and for business associates the processes that are used to conduct operations and the manner in which people interact.

IT governance

IT governance is broader than SOA governance and refers specifically to the aspects of governance that pertain to an organization’s information technology processes and the way that those processes support the goals of the business. IT governance as a subset of corporate governance deals with the management and control of IT assets, people, processes and infrastructures.

SOA governance

SOA governance identifies the changes to IT governance to ensure that the concepts and principles for service orientation and its distributed architecture are managed appropriately and that services are able to deliver on the business goals.

3.2 SOA Governance Life Cycle

Although SOA governance process is connected with SOA lifecycle, it has a life cycle of its own. Compared to SOA governance life cycle, SOA life cycle has different tasks and distinct phases. SOA governance operates in accordance with other forms of governance and, throughout its life cycle, represents iterative process. SOA governance life cycle consists of four phases [1]:

- Plan: the planning phase of building an SOA governance framework focuses on understanding the overall scope of the governance opportunity within the organization and identifying areas for improvement.
- Define: when the opportunities for improved governance are identified, business and IT people can work together to define and modify the current governance arrangements and mechanisms. New approaches to creating policies need to agree on at this time.
- Enable: solutions to governance needs are put into action during this phase of establishing the SOA governance framework. These solutions can include the deployment of new or enhanced governance arrangements. Governance activities within this phase influence how SOAs are deployed by enabling the policy enforcement infrastructure.
- Measure: During this phase, governance arrangements and mechanisms that were identified in the Define phase and deployed in the Enable phase are monitored. Activities occurring in this phase help ensure that processes, policies, and standards are being complied with and that the goals of the new governance framework are in fact being subsequently realized. If not, there is an opportunity for the business to refine and enhance its governance effectiveness by initiating a new cycle to enhance the SOA governance framework.

4 ITIL

ITIL is a public framework that describes best practice in IT service management. It provides a framework for the governance of IT, the 'service wrap', and focuses on the continual measurement and improvement of the quality of IT service delivered, from both a business and a customer perspective [7].

4.1 ITIL Life Cycle

This paper refers to third version of ITIL which consists of five core books each representing individual phase of ITIL service lifecycle. These phases [7] are:

- Service Strategy: the achievement of strategic goals or objectives requires the use of strategic assets. The guidance shows how to transform service management into a strategic asset.
- Service Design: guidance on designing IT services, along with the governing IT practices, processes and policies, to realize the strategy and facilitate the introduction of services into the live environment ensuring quality service delivery, customer satisfaction and cost-effective service provision.
- Service Transition: guidance for the development of capabilities for transitioning new and changed services into operations, ensuring the requirements of Service Strategy, encoded in Service Design, are effectively realized in Service Operation while controlling the risks of failure and disruption.
- Service Operation: guidance on achieving effectiveness and efficiency in the delivery and support of services to ensure value for the customer and the service provider. Strategic objectives are ultimately realized through Service Operation.
- Continual Service Improvement: guidance in creating and maintaining value for customers through better design, introduction and operation of services, linking improvement efforts and outcomes with service strategy, design, transition and operation.

5 SOA GOVERNANCE AND ITIL COMPARISON

At the highest level of an organization is corporate governance which refers to the processes for controlling and managing enterprise business. Within corporate governance operates IT governance that deals with domain controlling IT processes in greater detail in order to ensure business goals. SOA governance and ITIL classify in IT governance as shown in figure 2.

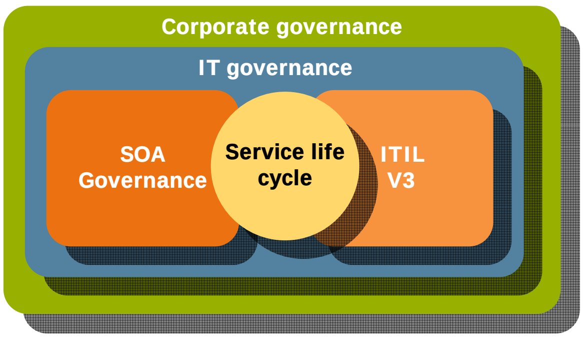

Figure 2: SOA governance and ITIL classification.

ITIL with its processes and continuous improvement provides methodology and framework for IT governance and thus classifies into IT governance domain. SOA governance operates in connection with SOA and IT governance in order to ensure planned business outcome. SOA governance and ITIL concepts are connected through service life cycle. While SOA is based on service orientation and service life cycle, ITIL introduces governance process with service life cycle and continuous improvement of service quality.

Basic difference between SOA governance and ITIL is the scope of the governance process. SOA governance focuses only on the processes in SOA domain, whereas, ITIL can be used also in governance processes in other IT domains.

5.1 Governance Life Cycle

SOA governance provides concepts and guidelines for measuring and improving of the SOA processes. Concepts and guidelines exist in a form of references which can be adapted to the needs of individual organization. SOA governance does not provide guidelines collected in one place like in the case of ITIL, however, it provides a concept established in different manner. The concept and the framework of the SOA governance described in this paper is developed and defined by IBM. Nevertheless, there are also guidelines and best practices developed by other groups or organizations, such as Oracle's framework [8] for governing SOA.

The connection between SOA governance life cycle and ITIL life cycle is shown in figure 3. The point of contact between the two life cycles is the Continual Service Improvement phase. ITIL focuses on principles such are organizational changes, roles and responsibilities, service measurement and service control. Continual service improvement in SOA governance process is enabled with collaboration of all phases rather than provided merely with separate life cycle phase.

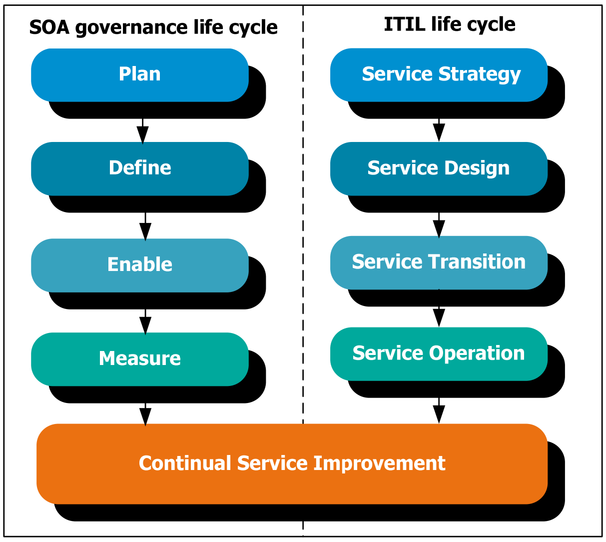

Figure 3: Comparison of the SOA governance and ITIL life cycle.

Defining governance processes and introducing governing life cycle are the key concepts in Plan phase and Service Strategy phase. The following phases, Define phase and Service Strategy phase, establish governance model and apply possible changes in order to improve governance process. Enable phase and Service Transition phase prepare all elements necessary for services to operate and, at the same time, provide activities such as organizational changes and change management. Measure phase and Service Operation phase refer to operational environment that is when services are available to customers. Activities used in Measure phase and Service Operation phase are for example measurement, controlling, review, refine and report.

5.2 Governance Processes

Introducing SOA strategy and ensuring that SOA delivers positive return of investment is achieved with flexibility and responsiveness of information technologies and business processes. Responsiveness and adaption of possible changes are the key principles of SOA governance. ITIL framework ensures these principles through service life cycle and continuous improvement of service quality process. For example, Release Management Process, Change Management Process and Configuration Management Process can be adapted from ITIL framework and successfully used for SOA governance process. These processes are present in ITIL phase Service Transition. IBM [1] classifies these processes into Manage phase of SOA life cycle. The purpose of Release Management Process is to assemble and position services into production and, at the same time, establish effective use of new or changed services. The role of the Change Management Process is to ensure that standardized methods are used for the efficient handling of all changes. Changes are recorded in the configuration management system and overall business risk is optimized. The purpose of configuration management process is to identify, control service assets and configuration items as well as to protect and ensure their integrity across the service lifecycle.

6 CONCLUSION

From a high-level view, SOA governance and ITIL can be compared according to their life cycle. The point of connection of both governance concepts is Continuous Service Improvement phase. Other phases have in common guidelines from individual phases of both life cycles.

Several frameworks and different guidelines can be used in order to introduce SOA governance. However, at the moment, in contrast to the case of ITIL, there are no standard and globally accepted guidelines for SOA governance. On the other hand, ITIL framework processes can be successfully adapted to and used for the SOA governance.

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IMPORTANCE OF SERVICE QUALITY IN SOFTWARE PRODUCT LINES

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ABSTRACT

In the paper, we have presented the importance of Service Level Agreements (SLAs) and Quality of Service (QoS) in software engineering. We have described and compared the role of SLAs and QoS. We have explored the correlation between these two concepts. We then addressed SLAs and QoS in the context of Software Product Lines (SPLs). But the focus of our paper is on introducing QoS and SLA aspects into SPL Engineering and SPL Architecture Modeling.

1 INTRODUCTION

Services are an important part of everyday life. From hailing a taxi to borrowing a book from the library, many things we do can be categorized as a service. In everday cases, we can usually judge the quality of the service we have received.

But in software engineering, it is not as easy as simply commenting on the quality of service. It is important to define service quality and have a document in which the quality of service is specified.

In this paper, we will look at the overall facts behind Quality of Service and Service Level Agreements and how these two concepts are handled in the Software Product Line Concept.

The paper is organised in the following manner: Section 2 deals with quality of service. Section 3 contains a description of the Service Level Agreement. Section 4 briefly describes Software Product Lines and Section 5 explains the role of Qos and SLA in Software Product Lines.

2 QUALITY OF SERVICE

Quality of Service (QoS) is an important element in enterprise transport infrastructure. The concept derives from ATM technology [8,10] and is about data traffic on a network. The idea behind using Quality of Service is used in many different service domains and systems for processing information.

The advantage of service quality management is in the fact that the customer can view, at certain points, how their applications are performing with regard to the goals they have set.

2.1 Principles of Quality of Service

The main principle of quality service is that a network can support a traffic stream with different levels of „quality of service“. It is beneficial for service applications to be predictive and to have a strong guarantee for services, which applications are using to run with the best effort possible [8,9].

There is also the principle in quality of service, which is important from a manager's point of view. For them it is important that the service boasts the best-effort measurement, because from this measurement they can deduce the cost.

2.2 Types of services

According to [8], we can classify services into three types:

- Commodity services,
- Core business services
- Value-added services.

These services are shown in the left part of Figure 1.

Value-added and core business services are self apparent from a strategic point of view. They have the ability to impact and maintain enterprise core competency and organizational specialzed knowledge and the ability to be renewed, if necessary. Commodity services mostly consist only of the cost of market participation and can be outsourced. These services are usually common to several processes and can be highly reusable. An example of using a commodity service is human resource management [8].

Value-added services are critical for business success; they are often highly reusable and it is possible that their subject can change. It is critical that value-added services are agile enough to support any changes that are made, without causing any interruptions.

In the right part of Figure 1, is the Service Level Agreement. A Service Level Agreement specifies guarantees for the network to give guaranteed performance boundaries based on the measurements. In most cases, network reqirements are defined in the Quality of Service and then specified in the Service Level Agreement.

For example, some applications require a certain level of bandwidth to function, mostly more than through its utilization [8].

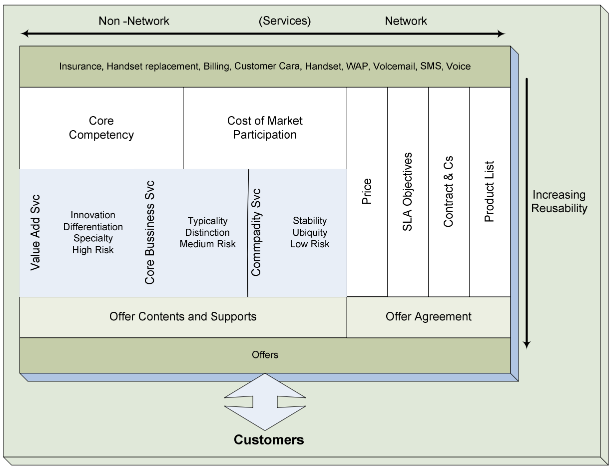

Figure 1: Relationship between service agreement and service management [8]

2.3 Business Points of Service Quality

The business points of Quality of Service have many different aspects. This is mainly due to the fact that values are spread across different layers of technology, processes, and procedures which impact the enterprise's marketing, operations, even business mission and objectives [8,9,10]. These points can be summarized as follows [8,9,10]:

- Customer „wishes" can be quoted in a Service Level Agreement. SLA is integrated with service models, which use different types of services in different business operations.
- Some models can work with the provider's list of services, with the abillity to view service inactivation. This helps providers find out which services are related to which problems, if they occur, and what the cost impact on customers is.
- End-to-end management is the key to ensuring high-quality services.
- From a customer's point of view, it is important to have effective services. Quality monitoring can assist providers and help them improve service efficiency.

The Quality of Service offered to a customer can be presented in the form of a Customer Level Agreement (CLA), Service Level Agreement (SLA), or Business Level Agreement (BLA). All providers have the obligation to satisfy the service criteria committed to in the Quality of Service. The performance measurements collected by the providers are consolidated into Quality of Service achievement reports and presented to customers [8].

2.4 Service Quality Monitoring

Services must be exactly and constantly monitored throughout their life cycles. This function assures service compliance within the targeted Quality of Service objectives by allowing adaptation strategies to be triggered via undesired metrics [8,9]. The need for quality factors increases the complexity in emerging technologies. It is important to have the option to monitor and control the Quality of Service factors in the enterprise system.

2.4.1. Measurements in Quality of Service

We will be looking at three measurements: business measurements, application measurements and session measurements. There are also other measurements, such as operational, transport and networking measurements [8,9].

2.4.2. Business Measurements

The flexibility of SOA opens up enterprise applications to deal with increased numbers of service requests. Capacity management is a discipline that can cost-effectively align IT processing and enterprise resources in the face of changing business [8,9].

The business capacity indicators are a set of metrics that show business requirements for services that should be implemented and set up in time. It is important to be knowledgeable about service levels, service level agreements and modeling of applications.
The service capacity is considered via quality indicators, which are described in the service level agreements.
The resource capacity is the measure of the utilization of the service components of the service infrastructure and its use within technologies.
Security focuses on the integrity of services; it provides the availability of services and makes its services free from attacks.

2.4.3. Application Measurements

This level of Quality of Service metrics are the closest indicators for service users [8,9,10].

Throughput indicates the ability of a service to process units of an application message per unit of time (worst, average, and best).
Responsiveness indicates the operational response time (worst, average, and best) per unit of time.
Information capacity indicates the (worst, average, and best) size of service (message) content in units of storage.

2.4.4 Session Measurements

Enterprise service customers may have many sessions for their applications[8,9].

Session availability indicates the percentage of accumulated available serving periods over a specified time period.
Reliability indicates the minimization of interruptions during service operation.
Maintainability indicates the ability of a service to be restored back to a normal state after an error has occured.

3 SERVICE LEVEL AGREEMENT

A Service Level Agreement (SLA) is a document that defines in two or more ways the rights and obligations under a contract for work [8,11]. The main idea behind having a Service Level Agreement is to set up the level of service to be provided by the provider and to reach an agreement on this. It is important to have this kind of document in case something breaks down. In that case, everything can be found in the agreement and no party can claim a lack of responsibility -- neither provider nor customer. The Service Level Agreement can be a few pages long or also a few hundred pages long. The basic components of the document are the responsibility of each side and there are metrics defined for acceptable parameters[11]. In the document one can also find descriptions of the applications and services for which the SLA is used. There are also written procedures for monitoring the service level and what needs to be done when something goes wrong.

Important is how both sides define the Quality of Service, which is then specified in the Service Level Agreement. It is necessary for the customer and the provider to monitor the SLA definitions of service quality with metrics.

Most metrics concern the quality of work performed by the service provider. The definition of quality may contain several metrics for accepable criteria [11].

Some metrics include [8,11]:

- Defect rates. This is the percentage that measures the errors in acceptance criteria for major delivereables.
- Technical quality. This measure looks at the code quality, such as the length of the program, its structure and its complexity.
- Service availability. This measures the time when the service is available.
- Servce satisfaction. This relates to the customer's level of satisfaction with the level of service level, as well as its quality and up time.

4 SOFTWARE PRODUCT LINES

The basic definition of an SPL is: »a set of software-intensive systems that share a common, managed set of features satisfying the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way" [13,14].

This definition is consistent with the definition traditionally given for any product line. But it adds more; it puts constraints on the way in which systems in a software product line are developed. Because substantial production economies can be achieved when systems in a software product line are developed from a common set of assets in a prescribed way, in contrast to being developed separately, from scratch or in an arbitrary fashion. It is exactly these production economies that make the software product line approach attractive [13].

4.1 Basic Software Product Line Concept

Software product lines can be described in terms of four simple concepts, [15,16] as illustrated in Figure 2 below:

Software asset inputs: a collection of software assets – such as requirements, source code components, test cases, architecture, and documentation – that can be configured and composed in different ways to create all of the products in a product line [15]. Each of them have a defined role in the architecture of the product line.

Decision models and product decisions: They describe the optional and varied features of a product [15].

The production mechanism and process: handles the process of building a product in the product line

Software product outputs: the products that come from a product line [15].

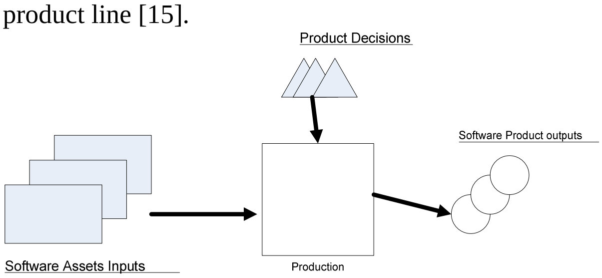

Figure 2: Basic SPL concepts [15]

These concepts illustrate the key objectives of software product lines: to capitalize on commonality and manage variation in order to reduce the time, quality effort, cost and complexity of creating and maintaining a product line of similar software systems [15,16].

5 THE ROLE OF QUALITY OF SERVICE AND SERVICE LEVEL AGREEMENT IN SOFTWARE PRODUCT LINES

There have been a few models presented that show how Service Quality is used in Software Product Line methodology.

Trendowicz talks [7] about quality modelling for SPL and about the properties that are important for quality.

In the article, we find main requirements for quality modeling to be:

Flexibility - A quality model should be flexible because of the context dependency of software quality. There are several quality contexts: company context, project context and process context. Company context includes the unique characteristics of a specific software company where the model is used [7].

Project context combines unique characteristics of a particular software project, like its domain.

Process context reflects the characteristics of a software development process, like its stability or the availability of measurable objects in different process phases.

Reusability – The need for profiting from past experience has pushed software development in the direction of product lines. In order to assure the development of high–

quality products, quality models should also follow this paradigm.

Weis et. al [12] talk about QoS enginnering with UML, it shows how you can model QoS properties with UML. If we look at the PLUS method in software product line engineering, we can see the comparison between these two models. This extension can be used when setting up software product line architecture in the modelling phase.

Liu et al. [6] present a QoS-based framework for SPL for real time and embedded systems. It presents domain and application engineering and also complies with the concepts of the SPLE and software architectures.

When we talk about QoS in SPL, there is also a discussion about the Service Level Agreement(SLA).

Research is being conducted in the field of Service-Oriented Software product lines (SOASPL). In the SOA methodology, it is essential to have an SLA document. Because SOA promotes software reuse, flexibility, visibility and comprehensibility, these concepts are very similar to those in software product lines; in this case we can use the same quality measurements as in SOA methodology.

6 CONCLUSION

To enable robust, end-to-end service contexts with acceptable and predictable service delivery and quality in an environment of varying connectivity and computational resources, we need to build on a robust architecture in the sense that it can enable swift adaptations and allow for changes in connectivity and the availability of computational resources. The significant challenge is to develop services that can establish quality of service for service needs. In this paper, we have seen some of the models that handle service quality in their architectures.

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Kognitivne znanosti

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14. oktober 2008 / October 14th, 2008
Ljubljana, Slovenia

PREDGOVOR

Pristopi in modeli pri raziskovanju zavesti/duševnih procesov

Letos že petnajstič nadaljujemo tradicijo vsakoletnih srečanj kognitivnih znanstvenikov v okviru Slovenskega društva za kognitivne znanosti in že enajstič pod okriljem multikonference »Informacijska družba«.

Letošnja konferenca ima specializirano temo »empatija«, prispevki pa pokrivajo širok spekter področij od filozofije, preko znanosti o sistemih do lingvistike, umetne inteligence do biologije in medicine. Kot taki odsevajo stanje na področju kognitivnih znanosti, kjer se problemov vsaka disciplina loteva po svoje (mnogokrat izjemno uspešno), malo pa je primerov uspešnega združevanja rezultatov v celovit, interdisciplinarne modele kognitivnih pojavov. Lahko bi rekli, da se kognitivna znanost kot enovita disciplina sooča z metodološko težkim problemom: kako povezati naravoslovje (ki preučuje nevrofiziološke procese) in humanistične vede (ki preučujejo doživljajske vsebine), ki je ekvivalent klasičnemu kognitivnemu »težkemu problemu« (torej problemu ločitve telesnega in duševnega).

Na kognitivni konferenci vzpodbujamo interdisciplinarno debato med znanstveniki, ki se tako ali drugače ukvarjajo z raziskovanjem zavesti. Pričujoči teksti vsebujejo poročila o raziskavah, pa tudi razmišljanja o predpostavkah, na katerih temeljijo posamezne raziskave (ki so znotraj posameznega raziskovalnega polja včasih tako samoumevne, da se jih sploh ne zavedamo).

Urban Kordeš
Matjaž Gams
Olga Markič

Učenje in odločanje: Analiza definicij osnovnih konceptov v Wikipedii z metodami analize besedil in omrežij

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POVZETEK

Prispevek predstavlja rezultate preliminarne analize besedil s področja učenja in odločanja. V ta namen smo analizirali 19 izbranih strani spletne enciklopedije Wikipedia z dvema računalniškima programoma: *Document Atlas* za analizo besedil (angl. *Text Mining*) in *Pajek* za analizo omrežij *(Network Analysis*). Pridobili smo informacije o vsebinski in strukturni povezanosti strani ter o odnosu med temeljnima proučevanima pojmoma: *učenje* in *odločanje*.

1 UVOD

Sodobna računalniška orodja za analizo podatkov (angl. *Data Mining*), analizo besedil (*Text Mining*) in analizo omrežij (*Network Analysis*) postajajo vse zmogljivejša, pa tudi vse bolj uporabna in dosegljiva. Še posebej so primerna za različne vrste iskanja in raziskovanja strukturnih in vsebinskih povezav med predmeti proučevanja. V tem prispevku predstavljamo primer uporabe dveh takšnih orodij za potrebe interdisciplinarnega raziskovalnega projekta. Pokazati želimo, da je mogoče na takšen način razmeroma hitro in preprosto dobiti zanimive in povsem uporabne raziskovalne rezultate. Ob tem želimo spodbuditi uporabo takšnih orodij tudi na drugih raziskovalnih področjih.

Projekt *Metodološki vidiki raziskovanja kognitivnih procesov: učenje in odločanje* (ARRS J7-9792, 2007–2009) je interdisciplinaren temeljni raziskovalni projekt, katerega cilj je razvoj interdisciplinarne raziskovalne paradigme, ki bi združevala in nadgrajevala dosedanje raziskovalne pristope (Kordeš, 2007). Projekt proučuje dva povezana kognitivna procesa, *učenje* in *odločanje*, ki ju poskuša bolje razumeti skozi integracijo interdisciplinarnih parcialnih znanj. V ta namen projekt združuje raziskovalce z različnih področij: filozofije, psihologije, nevroznanosti in umetne inteligence.

Motiv za izvedbo raziskave, opisane v tem prispevku, je nastal na enem od projektnih sestankov, kjer smo ugotovili, da je potrebno za učinkovito medsebojno delo in razumevanje natančno definirati slovar temeljnih pojmov s področja raziskovanja, jih opredeliti z različnih interdisciplinarnih vidikov in opisati povezave med njimi. Določili smo naslednje ključne pojme: *učenje*, *odločanje*, *misel*, *čustvo*, *dejanje*, *okolje*, *odgovornost*, *racionalnost*, *avtorstvo*, *znanje*, *cilji*. Sprva smo imeli namen slovar oblikovati sami, potem pa smo ugotovili, da so na spletni enciklopediji Wikipedia opisi teh pojmov (glejte dva primera na sliki 1) zelo dobri. Ustrezajo vsebinsko, strokovno in po obsegu, hkrati pa omogočajo različne analize povezav med njimi.

V okviru pričujoče raziskave smo si zato zastavili naslednje cilje:

- Ugotoviti, kateri ključni pojmi, pomembni za projekt, so opisani na Wikipedii in kako.
- Kako so ti pojmi med seboj vsebinsko povezani?
- Kakšen je odnos med ključnima konceptoma, "*učenje*" in "*odločanje*", ter katere so skupne točke med njima?

2 METODA DELA

Na spletni enciklopediji Wikipedia smo izbrali 19 strani (t.i. gesel oziroma člankov), ki so po našem mnenju najbolj ustrezale izbranim ključnim besedam: *Decision-making*; *Cognition*; *Choice*; *Learning*; *Memory*; *Behaviors*; *Experience*; *Education*; *Action_(philosophy)*; *Philosophy_of_action*; *Thought*; *Feeling*; *Environment*; *Context*; *Responsibility*; *Rationality*; *Knowledge*; *Objective_(goal)*; *Author*. Vse te strani smo zajeli dne 16.4.2008.

Besedila smo analizirali z dvema računalniškima programoma: *Document Atlas* in *Pajek*. Oba programa sta plod domačega znanja in brezplačna.

Document Atlas (http://docatlas.ijs.si/) je program za klasifikacijo in vizualizacijo velikih količin dokumentov (Fortuna, et al., 2005). Program analizira množice besed, ki nastopajo v vhodnih dokumentih, ter razpozna tiste ključne besede, ki so med dokumenti najbolj podobne oziroma najbolj različne. Na tej osnovi oblikuje dvodimenzionalni prikaz dokumentov, kjer so med seboj podobni dokumenti prikazani skupaj. Grafično je prikazana je tudi gostota dokumentov. Dokumenti, ki so prikazani blizu skupaj, so med seboj vsebinsko povezani, bolj gosto posejani dokumenti pa običajno označujejo neko skupno temo oziroma obravnavani koncept.

V naši analizi smo *Document Atlas* uporabili na treh množicah dokumentov:

- originalni dokumenti, zajeti z Wikipedie v formatu HTML;
- prečiščeni dokumenti v tekstovnem formatu, pri čemer smo iz originalnih dokumentov izločili vse označevalne in nevsebinske dele (slika 2, levo);
- samo ključne besede, ki jih eksplicitno navaja vsak izvorni dokument (slika 2, desno).

Pajek (http://pajek.imfm.si/) je program za analizo velikih omrežij (Batagelj, Mrvar, 2003; De Nooy et al., 2005). Omrežja so predstavljena v obliki grafov, ki jih mogoče analizirati, preblikovati in prikazovati s številnimi metodami, realiziranimi v programu.

V našem primeru smo analizirali graf povezav med spletnimi stranmi, upoštevajoč eksplicitne URL naslove, navedene na straneh. Za razliko od programa *Document Atlas*, s katerim smo iskali *vsebinske* povezave med dokumenti, gre pri *Pajku* torej za *strukturno* analizo spletnih povezav med dokumenti. Poleg osnovnih 19 strani smo v graf povezav vključili še vse tiste strani Wikipedie, na katere je mogoče priti s teh strani v enem koraku (skupaj 1777 dokumentov). Izdelali smo več grafičnih prikazov. V skladu z v uvodu omenjenimi cilji sta najpomembnejša dva prikaza:

- povezave med osnovnimi 19 dokumenti (slika 3), in
- graf povezav med dokumentoma *Decision-making* in *Learning* (slika 4).

Slika 1: Izseka dveh strani na spletni enciklopediji Wikipedia (Vir: Wikipedia, 2008)

3 REZULTATI

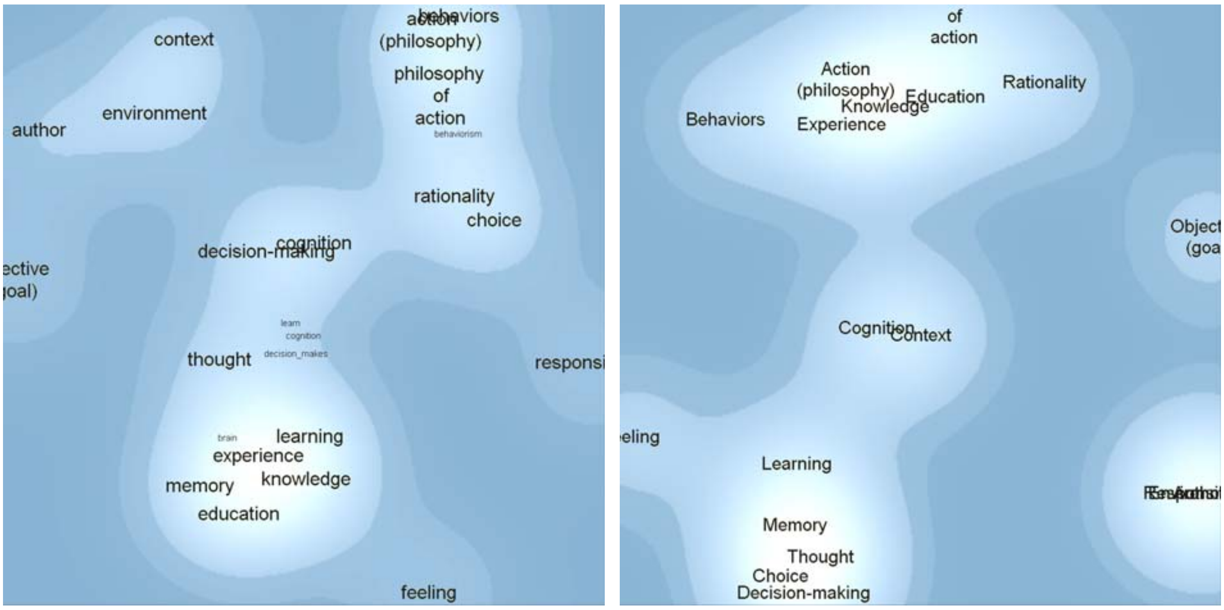
3.1 Analiza vsebinskih povezav s programom *Document Atlas*

Prva analiza, izvedena na originalnih dokumentih v formatu HTML, ni dala smiselnih rezultatov. Izkazalo se je, da nekateri elementi teh dokumentov, ki služijo le oblikovanju in označevanju besedila, motijo program, saj jih razume kot ključne besede. Prevladale so povezave med dokumenti, ko so bile bolj oblikovne kot vsebinske narave. Skupaj so se znašli dokumenti istih avtorjev, ki so uporabljali značilne oblikovne in slogovne elemente.

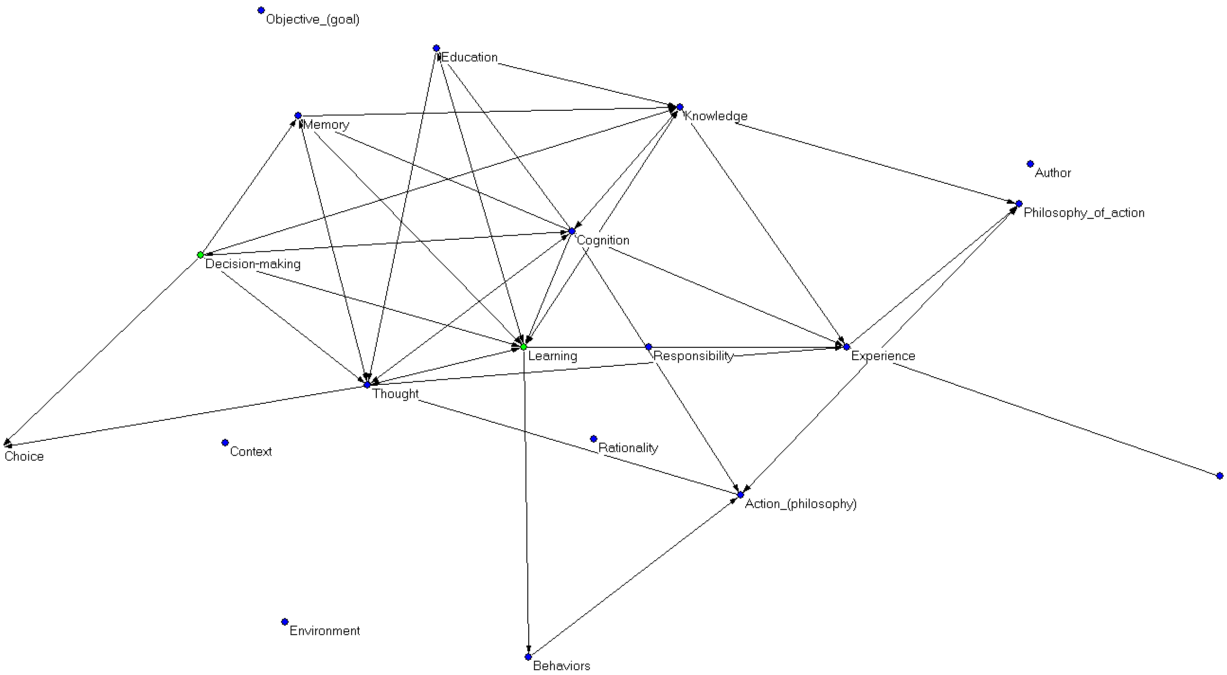
Boljši pa so bili rezultati na preostalih dveh množicah vhodnih dokumentov: prečiščenih besedilih (slika 2, levo) in seznamih ključnih besed (slika 2, desno). V obeh primerih sta se oblikovali dve večji skupini med seboj povezanih konceptov ter nekaj manjših skupin. Prvo večjo skupino označuje pojem *learning*, ki se povezuje s pojmoma *memory* in *thought* ter, v nekoliko večji razdalji, *decision-making*. Druga večja skupina vsebuje pojme s področja filozofije: *philosophy of action*, *behaviors*, *rationality*. Nekateri pojmi so enkrat bližje eni in drugič drugi skupini: *choice*, *education*, *experience*. Nekateri pojmi pa so vedno razmeroma oddaljeni in tvorijo svoje manjše skupine: *objective* (*goal*), *feeling*, *author*, *environment* in *context*.

3.2 Analiza strukturnih povezav s programom *Pajek*

Celotni analizirani graf je obsegal 1777 dokumentov, kar pomeni, da je 19 izbranih strani Wikipedie neposredno povezanih s 1758 drugimi dokumenti Wikipedie. Gre torej za veliko število povezav in zelo dobro povezanost izbranih dokumentov z drugimi dokumenti Wikipedie.



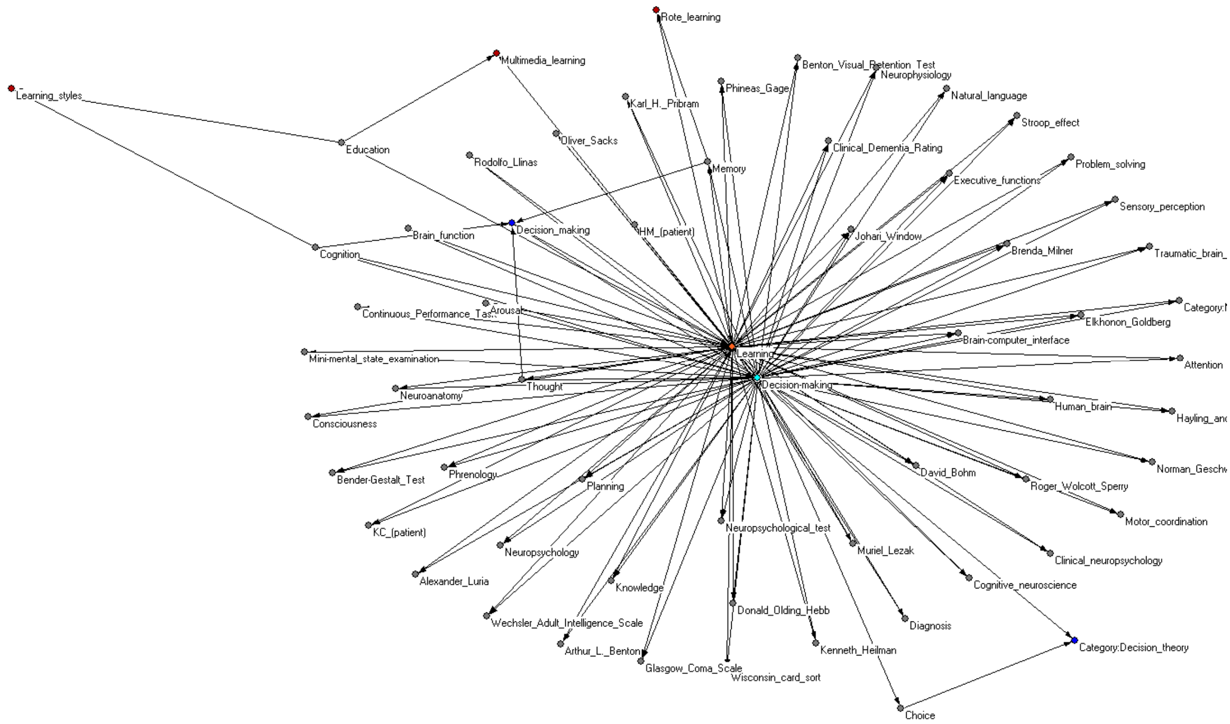
Slika 2: Vsebinska podobnost dokumentov: prečiščenih besedil (levo) in ključnih besed (desno)



Slika 3: Neposredne povezave med dokumenti

Neposredne povezave med izbranimi 19 dokumenti prikazuje slika 3. Puščice označujejo smeri povezav. Razvidna je osrednja vloga pojmov *learning*, *cognition*, *knowledge*, *thought*, *decision-making*, *memory*, *education* in *experience*, ki imajo veliko število povezav in so tudi med seboj dobro povezani. "Filozofska linija" *behaviors*, *philosophy_of_action* in a*ction_(philosophy)* je nekoliko odmaknjena, vendar tudi povezana med seboj. Tudi tu imamo elemente, ki so slabo povezani z ostalimi (*choice*, *feeling*) ali pa sploh ne (*context*, *environment*, *rationality*, *author*, *reponsibility*).

Zanimiv je tudi graf povezav med dokumentoma *learning* in *decision-making*. Slika 4 prikazuje ta dva dokumenta ter vse dokumente Wikipedie, preko katerih sta ta dva dokumenta povezana v največ dveh korakih. Jasno so razvidne ključne besede, ki povezujejo ta dva koncepta, na primer tiste, povezane s področji kognitivnih in nevroznanosti ter teorije in prakse odločanja. Veliko je povezav preko strani z opisi pomembnih raziskovalcev z omenjenih področij, kar je neposredna posledica dejstva, da analiziramo strani spletne enciklopedije.



Slika 4: Povezave med learning in decision-making v največ dveh korakih

4 ZAKLJUČKI

Opisana preliminarna raziskava je pokazala predvsem dvoje: da so sodobni programi za analizo besedil in omrežij resnično zelo zmogljivi, dostopni in preprosti za uporabo, ter da z njimi dobljeni rezultati omogočajo dober vpogled v vsebino in strukturo dokumentov z obravnavanega raziskovalnega področja. V našem primeru smo dobili zelo dober pregled nad področji, povezanimi z osrednjima proučevanima kognitivnnima procesoma: *učenje* in *odločanje*. Generirani grafični prikazi so sprožili več plodnih razprav v projektni skupini, pokazali so na povezave, ki bi jih sicer lahko spregledali, ter vzpodbudili razmišljanja o manjkajočih povezavah, ki bi jih morebiti lahko osvetlili v okviru projekta.

Pri delu s programom *Document Atlas* smo spoznali vpliv "prečiščenosti" besedil na rezultate analiz. Pred vsebinsko analizo je potrebno iz dokumentov izločiti označevalne in oblikovne elemente, sicer le-ti preveč vplivajo na rezultate. Pri vsebinski analizi smo dobili zelo dobre rezultate že samo iz ključnih besed, kar bi lahko poenostavilo morebitne nadaljnje analize na večjih množicah dokumentov.

Pri rezultatih programa *Pajek* nas je presenetilo veliko število povezav med stranmi Wikipedie. Izbranih 19 strani je neposredno povezanih s kar 1758 drugimi stranmi, kar pomeni, da število zunanjih povezav zelo hitro narašča z izborom osnovnih dokumentrov in da so le-ti dobro integrirani v spletno enciklopedijo. Po vsebinski plati smo ugotovili, da sta področji učenja in odločanja med seboj dobro povezani preko osnovnih strani, še predvsem preko strani *cognition* in *thought*. Ko v izbor vključimo še dodatne strani Wikipedie, še posebej izstopajo povezave med njima preko področij, povezanih z nevroznanostmi.

Opisana raziskava je bila preliminarna in v več pogledih omejena. Predvsem je šlo za subjektiven, *ad-hoc* izbor osnovnih dokumentov, ki bi bil prav lahko tudi drugačen. Število dokumentov, 19, je majhno in vsi izvirajo iz istega vira (Wikipedia). To pomeni, da je izbor pristranski, hkrati pa občutljiv na vplive avtorstva in oblikovanja dokumentov. V bodočih raziskavah bi bilo zato treba uporabiti bistveno večje število dokumentov iz različnih virov. V tem primeru bi bile smiselne tudi kvantitativne analize grafa povezav med dokumenti.

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INTROSPEKCIJA IN EGZOSPEKCIJA

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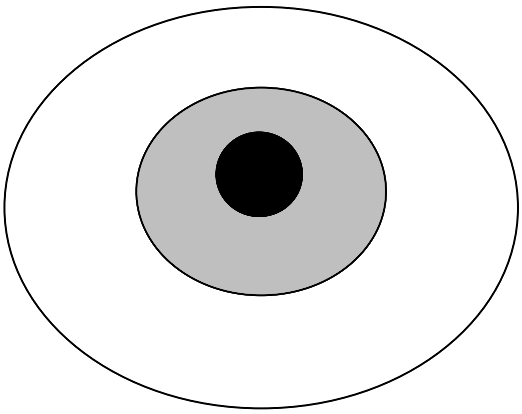
POVZETEK

Referat nadaljuje pretežno filozofsko tematiko lanskega referata "*Kot z očesom in vidnim poljem (5.633)"*, ki je komentiral popularno mesto v Wittgensteinovem "*Traktatu*" (Bojadžiev 2007). Tokrat gre bolj za notranje videnje (introspekcijo), postulate tega "videnja", funkcijo pravkar uporabljenih navednic in možne omejitve takega videnja.

Dualizem običajnega, zunanjega videnja in bolj skrivnostnega notranjega videnja (introspekcije) v naslovu referata bi morda za začetek kazalo zamenjati z bolj diferencirano shemo:



ki ponazarja prostorska razmerja v belo – sivo – črni trojici [percepcija, propriocepcija, apercepcija]. Propriocepcija, zaznavanje lastnega telesa od znotraj, se tradicionalno upošteva kot del introspekcije, ki pa v razpravah o njej pogosto potegne krajši konec. To morda ustreza običajni perspektivi filozofa kot mirujočega, stacionarnega, intenzivno reflektirajočega organizma, ki pogosto še zapre oči da bi bolje videl oz. razumel, kaj in kako pravzaprav vidi, ko gleda vase. Ta perspektiva zanemarja ključno dejstvo, da smo gibljivi (animated) organizmi, ki se v tej funkciji opirajo na zaznavanje, sveta in lastnega telesa v gibanju po njem. Tematika jaza/subjekta/zavesti je tako videti bližja sivi coni propriocepcije, o kateri se ne ve prav dosti, kot pa še bolj temni, črni coni »gledanja« lastnih mentalnih stanj (Sheets-Johnstone 1998).

V nasprotju z običajnim, zunanjim gledanjem (sveta) ni v metafori notranjega očesa (ednina!) jasno niti kdo, če sploh kdo, niti kam, niti kaj, niti kako "gleda". Kljub temu pa se introspekciji pogosto pripisujejo naravnost čudežne lastnosti: nezmotljivost, vsevidnost oz. vsevednost subjekta introspekcije, njegov privilegiran dostop (Ule 2001, str. 302). Ti postulati ne veljajo za običajno, zunanje gledanje – nasprotno, to je načelno zmotljivo, ne vidi vsega, privilegirano pa je le v geometričnem, prostorskem smislu. Poleg tega ima običajno gledanje svoje omejitve: oko samo ima slepo pego, videnje z njim pa svoj mrtvi kot: kar ne vidimo, je ravno oko samo, in njegova bližnja okolica (obraz, glava, vrat, …; cf. Harding). Zato je naloga samo-prepoznavanja v zrcalu, pomembna za konstitucijo zavesti, tako težka, da jo obvlada le manjše število organizmov. Lahko bi rekli, da ni čudno, da se ne moremo kar tako prepoznati v zrcalu, ko pa v njem vidimo ravno to, kar sicer nikakor ne moremo videti. Po analogiji s to omejitvijo bi lahko domnevali, da ima tudi »notranje zrenje« kakšno podobno omejitev; kot pravi Dolar:

> Zavesti forma njenega početja konstitutivno uhaja ... Notranji moment - celo pogoj - izkustva zavesti je, da ni samo sebi prosojno, da si zavest ne more stopiti za hrbet, in ta netransparenca je vsa njena konsistenca (Hegel in objekt, str. 53).

Do podobne domneve pridemo, če uporabimo težja teoretska orodja in primerjamo implikacijske postulate o nezmotljivosti in vsevednosti introspekcije (če zaznavam neko mentalno stanje, sem res v njem; če sem v nekem mentalnem stanju, ga tudi zaznavam) z zanesljivostjo (soundness) in popolnostjo (completeness) refleksivnega sistema: oboje skupaj ne bo možno, introspekcija je bodisi nezanesljiva bodisi nepopolna, ali pa oboje. Podobno bi lahko ugotovili ob kvantifikacijski formulaciji "vsevednosti subjekta introspekcije«:

> Naše doživljanje *stalno* spremljajo prepričanja o doživljanju, pravzaprav *vse*, kar počnemo, spremlja *neka* zavest o tem, kar počnemo in kako to počnemo (Ule 2001, str. 289; podčrtal DB)

Ta kvantifikacijska struktura ($\forall\exists$), in zahtevnost njene potrditve, navaja na domnevo, da lahko takšne in podobne postulate o strukturi introspekcije postavljamo le zato, ker ta struktura sama ostaja v mrtvem kotu introspekcije, kar omogoča tako različne rešitve za "argumente" introspekcijske fukcije (kdo, kam, kaj in kako gleda)

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ALI SMO STROJI Z EMPATIJO?

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POVZETEK

V prvem delu je predstavljen pogled Rodney Brooksa na razvoj strojne inteligence. Čeprav gre za verzijo trde umetne inteligence, znano desetletja in zadnje čase v nemilosti, je zanimivo pogledati novejšo in bolje podprto argumentacijo. V drugem delu je analizirana empatija. Ni nobene zapreke za čustva ali empatijo tudi pri strojih, čim res dosežejo neko inteligenco. Ljudje pa se že sedaj empatično navezujemo na programe, računalnike, robote in stroje.

1. UVOD

PHOTO: SETH RESNICK/GETTY IMAGES

Slika 1: Rodney Brooks, znameniti raziskovalec umetne inteligence na preprostih umetnih bitjih z MITja, je leta 2008 ponovil tezo: »Sem robot. Vi ste tudi.«

Umetna inteligenca kot znanstvena disciplina naj bi se začela leta 1956 je v Dartmouthu, ZDA, ko je John McCarthy organiziral konferenco z naslovom The Dartmouth Summer Research Project on Artificial Intelligence. Najpomembnejši raziskovalec umetne inteligence in računalništva ter informatike je bil Alan Turing, ki je postavil vrsto ključnih konceptov od Turingovega stroja, Turingovega testa do Church-Turingove teze. Turing je med drugim postavil nekaj zanimivih konceptov kot Church-Turingovo tezo, univerzalni Turingov stroj in Turingov test. Njegovo stališče osebno ni bilo povsem jasno, čeprav je eksplicitno napovedal, da je lahko računalniki računajo, mislijo in čutijo kot ljudje in da je samo vprašanje časa, kdaj bo do tega prišlo (Turing 1947). Velika večina strokovnjakov temu ne ugovarja, mnenja pa so deljena glede načina, na katerega naj bi to prišlo in glede datume tega dogodka.

V umetni inteligenci je več pristopov, od trde do šibke ali kognitivne (Gams 2001, 2003). Znano stališče trde smeri (GOFAI - Good OldFashioned AI) je, da bo razvoj bolj ali manj linearen, da bodo računalniški sistemi počasi postajali čedalje sposobnejši in da bodo končno dosegli in presegli človeka. To stališče je precej skladno s Church-Turingovo tezo in Turingovim strojem, od koder bolj ali manj sledi, da je vse izračunljivo, tj. tudi tisto, kar lahko ljudje sklepajo, možno narediti s Turingovim strojem oz. računalnikom.

2. NOVA TRDA INTELIGENCA

Brooksovi argumenti so naslednji (slika 1; Brooks 2008): Vsi ljudje in sploh vsa živa bitja smo roboti. Sestavlja nas na milijarde biomolekul, ki delujejo po naravnih zakonih in sestavljajo kompleksna bitja. Te molekule interaktirajo med seboj po zakonih narave, čeprav nam ne v celoti znanih, in njihovo skupno delovanje opazimo kot zavest, inteligenco ali čustva. Podobno kot Turing torej tudi on ne vidi razloga, zakaj ne bi delovanja živih bitij replicirali na takem ali drugačnem stroju – biološkem, kemičnem ...

Stroji – umetna bitja – bodo sodelovali z ljudmi in jih ponekod začeli bistveno prekašati. Tu se Brooks strinja z večnim AI optimistom Rayem Kurzweilom, ki je leta 2000 napovedal, da bodo okoli 2020 računalniške umske sposobnosti prešle človeške. Leta 2005 je izdal nadaljevanje (Kurzweil 2000; 2005). V tem delu opisuje nadaljevanje idej kot: nadaljnji razvoj strojne inteligence, povezovanje računalnikov in ljudi preko direktnih vmesnikov, nastanek mešanih bitij-strojev-računalnikov itd.

Medtem ko Brooks in Kurzweil (2005) ne dvomita o bližnji čudoviti bodočnosti, kjer bodo ljudje zaradi razvoja umetne inteligence živeli čedalje bolje in bolje, Prav tako drži tudi naslednja Brooksova trditev, da danes najdemo praktične aplikacije umetne inteligence skoraj povsod, od internetnih iskalnikov do prepoznavanja glasu, naprav za vbrizgavanje goriva, in programov za nakupovanje delnic. Prvi primeri širšega prodora fizičnih strojev – robotov, so hišni roboti, ki na veliko prihajajo v naš vsakdan. Trenutno najbolj prodajani robot vseh časov je Roomba, ki so ga prodali v milijonih izvodov (Wikipedia, slika 2).

Slika 2: Robotski sesalnik Roomba je najpogosteje uporabljani robot v človeških domovih.

Za tržno uspešnost Roombe je bilo potrebno izpolniti nekaj pogojev, med njimi tudi čisto inženirske male popravke kot vrteča se metlica na robu, da lahko doseže skrajni rob ali senzor stopnic, da se ne razbije. S stališča znanosti pa so najpomembnejši novi algoritmi umetne inteligence, razviti na MITju v okviru raziskav robotskih žuželk. Brooks je namreč zaposlen tako v akademskem kot poslovnem okolju – v podjetju, ki izdeluje Roombe. Pred desetletji so se robotski sesalniki pomikali ali bolj ali manj naključno, ali pa so si zapomnili sobo in jo posesali črto za črto. Roomba se na oko obnaša bolj kot slepa žuželka. V resnici kombinira vrsto zamisli in postopkov od naključnosti do posameznih specifičnih algoritmov za posebne pogoje. Primer je npr. »ujetje« pod omaro, kjer je vhod ravno tako velik, da je prišel notri. Ko Roomba čez nekaj časa ugotovi, da je ujet v malem prostoru, skuša preiskati pregrajo delček po delček, dokler ne najde izhoda. Pri čiščenju samem se drži nekaj pravil, občasno pa prekine normalno preiskovanje in se naključno odloči. Rezultat čiščenja ni enakomerno posesana površina, kot bi jo npr. človek, ampak je ponekod posesano večkrat, ponekod pa morda celo nikoli. V povprečju je Roomba približno 4x počasnejši kot človek, vendar posesa bolje, ker večkrat posesa pod različnimi koti. Sam tudi ugotovi, kje se nahaja bolj umazana površina in se tam zadrži več časa.

Osebna izkušnja avtorja tega članka z Roombo je izredno pozitivna. Ne samo da je pri ceni okoli 300 Eurov v Evropi oz. 300 $ v ZDA bistveno cenejši kot najeta pomoč in se investicija povrne približno v letu (toliko traja garancija), z njim je tudi bistveno manj nepričakovanih zapletov. Če računamo, da je cena pomoči okoli 5-7 Eure na uro in da smo pri avtorju doma za enodnevno pomoč plačali po 50 Eurov, v enem letu to znese 2500 Eurov. Tudi pri minimalni oceni, da bi šlo za sesanje le 6 Eurov na teden, to znese 300 Eurov na leto. V enem letu se torej v večjem stanovanju ali hiši investicija že izplača. Cenovno nekoliko manj ugodni so čistilci bazenov, robotske kosilnice trave, roboti za umivanje tal itd.

Poglavitna prednost pri robotski pomoči pa je v tem, da deluje avtonomno brez človeškega nadzora. Npr. čiščenje sprožimo pred odhodom na jogging in ni potrebno nikogar čakati, nikomur odpirati vrat ali dajati ključa itd. Morda tehnično nerazgledane moti, da je dobrodošlo nekaj poznavanja mehanizmov, recimo pri rednem čiščenju, po drugi strani pa je lahko Roomba prav prijetna poživitev s svojimi melodijami pri delu, oglašanju, ko se npr. zatakne ali sporoča svoj položaj ali ko mu je zmanjkalo elektrike. Sem in tja se vseeno zatakne, recimo ko posesa kabel in ne more naprej.

Po Hendlerju (2006), je zelo pomembno, da se zavedamo, da je v obnašanju Roombe skrito ogromno znanja, recimo sto človeških let izkušenj. Žuželke so morda na videz zelo naključne pri svojem premikanju, so pa rezultat milijonov let evolucije. Raziskave na MITju so neposredno prenesene v gibanje Roombe, čeprav na prvi pogled to ni očitno, saj se zdi, kot bi se gibal naključno. Če v takih aplikacijah ne priznamo vloge umetne inteligence v njej, pa čeprav na nivoju žužkov, potem sami zanikamo uspešen prenos raziskovalnega znanja v prakso. Pomembno je tudi priznati tudi akademsko vrednost omenjenih metod. Če namreč pristanemo na to, da je aplikacija preprosta in da v resnici ni prave človeške inteligence v tej aplikaciji, torej prave umetne inteligence, potem nobena aplikacija umetne inteligence ne sodi na področje umetne inteligence. S tem ponovimo staro napako raziskovalcev – aplikacija znanja s področja znanstvene vede je sicer res aplikacija, torej ni več znanost, je pa z določene stroke in je dokaz uporabnosti znanstvenih metod. Tudi Brooks je tega mnenja.

Po drugi strani pa drži, da noben sistem umetne inteligence ni sposoben smotrno se pogovarjati več kot nekaj naučenih stavkov. Z drugimi besedami, posamične aplikacije, tudi npr. igranja šaha, so izredno koristne, uspešne in presegajo človeške možnosti, pri nalogah splošne inteligence ali komunikacije pa ni videti nobenega bistvenega napredka. Sedanji nivo prepoznavanja objektov ali pogovora je nekje na nivoju dvoletnih do triletnih otrok (slika 3).

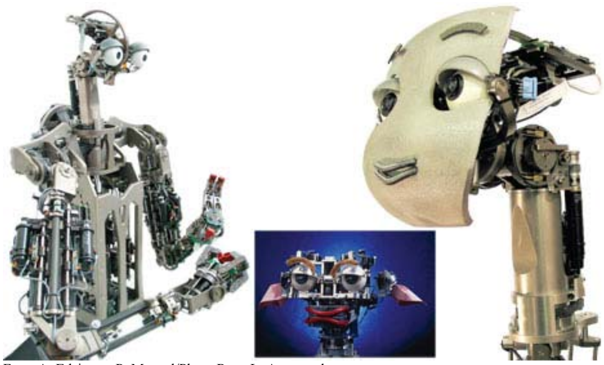

Foto: A. Edsinger; P. Menzel/Photo Res.; L. Aryananda

Slika 3: Brooksova skupina na MITju se ukvarja s humanoidnimi socialnimi roboti, ki so sposobni vidne in zvokovne komunikacije z ljudmi.

Zanimiva je Brooksova misel, da roboti/računalniki ne bodo postali sposobnejši od nas že zato, ker kmalu ne bo več ljudi v klasičnem smislu. Ljudje namreč postajajo čedalje bolj združeni s stroji in gre torej za kombinacijo. Po svetu je okoli 50.000 ljudi, katerih možgani so neposredno povezani s čipi – gre za sisteme za pomoč gluhim. Obstajajo prototipi umetnih okončin, recimo rok, kjer z možgani krmilimo umetno roko. Po Brooksu bodo ljudje postajali čedalje bolj robotski/elektronski/mehanski, roboti pa bodo postajali čedalje bolj biološki/organski in slej ko prej bo praktično nemogoče razločevati med njimi.

Poglavitna področja moderne umetne inteligence (Future of AI revije 2006; IEEE Intelligent systems 2006; AI Magazine 2005 in 2006) so usmerjena v raziskave na človeškem nivoju, na recimo nivo preprostih bitij, na socialni nivo združb. Druga značilnost je usmerjenost stran od formalnih domen, kot je šah in v smeri npr. RoboSoccerja, dejanske komunikacije med roboti in ljudmi itd., kjer je program umetne inteligence umeščen v neko fizično ali logično napravo, je utelešen, deluje v realnem času in v realnih ali skoraj realnih pogojih.

3. EMPATIJA IN STROJI

Nobenega dvoma ni, da se ljudje čustveno navežemo na predmete in stroje. Glasbeniki so pogosto "zaljubljeni" v svoje inštrumente, recimo klavir ali violino. Podobno so računalničarji v neki posebni relaciji z računalniki. Roboti in računalniki pa nudijo nekaj več v primerjavi s stroji. V določeni meri so interaktivni in celo inteligentni. Denimo, pogosti primeri na internetu kažejo, da se ljudje navežejo na Roombo in mu pripisujejo atribute kot "neumen" ali "prijeten" in celo "član družine". Pri tem ime Roomba pri premikanju približno toliko inteligenten kot kakšen ščurek. No, dečki imajo včasih čisto radi tudi kakšne žuželke.

Ko bodo računalniki in roboti postajali čedalje inteligentnejši, se bo prav gotovo začela pojavljati tudi povečana empatičnost. Roboti so se sposobni premikati, učiti in prilagajati vsakemu uporabniku posebej. Do pravih čustvenih odnosov pa verjetno manjkajo lepa desetletja.

Znan je Turingov test, ko se pogovarjamo preko računalnika z dvema aktorjema in skušamo ugotoviti, kateri je človek in kateri računalnik (Turing test, Epstein idr. 2008).

V zvezi z empatijo je bolj poznan **Voight-Kampffmanov** test, ki skuša ugotoviti, ali je na videz človeško bitje v resnici android. Testirancu kaže slike in ga sprašuje o nenavadnih situacijah, ki pri običajnih ljudeh sprožijo značilne empatične situacije. Testiranca lahko opazuje, pogosto pa hkrati meri biometrične odzive in gre v bistvu za neke vrste empatični poligraf. Podoben test je bil prikazan v SF filmu Blade Runner.
http://www.technovelgy.com/ct/content.asp?Bnum=126
Nejasno sicer je, zakaj ne bi testiral molekularno-kemijskih lastnosti npr. kože, ampak to je pač SF.

Raznovrstne raziskave so pokazale, da se ljudje pravzaprav hitro ujamemo v empatične odnose z računalniškimi programi. Znan je primer ELIZE pred 30 leti, kjer so se ljudje ujeli v poglobljene osebne pogovore z zelo preprostimi programi.

Novejše raziskave kažejo, da so virtualni agenti, ki »kažejo« empatične odnose do uporabnikov, bolj uspešni v komunikaciji. Ljudje se raje in bolj zainteresirano »pogovarjajo«.

Omenjeni programi so osnovani na naslednjih načelih:
a) posnemajo običajne empatične oz. druge čustvene raekcije, ki se pojavljajo med ljudmi
b) testirajo raznovrstne komunikacijske vzorce med ljudmi in računalniki in ugotavljajo, kje bi se ljudem zdela primerna določena količina empatije ali čustvenosti
c) razvijajo teoretične modele, ki pogosto temeljijo na klasični matematiki ali kognitivnih modelih.

V (Ochs idr. 2008) je opisan primer takega sistema, ki je implementiran kot dodatni modul za empatična čustva v komunikacijsmem vmesniku agenta. Modul za empatijo se vključi v komunikacijo, ko se pojavi primerna situacija. Testiranja so pokazala uspešnost pristopa v pogojih komunikacije v realnem času.

Slika 4: Pri nas razviti sistem Janez simulira minimalne človeške odzive na zelo osnoven način.

Na sliki 4 je prikazan sistem za inteligentno komunikacijo Janez. Nastal je v okviru raziskav Inteligentnega doma in podobno kot Vida, inteligentna davčna svetovalka, svetuje in komunicira z uporabniki. Za komercialne sisteme je značilno, da kažejo minimalno grafično animacijo in skušajo odgovoriti na najbolj značilna vprašanja o tematiki. Običajno imajo pripravljene tudi odgovore na »človeška« vprašanja kot »A sem lep?« ali »Kaj si neumen«.

4. ZAKLJUČEK

Računalniki in roboti nedvomno prodirajo v naša življenja. Do njih že sedaj čutimo določena čustva, med drugim

empatijo, ko se pokvarijo, ali jih kdo uniči. Avtor osebno je bil prav gotovo žalosten, ko se je njegov Roomba poškodoval. Kako se počutite, ko vam kdo razbije avto?
Pomembno je zavedati se, da je nekaj malega umetne inteligence v dobršnem delu vseh modernih storitev od internetnih iskalnikov do robotskih sesalcev Roomba. Ni nikakršnega dvoma, da se bo trend čedalje večje inteligentnosti in fleksibilnosti v sistemih nadaljeval in povečeval, z njimi pa tudi stopnja empatičnosti.

Pri inteligenci ali empatiji na človeškem nivoju so razmere manj jasne. Optimisti kot Brooks napovedujejo svetlo in inkrementalno bodočnost preko v robotih utelešenih programov in preko vgrajevanja čipov in naprav v ljudi. Bolj vprašljiva je napoved, da bodo stroji v bližnji prihodnosti resnično postali inteligentni in zavestni kot ljudje, s podobnimi čustvi in empatijo.

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NEURAL BASIS OF EMPATHY

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Introduction

Empathy has a long history recollected in a first rate hall of fame. Ever since Adam Smith made it the basis of our moral judgments and Kant the basis of our aesthetical judgments, Darwin had to cope with the paradox that it created with his theory of natural selection, Freud considered it as the precursor of the analytical transfer and Husserl thanked it as a way to keep the cogito without falling into the vicious circle of solipsism. Sartre said bluntly in the two-pages *avant-propos* of his thick three-volumes on Flaubert that it had been his only method.

Hiwever, the almost forgotten central figure in twentieth century literature on empathy is Theodor Lipps. He switched empathy from aesthetics to psychology. However, Freud on the one hand and Husserl on the other hand have pushed him to the backstage. If he is still quoted, he remained mostly unread. Besides this decisive switch, his contribution is twofold. First, whether through empathy one really transposes oneself in others or simply convey in oneself what others think or feel. Second, that empathy does not only bind humans together, but also humans to other animals and even to things. As Dennett put it, in order to anticipate the reactions of a bridge to different happenings, the engineer must « pretend to be a bridge ».

After the War, empathy has been used, mainly in the United States, to show, in behavioral studies, that humans' actions were not always motivated by egoistic utilitarian goals, but could also be geared by altruistic motives and then provide a psychic basis to the theory of justice (Rawls, Hoffman). During the last decades, cognitive studies of empathy have either been aimed at finding how we become aware of others' emotions (Decety) or how mirror neurons provides its neural basis (Rizzolatti and his Parma school.)

I have tried to clarify these issues. I differentiated empathy from sympathy and from compassion and endeavored to find the neural basis of such a differentiation.

Empathy, sympathy and compassion

I have tried to show, first on theoretical grounds and then experimentally, that empathy is a cognitive process whereas sympathy is an affective process. Through empathy, we are able to put ourselves in others' shoes and to look at the world from their own point of view. Through this spatial shift, we are able to put ourselves in their situations, and face the problems they deal with. Then two possibilities arise, either we feel what they feel and we approve of their deeds, or we do not and disapprove of them. In that sense, empathy is at the root of our moral judgments, as Smith has claimed long ago. Value judgments are more deeply entrenched in our cognition than meaning attributions, ethics is more fundamental, or primitive, than semantics. Empathy appears thus as a top down process, from cognition to emotion.

Sympathy is the reverse, it is a bottom up process. We first sympathize with others' emotions and then figure out what is the cognition that lies behind it. The paradigmatic case is uncontrollable laughter. Whenever we come to people laughing uncontrollably, we start ourselves to laugh without even knowing why. And it happens that upon knowing why they were laughing, we judge that it was not worth it. Once again me make a moral judgments. But this time we start with the others' deeds to infer their thoughts. It is the same with sorrow or affliction. If we enter a Church where people are gathered to mourn a beloved, we cannot help to be in sorrow although we do not know the defunct.

We are compassionate when, either by empathy of sympathy, we come to feel or to understand the hardships others are suffering and decide to go to their relief. This is neither a cognitive nor an affective process but a pragmatic one. A child might go take his mother by the hand to drive her to a crying fellow child and glance at her so that she consoles him.

Experiments

I have tried, with a doctorate student, Bérangère Thirioux, and a colleague from the College de France, Alain Berthoz, to find out the neural basis of these distinctions. My hypothesis, that these experiments were devised to validate or invalidate, was that empathy and sympathy would differentiate one from the other when subjects were put in a situation forcing them to act as another subject facing them. Whether they do so in a mirror symmetry or in a reflection symmetry would indicate that they empathize, resp. sympathize, with the model.

In the first experiment we studied mental own body transformations within social interactions carried out from the first (1PP) or the third person perspective (3PP). To investigate how these *mental* transformations manifest themselves in the *physical* body, we designed a motor paradigm using rotation and reflection symmetry. In virtual reality, participants acted, on the same line, with a front-facing female tightrope walker walking forward and backward. While she leaned to the left and right, we investigated the symmetry of the tilts executed by the participants. Without any instruction, participants leaned unconsciously in rotation symmetry. When instructed to lean without imposed direction, participants leaned spontaneously in reflection symmetry. We hypothesized that physical body rotations reflect that participants imagine themselves in the tightrope walker's body position, while physical body reflections indicate that participants imagine the tightrope walker as their reflection. This paradigm allows the systematic study of spontaneous 1PP and 3PP mental own body transformations in interactive and ecological conditions.

Our results support the hypothesis that individuals take directly the visuo-spatial perspective of the other individuals with whom they are spontaneously interacting, that is, without any instruction. By contrast, individuals keep their own perspective and mirror the others when explicitly asked to act with them and to execute the movements that they observe. We proposed the coexistence of two different processes within self-other interactions: a direct perspective taking and a direct mirroring. The involvement of such processes seems to depend upon the bodily relations between individuals. The more these relations increase, the more individuals mirror the other's movements. The more these relations decrease, the more individuals take the others' visuo-spatial perspective.

The second experiment, carried over in Olaf Blanke laboratory in Lausanne tried to localize the area in the brain where empathy as mirroring was taking place. Since our colleague from Lausanne was a specialist of heautoscopy that he localizes in the parieto-temporal junction, and since empathy, as I define it, was a kind of heautoscopy, we devised an EEG experiment using the same setting as the previous one.

We measured brain activity related to self-other interactions carried out either from one's own perspective (1PP) or from the other's perspective (3PP) *via* mental transformations of embodiment and disembodiment. We used event-related potentials (ERPs) recorded via 192-channels EEG recordings, when participants were interacting with a virtual female tightrope walker leaning randomly to her left or right. Firstly participants were asked to lean without direction instruction when the tightrope walker was leaning. All participants leaned spontaneously in rotation symmetry. Secondly, in two imposed tasks, participant leaned while asked to perform mental transformation, using either embodiment or disembodiment. We found converging evidence that individuals performed a spontaneous disembodiment to interact with another from the other's visuo-spatial perspective. We showed that embodiment recruited a right fronto-temporal network, revealing that the *human* mirror neuron system codes for mirroring process. Confirming the temporo-parietal junction as a crucial structure for spatial unity of self and body, we further show the TPJ as a key neural locus coding *selectively* for *spontaneous* disembodiment while 3PP-taking.

We used a test devised by Bérangère Thirioux to check that participants who engaged in mirroring were actually empathic with the tightrope walker.

»METODA« RAZISKOVANJA IZKUSTVA

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Povzetek

Fenomenološko raziskovanje je skupno ime širokega spektra raziskovalnih smeri, ki poskušajo ujeti doživljanje – svoje doživljanje, doživljanje drugih, doživljanje posebnih stanj in bivanjskih pozicij... V tekstu na kratko spregovorim o epistemoloških osnovah tega pristopa. Več pozornosti posvetim nekaterim (nenavadnim) lastnostim dialoške prakse, ki omogoča raziskovanje izkustva (t.i. fenomenološkega dialoga).

Sistematično empirično raziskovanje izkustva

The laws of statistics and probability: so true in general, so fallacious in particular

Matematik in filozof Edmund Husserl se je približno sto let nazaj zavedel preproste resnice, da je – kljub vsemu – izkustvo primarno in konec koncev vse kar imamo ter da, na noben način ne moremo pobegniti iz njegovega polja. Pozval je: "Nazaj k stvarem samim!" – torej od ideje o stvareh (kot naj bi bile) k stvarem kot se nam kažejo. Poziv simbolično zaznamuje začetek enega najmočnejših filozofskih gibanj dvajsetega stoletja: fenomenologije. Husserl je bil dobro izurjen v postopkih naravoslovne znanosti, vendar se mu je zdelo nedopustno, da na račun zamaknjenosti v teoretske razlage zanemarjamo živo, neposredno izkustvo. Fenomenologijo si je zamislil kot rigorozno vedo, ki naj sistematično preiskuje izkustvo: stvari (oz. fenomene) kot se nam kažejo (namesto neposrednemu doživljanju mnogokrat skritih resnic in zakonitosti, s katerimi se ukvarja ostala znanost).

Nekaj osnovnih metodoloških smernic Husserlovega raziskovalnega načrta[1]:

- Odredotočenje na fenomene (stvari kot se kažejo v našem izkustvu) in *epoche* – postavljanje v oklepaje. Husserl predlaga "puščanje običajnih privzetkov o stvareh ob strani" (oz. dajanje le-teh v "oklepaje") in *fenomenološko redukcijo* – redukcijo opazovanega na fenomene "kot tisto edino, kar je dano v izkustvu in gotovo". Kot piše Kotnik (2003, str 102) je poudarek na "raziskovanju danega izključno v izkustvu, toda vključeno mora biti celotno izkustvo in prvi korak je spoznavanje o kompleksnosti in neskončnosti tega polja."
- Pravilo: "Ne razlagaj, ampak opisuj!" To je najpomembnejša metodološka smernica za fenomenološko raziskovanje. Morda izgleda navodilo na prvi pogled preprosto, vendar je njegova izvedba zelo kompleksna in zahteva dobršno mero refleksije in spretnosti. Šele, ko v praksi poskusimo *samo opisovati* doživljanje, ne da bi ga kakorkoli klasificirali, umeščali v teoretske okvire, pojasnjevali ipd.,se zavemo kako globoka je naša potreba po razlagi in kako težko se ji izognemo. Kotnik (pav tam) citira Ihdeja, ki govori o "težavnosti razlikovanja med dejansko opisljivim izkustvom, *kot* se kaže samo kot neposrednost, in neizkustvenimi elementi kot so domneve ali predpostavke. Razlaga je namreč kakršnakoli teorija, ideja, pojem ali konstrukcija, ki teži v ozadje fenomenov."
- Vzdržimo se prepričanj oziroma ocenjevanj "realnosti" opaženih fenomenov. Brez intersubjektivnega preverjanja (ki je značilno za znanstveno metodo) ne moremo razločiti med "iluzijo" in "resničnostjo". Z vidika primarnosti neposrednega izkustva je takšno razlikovanje le en način urejanja doživljajskega sveta (in torej nima višje vrednosti od drugih možnih razlikovanj), zaradi tega Huserl priporoča, da se celo to – na videz tako primarno sodbo – postavimo v oklepaj in opazujemo polje izkustva kot se kaže, brez presojanja.

Husserl je dodal še eno smernico – poziv k iskanju skupnih vzorcev, ki naj omogoči intersubjektivnost fenomenologije. Na tem mestu se ne bom ukvarjal z razlogi *pro et contra* takšne možnosti. Namen teksta je samo opis metode za zbiranje »empiričnega« gradiva (torej poročil o doživljanju) pri fenomenološkem raziskovanju in ne o njegovi analizi. Pri takšnem zbiranju, prav gotovo ne smemo soditi poročil glede na njihovo primerljivost z izkustvi drugih.

Metoda

Fenomenološko raziskovanje lahko torej v splošnem definiramo skupino empiričnih raziskovalnih metod, pristopov, načinov zbiranja in/ali analize gradiva, ki

[1] Smernice povzemam po poenostavljenem, a odličnem pregledu fenomenologije v Kotnik (2003, str. 102) – od tod so vse dobesedne navedbe, ki delno sledi Ihdeju (1977, str. 32 do 45).

temeljijo na zgoraj opisanih (fenomenoloških) epistemoloških temeljih ter smernicah.

Zanima nas torej izkustvo. Namesto (objektivnih) tretjeosebnih opisov in teorij ("od zunaj") – raziskujemo človekovo živo izkustvo oziroma doživljanje ("od znotraj"). Fenomenološko raziskovanje je skupno ime širokega spektra raziskovalnih smeri, ki poskušajo ujeti doživljanje – svoje doživljanje, doživljanje drugih, doživljanje posebnih stanj in bivanjskih pozicij...

Očitno lahko pridemo do izkustva samo na dva načina: z introspekcijo (svoje izkustvo – prvoosebno raziskovanje oz. samospoznavanje) in s spraševanjem (t.i. drugoosebno raziskovanje)[2]. Znanstveno relevantna je predvsem slednja oblika, torej dialog.

Na tem mestu se ne bom spuščal v epistemološko analizo raziskovanja izkustva, treba pa je povedati, da izkustvo nima enakega statusa kot npr. oprijemljiv, fizičen svet. Na tem področju je težko razlikovati med kreiranjem in raziskovanjem. Osnovni cilj dialoške metode je odpiranje prostora sogovorcu – prostora v katerem se pojavlja/kaže izkustvo, v vse bolj izčiščeni in natančni podobi. Spraševalec omogoča širjenje zavedanja sogovornikovega doživljanja; s svojimi vprašanji mu pomaga "odkriti" (ustvariti?) področja doživljajskega sveta, ki se jih morda prej ni zavedal. Vprašanja so samo opora – delujejo bolj na odnosnem kot na vsebinskem nivoju komunikacije. Zelo pomembno je vzdrževanje spraševalčeve odprtosti in vztrajanja v položaju "ne vem" – bolj kot se uspe "očistiti" vnaprejšnjih sodb, idej in prepričanj, več prostora je s tem ustvaril za nova spoznanja. Spraševani mora čutiti, da njegove besede nekam "sedejo", da je slišan in viden. Vprašanja "zakaj" pri fenomenološkem dialogu odpadejo, saj ne želimo vzpodbujati razlag in interpretacij. Zanima nas predvsem "kako".

Seveda je koristno, da imamo pred dialogom idejo katere spoznavne kategorije bomo raziskovali, vendar je to le »plan B«, ki nam pomaga iz zatišja, če sogovornik izgubi nit. Če se le da, pa ima sogovorniik glavno besedo pri določanji smeri dialoga.

Pri fenomenološkem raziskovanju se odrekamo pričakovanju, da bodo rezultati raziskovanja intersubjektivno primerljivi. Lahko, da bo v procesu raziskovanja prišlo do strinjanja okrog »rezultatov«, lahko da bomo določene pojave celo raziskovali skupaj. Nikakor pa intersubjektivno strinjanje ali nestrinjanje ne bo merilo za resničnost povedanega. Prostor, ki se mora ustvariti pri fenomenološkem dialogu *ne sme biti* prostor preverjanja.

[2] Sodbe o izkustvu glede na vedenje (tretjeosebno raziskovanje) niso v domeni fenomenološkega raziskovanja.

Naj ponovim, da nas pri fenomenološkem raziskovanju ne zanimajo objektivne resnice. Material, ki ga zbiramo je odnosen, ne pa absoluten: kako nekdo nekaj doživlja oziroma kaj je *nekaj* za *nekoga* (in ne kaj je objektivno res za vse).

Prostor, ki ga nameravamo ustvariti torej ni prostor preverjanja, kritiziranja, sklicevanja na… itd. Energijo, ki polni prostor fenomenološkega dialoga lahko označimo z besedami *raziskovanje* ali *aktivno sprejemanje*. Formula za to je: raziskovanje = dopuščanje + pozornost oz. zanimanje. Kot vsako raziskovanje, je tudi prvoosebno sestavljeno iz pasivnega in aktivnega dela. Pasivni del je dopuščanje avtorjeve zgodbe, da je kakršna je, brez vpletanja spraševalčeve zgodbe (ta del ustreza fenomenološkemu postavljanju v oklepaje, *epochee*). Aktivni del pa je radovednost – sila, ki poganja raziskovanje.

Med spraševanim in spraševalcem mora vladati *zaupanje*, da je njuno delo za oba eksistencialno zavezujoče. To pomeni, da se oba po najboljših močeh trudita izogniti se t.i. »satelitom«[3] (Petitmengin, 2007) in da se oba zavedata, da ju njuno početje (lahko) spreminja. Prav ta pripravljenost na osebno spremembo – je neke vrste zaščitni znak t.i. udeleženega raziskovanja.

Osnovno metodološko orodje za prvoosebno raziskovanje je torej radovednost oziroma čudenje. Če se poskušam izraziti z budistično terminologijo: potrebujemo ljubeč pogled, ki je sposoben objeti opazovano (opazovanega) z aktivnim sprejemanjem. Torej se zanimati zanj (zanjo) a mu (ji) hkrati dopustiti, da je kakršen (kakršna) je. Empatija, kot jo navadno razumemo (vživljanje v sogovornika skozi primerjavo s svojimi izkušnjami) torej ne pride v poštev. Takšno stališče bi samo zožilo raziskovalni prostor, zreduciralo radovednost na iskanje ustreznega primera pri sebi in pomaknilo pozornost od spraševanega k spraševalcu.

Kdo je v resnici raziskovalec?

Čisto na kratko naj omenim še eno posebnost drugoosebnega fenomenološkega raziskovanja. Kljub temu, da je znanstvenik večinoma v vlogi spraševalca, sta v resnici vlogi zamenjani: resnični raziskovalec je tisti, ki odgovarja. Spraševalec mu je le v oporo pri raziskovanju svojega doživljajskega prostora. Ker je svoje izkustvo zelo težavno sistematično in rigorozno preiskovati je dialog v bistvu pomoč pri opazovanju polja svojega doživljanja.

Primarni cilj takšnega fenomenološkega dialoga ni pridobitev propozicionalnih spoznanj o svojem izkustvenem svetu (kot pri Husserlianski metodi), ampak je spremeniti (razširiti) doživljanje. Jack Petranker (2003) piše, da vsako raziskovanje (lastnega) doživljanja, to doživljanje spremeni.

[3] "Sateliti" imenujemo poročila, ki se oddaljijo od čistega opisa doživljanja. Na primer: pojasnitve okoliščin, mnenja, ocene, navajanje ciljev, opravičujoče teorije, teoretske pojasnitve itd.

Rezultat je na novo oblikovan doživljajski svet, predvsem pa izpiljena *veščina* samo-opazovanja.

Na tej točki – ko se brišejo meje med raziskovalcem, raziskovanim in orodjem raziskovanja – smo prekoračil meje znanstvenega, vsaj kot je pojem razumljen dandanašnji. Zato bom tu končal, v upanju, da kmalu vznikne kultura raziskovanja vznemirljive pokrajine človekovega živega izkustva – pokrajine, ki jo je sodobni način dojemanja sveta odrinil povsem na rob.

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POLJUDNA PSIHOLOGIJA, EMPATIJA IN PROBLEM DRUGIH UMOV

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POVZETEK

V članku na kratko predstavim poljudno psihologijo kot okvir za razumevanje vedenja. Pokažem, kako lahko pojem empatije, razumljen kot notranje posnemanje, pomaga pri reševanju problema drugih umov. Pri teme se oprem na simulacijsko teorijo in nevrološke mehanizme posnemanja ter »zrcalne nevrone«.

1 POLJUDNA PSIHOLOGIJA

Odrasli ljudje »praviloma« razvijemo sposobnost, da razumemo druge ljudi kot razumna bitja, ki imajo razloge za svoja dejanja, da prepoznavamo njihova duševna stanja in razlagamo vedenje sočloveka s pomočjo vzročnih moči njegove duševnosti. Tako, na primer, razumemo, da človek vidi predmete, ki se nahajajo v njegovem vidnem polju, se odloča o prihodnjem dejanju, se spominja preteklih dogodkov, občuti bolečino, se veseli uspeha, je žalosten, se počuti osamljeno, itn. Prav tako dojamemo, da je vedenje osebe odvisno od njenega duševnega stanja, na katero vzročno vplivajo okolje in drugi ljudje. Na primer, predvidevamo lahko, da prijatelj ne bo šel na Triglav, ker se boji višine, in razumemo, da se bo raje odločil za počitnice na morju, ker je prepričan, da je morski zrak zdravilen. Razumemo njegovo razočaranje, ker ni naredil izpita, čeprav je pričakoval uspeh. Povprečen človek tako pri razumevanju, napovedovanju in razlagi vedenja uporablja psihološke pojme kot so prepričanje, želja, strah, bolečina, dvom, veselje, ljubezen, spomin, prepoznavanje. Sposobnost, da na tak način razumemo druge ljudi kot duševna bitja, je nedvomno psihološki temelj za to, da sebe dojemamo kot družbena bitja in polnopravne člane družbene skupnosti. Nezmožnost »branja uma« pa pomeni resno oviro pri uspešnem uveljavljanju lastnih interesov povsod tam, kjer je potrebno sodelovanje z drugimi ljudmi.

V filozofiji se je za tak okvir, ki nudi množico zdravorazumskih prepričanj o tipičnih vzrokih vedenja, ki jih ljudje implicitno posedujemo, uveljavil izraz poljudna ali zdravorazumska psihologija (folk psychology).

Težave nastopijo, če želimo poljudno psihologijo bolj natančno opredeliti. To niti ne preseneča, saj jo predvsem vsakodnevno uporabljamo, ne pa teoretsko razmišljamo o njej. Zato je povsem razumljivo, da imajo znanstveniki različna mnenja o tem, kako jo interpretirati. Nekateri filozofi, npr. Fodor (1987) in P. M. Churchland (1989), menijo, da je poljudna psihologija teorija, drugi, kot npr. Dennett (1991), pa jo razumejo bolj kot »umetnost« interpretiranja in razlaganja. Interpretiranje poljudne psihologije kot teorije je odprlo tudi nadaljnja vprašanja o njeni potencialni redukciji/eliminaciji glede na znanstveno psihologijo in nevroznanost. Fodor je zagovarjal stališče psihološkega realizma, da je poljudna psihologija dovolj dobra osnova za razvoj znanstvene psihologije in kognitivne znanosti. Churchland pa je prepričan, da izsledki nevroznanosti kažejo, da gre pri poljudni psihologiji za radikalno napačno teorijo, da se njene postavke dejansko ne nanašajo na realne entitete. Podobno kot flogiston ali čarovnice, ki nimajo več mesta v znanstvenih teorijah, bodo tudi mentalni pojmi, ki jih uporabljamo v poljudni psihologiji (prepričanja, želje, namere, strah, veselje,…) odstranjeni iz znanstvenih teorij.

Kot ugotavljata Stich in Ravenscroft (1994) pa je zadeva še bolj zapletena, saj je mogoče razlikovati dva različna smisla »poljudne psihologije«: (1) eksternalistično pojmovanje, po katerem je poljudna psihologija teorija duha (uma), implicitna v našem vsakdanjem govorjenju o mentalnih stanjih in implicitno definira izraze kot so »prepričan sem«, »želim« in (2) internalistično pojmovanje, po katerem je poljudna psihologija teorija psihologije človeka, ki je predstavljena v umu/možganih in je podlaga vsakdanji sposobnosti napovedovanja in razlage lastnega vedenja in vedenja drugih ljudi. Poljudna psihologija je tako struktura podatkov oziroma predstavitev znanja, ki posreduje med našim opazovanjem vedenja v določenih okoliščinah in našim napovedovanjem in razlago tega vedenja.

Trditev, da naše vsakdanje razumevanje mentalnih stanj tvori poljudno teorijo duha (uma) se pogosto označuje kot »teorija teorija« (»theory theory«, v psihologiji tudi teorija uma). Podobno kot pri poljudni psihologiji lahko tudi pri »teoriji teoriji« razlikujemo med eksternalističnim in internalističnim pojmovanjem. Po internalistični različici v mentalnem besednjaku izražena sposobnost napovedi in razlage - osrednjo vlogo igrajo propozicionalne naravnanosti: prepričan sem, da …, želim si, da,…, nameravam, vključuje notranje predstavljeno teorijo –

sistem mentalnih reprezentacij, nekakšen kognitivni mehanizem. Prav opredelitev tega notranjega vzročnega mehanizma je predmet raziskovanja v sodobni kognitivni psihologiji in nevroznanosti. O

Diskusije o poljudni psihologiji so po eni strani vpete v sodobno raziskovanje v kognitivni znanosti, po drugi strani pa nadaljujejo razprave iz filozofije družbenih ved poznega devetnajstega in zgodnjega dvajsetega stoletja. Eno izmed temeljnih filozofskih vprašanj družboslovja je, kako izbrati in utemeljiti metodologijo raziskovanja. Ali tudi v družboslovju, npr. zgodovini in sociologiji, slediti metodi razlage (Erkleren, explanation), ki se uspešno uporablja v naravoslovju, ali pa epistemski dostop do drugih umov zahteva radikalno drugačne pristope. Namesto razlage, ki išče vzročne povezave in zakone, se znanost o družbi loteva interpretativnega razumevanja (Verstehen, understanding). Zagovornike prvega pristopa običajno imenujemo »naturaliste«, zagovorniki drugega pa izhajajo iz hermenevtične tradicije. Razprava o temeljnih epistemoloških vprašanjih znanosti o človeku bi močno presegala okvir tega članka[1], zato se bomo v nadaljevanju omejili na problem drugih umov (problem of other minds) in možnosti, ki jih za reševanje le-tega prinaša razumevanje empatije in simulacijske teorije.

2 EMPATIJA

Empatija je izraz, ki ima svoje jezikovne korenine v grščini, vendar je pojem empatija prišel v strokovno terminologijo dokaj pozno. V angleščino (empathy) ga je kot prevod za nemški izraz »Einfühlung« leta 1909 uporabil psiholog Titchner. Uvedbo izraza »Einfühlung« kot strokovnega izraza v estetiko sicer pripisujejo Vischerju, v bolj neformalnem smislu, kot »vživeti se« v umetniško delo ali v naravo, pa so ga uporabljali že romantični misleci (Herder, Novaliis). (Stueber, 2006: 6). Kot osrednji pojem za filozofsko in psihološko analizo estetskih doživetij je pojem »Einfühlung« uporabljal nemški filozof Lipps. Kot ugotavlja Stueber (2006), je Lipps empatijo razumel kot pojav »notranjega posnemanja«, kjer se v lastni duševnosti zrcalijo mentalne aktivnosti ali občutki druge osebe na podlagi telesnih gest ali izrazov obraza. Lipps empatije tako ni omejeval samo na čustva, ampak mu je pomenila osnovo za prepoznavanje vseh mentalnih aktivnosti in s tem za prepoznavanje drugih duševnih bitij.

Ne preseneča, da je empatija v začetku 20. stoletja igrala pomembno vlogo zlasti med hermenevtiki in fenomenologi, ki so zavračali naturalističen pristop in poudarjali človekovo neposredno izkustvo. Kazalo pa je tudi, da bo mogoče z empatijo kot osrednjim pojmom priti do boljše rešitve vprašanja drugih umov.

3 PROBLEM DRUGIH UMOV

Kot smo omenili že na začetku, ljudje običajno brez pomislekov sprejemamo, da soljudje podobno doživljajo fizični svet in da imajo podobno notranje življenje kot mi sami – občutijo bolečino, se veselijo, razmišljajo, se odločajo, itn.. Njihovega notranjega življenja sicer ne poznamo podrobno, a ne dvomimo, da obstaja. Toda, kaj upravičuje našo gotovost? Filozofi so vprašanje o tem, kaj upravičuje naše osnovno prepričanje, da imajo tudi drugi ljudje notranje življenje, poimenovali problem drugih umov. Težava je v razliki med dostopom do naših lastnih mentalnih stanj in do mentalnih stanj drugih. Do lastnih dostopamo neposredno, do drugih pa posredno, in, vsaj včasih imamo o lastnih mentalnih stanjih neposredno znanje, medtem ko naše znanje o drugih mentalnih stanjih ni nikoli neposredno. Tu je torej bistvena asimetrijo.

Običajno se problem rešuje s sklepanjem po podobnosti. Najprej ugotovimo, da so mi drugi ljudje zelo podobni. Narejeni so iz iste snovi, poleg tega pa se v podobnih situacijah vedejo zelo podobno. V mojem primeru je vzrok za vedenje določeno mentalno stanje *M*, ki ga neposredno izkušam iz vidika prve osebe. Sklepam, da je *M* vzrok tudi za vedenje druge osebe. Na primer, kadar se udarim, me zaboli in zastokam. Tudi kadar se kdo drug udari, zastoka. V mojem primeru je bila vzrok za stokanje bolečina, torej je bolečina vzrok tudi za vedenje v drugem primeru. Tako preprosto sklepanje – Millovo sklepanje po analogiji, predpostavlja kartezijansko pojmovanje uma, po katerem je dostop do lastne duševnosti neposreden in nezmotljiv, znanje o drugih umih pa je posredno in zmotljivo. Rešitev je bila tako zaradi šibkosti sklepanja po analogiji kot zaradi kartezijanske predpostavke deležna mnogih kritik, na primer znana Wittgensteinova kritika v *Filozofskih raziskavah* in diskusija, ki ji je sledila.

Z vpeljavo empatije se je ponudila alternativa reševanju problema s sklepanjem po podobnosti. Fenomenologi, ki so zavračali kartezijansko pojmovanje uma (Husserl, 1975), so prevzeli pojem empatije kot nereducibilen tip izkustvenega dejanja. To naj bi omogočilo, da na drugo osebo gledamo kot na sebi podobno, ne da bi uporabili sklepanje po analogiji. Menili so, da so določena mentalna stanja neposredno prepoznavna, ker so izražena z določenimi stanji človeškega telesa, gest in izrazov na obrazu. Tako stališče je bilo sprejemljivo za čustvena stanja, ni pa nudilo dobrega odgovora, kako prepoznati prepričanja in želje, ki igrajo osrednjo vlogo v poljudni psihologiji. Prav zato pojem empatije v analitični tradiciji ni imel vidnejše vloge vse do konca osemdesetih let prejšnjega stoletja, ko so jo znova obudili zagovorniki simulacijske teorije.

3 EMPATIJA IN SIMULACIJSKA TEORIJA

Med kognitivnimi znanstveniki se je razvila interdisciplinarna diskusija o poljudni psihologiji,

[1] Več o filozofskih vprašanjih družboslovja in omenjeni epistemološki dilemi lahko preberete v Holis (2002).

natančneje o tem, kako najbolje opisati mehanizme, ki podpirajo naše sposobnosti, da interpretiramo, razlagamo in napovedujemo vedenje drugih. Kot pravi Chris Frith, skuša znanost razložiti, kako razumemo druge ume. In dodaja, da to ni različno od razlage tega, kako mi kot posamezniki razumemo fizični svet. V obeh primerih je moje znanje zaobseženo v modelih, ki jih ustvarjajo možgani, le da gre enkrat za modele fizičnega sveta, enkrat pa za modele mentalnega sveta (Frith, 2007: 140).
Kot smo omenili, zagovorniki »teorije teorije« predlagajo kognitivni model - notranji vzročni mehanizem, ki ustreza pravilom logike oziroma racionalnim argumentom, kot je praktični silogizem, s katerimi v poljudni psihologiji razlagamo in napovedujemo vedenje.

Lippsovo razumevanje empatije kot notranje posnemanje je dobilo sodobnega nadaljevalca v simulacijski teoriji. Teoretiki simulacijske teorije menijo, da predstavljamo mentalne aktivnosti drugih tako, da naredimo mentalne simulacije oziroma sami izvedemo podobne procese. Naše vsakodnevne sposobnosti biti poljudni psiholog tako predstavljajo egocentrično metodo, saj uporabimo samega sebe kot model za mentalno življenje drugih oseb. Za razliko od teorije teorije se znanstveniki pri simulacijski teoriji ne opirajo na teoretski pristop in ne zahtevajo shranjevanja splošnih pravil.

Ideja empatije kot notranjega posnemanja in simulacijska teorija sta dobili empirične potrditve tudi »od spodaj«. Kot kažejo raziskave v nevroznanosti, igrajo tako imenovani »zrcalni nevroni« pomembno vlogo pri prepoznavanju čustvenih stanj in namer drugih oseb. Ugotovili so, da prihaja do pomembnega prekrivanja nevronskih mrež, ki so aktivne takrat, ko opazujemo dejanje druge osebe, in mrež, ki so aktivne, kadar sami izvajamo enako dejanje. Podobno velja za prepoznavanje čustev druge osebe na podlagi njenega izraza na obrazu in naše lastno doživljanje tega čustva (več o zrcalnih nevronih v Rizzolatti, Singaglia, 2008). Gallese na primer navaja, da so fMRI raziskave pokazale, da doživljanje gnusa in biti priča enakemu čustvu, ki je izraženo na obrazu nekoga drugega, aktivira iste nevronske strukture (anterior insula) na isti prekrivajoči se lokaciji. Po mnenju Gallesa to, vsaj za čustvo gnusa, dokazuje, da sta prvo in drugo osebni izkustvi podprti z aktivnostjo skupnega nevronskega substrata. Ugotavlja, da kadar vidim izraz na obrazu nekoga drugega in me ta zaznava vodi do izkustva *tega* izraza kot določenega čustvenega stanja, ne pridem do tega razumevanja z argumentom po analogiji. Čustvo drugega je osnovano, izkušeno in torej neposredno razumljeno skozi utelešeno simulacijo, kar ustvarja skupno stanje telesa. Prav to sproženje nevronskega mehanizma, ki si ga delita opazovanec in opazovani, omogoča neposredno izkustveno razumevanje.

Stueber (2006) gleda na zrcalne nevrone kot na mehanizme za osnovno empatijo, ki nam omogočajo, da s pomočjo izrazov obraza neposredno dojamemo čustva drugih oseb in razumemo njihovo gibanje telesa kot ciljno naravnana dejanja. Raziskave so pokazale tudi, da uporabljamo različne nevrobiološke mehanizme za zaznavanje gibanja fizičnih predmetov in bitij, ki so ciljno naravnana. Naši možgani avtomatično posnemajo dejanja drugih ljudi, ne posnemajo pa premikanja predmetov (Frith, 2007:148). Tako že na osnovni ravni razločujemo med fizičnimi predmeti in predmeti, ki so bolj podobni nam samim.

Diskusijo o poljudni psihologiji, problemu drugih duhov in empatiji lahko sklenemo z mislijo, da mehanizmi osnovne empatije morda nudijo dobro osnovo za razvijanje intersubjektivno dostopnega poljudnopsihološkega okvirja, ki ga ne bodo pestile tradicionalne težave problema drugih umov.

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KOGNITIVNA INHIBICIJA EMOCIONALNIH DRAŽLJAJEV PRI OSEBAH Z BIPOLARNO MOTNJO RAZPOLOŽENJA

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POVZETEK

V predstavljeni raziskavi smo ugotavljali, kakšna je kontrola kognitivne inhibicije emocionalnih dražljajev pri osebah z bipolarno motnjo (BM) in kako se le-ta povezuje z razpoloženjskimi stanji. Uporabili smo Hamiltonovo lestvico depresije (Ham-D), Youngovo lestvico manije (YMRS), Lestvico notranjega počutja (ISS) in Emocionalni Go/No-Go test. Rezultati so pokazali, da ima skupina z BM slabšo kognitivno inhibicijo emocionalnih dražljajev kot kontrolna skupina, pri čemer se nekatere mere kontrole kognitivne inhibicije ne povezujejo s psihiatrično oceno razpoloženjskih stanj, ampak se povezujejo s samooceno le-teh.

1.0 UVOD

Bipolarno motnjo razpoloženja uvrščamo med razpoloženjske (afektivne) motnje. Le-te označujejo motnje, za katere so značilna močna emocionalna doživljanja depresije ali manije ali obojega.
Dolgo so raziskovalci mislili, da obdobja med posameznimi epizodami znotraj bipolarne motnje (*evtimijo*) odražajo popolno okrevanje in s tem tudi izboljšanje na vseh področjih delovanja. Vendar pa rezultati raziskav vedno bolj kažejo, da so določeni kognitivni deficiti prisotni tako v maničnih in depresivnih epizodah kot tudi v fazah evtimije. Pojavljajo se predvsem na treh področjih, in sicer na področjih spomina, pozornosti in izvršitvenih funkcij (Simonsen in dr., 2008).

1.1 Impulzivnost

Impulzivnost je eden izmed pomembnih aspektov bipolarne motnje. Za prenagljenimi nakupi, igrami na srečo in nepremišljenimi odločitvami, ki bolnika pahnejo v precejšnjo nesrečo, se pogosto skriva prav ta aspekt motnje. Raziskovalci si niso enotni glede definicije tega pojma, vendar se pogosto opirajo na definicijo, ki označuje impulzivnost kot predispozicijo za hitre, neplanirane reakcije na notranji ali zunanji dražljaj, brez ozira na negativne posledice teh reakcij na impulzivnega posameznika ali druge (Asahi in dr., 2004).
Raziskave kažejo, da se impulzivnost znotraj bipolarne motnje izraža kot poteza in kot stanje.
Rezultati raziskav, ki so za ugotavljanje impulzivnosti uporabljale samoocenjevalne lestvice (npr. Peluso in dr., 2007) kažejo, da se impulzivnost znotraj bipolarne motnje odraža kot razmeroma stabilna komponenta (poteza). Raziskave, ki so uporabljale laboratorijske meritve (npr. Test IMT-DMT, Emocionalni Go/No-Go testi; npr. Moeller in dr., 2001), pa kažejo na impulzivnost kot odsev izraženosti simptomtov.

1.2 Kognitivna kontrola

V nevropsihologiji se v povezavi z impulzivnostjo kot stanjem in z inhibicijo vse bolj uveljavlja pojem *kognitivna kontrola.* Ta vključuje koordinacijo kognitivnih podprocesov (npr. delovnega spomina, pozornosti, inhibicije), ki na eni strani usmerjajo pozornost na relevantne informacije, na drugi strani pa inhibirajo ciljno nerelevantne informacije ter avtomatične odgovore. Slaba inhibicija odgovora se kaže pri posameznikih, ki le s težavo zadržijo in inhibirajo neprimerne misli in vedenje in je lahko eden izmed kognitivnih simptomov, ki se pojavljajo pri raznih motnjah, kot so npr. shizofrenija, zloraba drog, ADHD in afektivne motnje (Casey, 2005).

Raziskovalci so kaj kmalu ugotovili, da kognicije ne moremo preprosto ločiti od emocij, saj se ta dva sistema prepletata in recipročno delujeta drug na drugega, kar se kaže tudi pri kognitivni kontroli. Tako imajo emocionalne informacije vpliv na kognitivne procese, hkrati pa lahko kognitivna kontrola vpliva na emocionalne odzive. Pri posameznikih z afektivnimi motnjami naj bi bili tako okvarjeni procesi kognitivne kontrole, ki posredujejo vpliv emocionalnih dražljajev na vedenje (Ladouceur in dr., 2006).

2.0 NAMEN RAZISKAVE

Namen raziskave je bil ugotoviti, kakšna je kontrola kognitivne inhibicije emocionalnih dražljajev pri osebah z bipolarno motnjo in kakšna je povezanost kontrole kognitivne inhibicije emocionalnih dražljajev z razpoloženjskimi stanji (manija, depresija, evtimija).

Cilji raziskave so bili ugotoviti, ali je pri osebah z bipolarno motnjo kognitivna inhibicija, v primerjavi s kontrolno skupino, zmanjšana, ali kažejo osebe z bipolarno motnjo z bolj izraženo manično simptomatiko zmanjšano kontrolo kognitivne inhibicije v okviru prijetnega emocionalnega konteksta in ali kažejo osebe z bipolarno motnjo z bolj izraženo depresivno simptomatiko zmanjšano kontrolo kognitivne inhibicije v okviru neprijetnega emocionalnega konteksta.

3.0 METODA

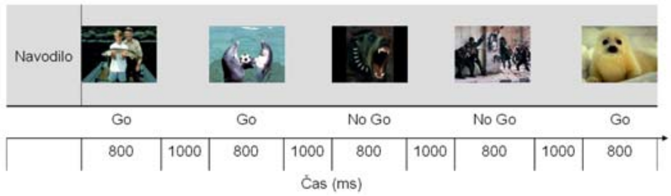
3.1 Udeleženci

V raziskavi je sodelovalo 39 oseb, ki imajo diagnosticirano bipolarno motnjo razpoloženja (skupina oseb z bipolarno motnjo BM) in 38 oseb brez psihiatrične diagnoze (kontrolna skupina KS). Skupini se ne razlikujeta glede na starost, spol in leta izobrazbe.

3.2 Pripomočki

Za ugotavljanje stopnje izraženosti maničnih oz. depresivnih simptomov smo uporabili lestvici *Hamiltonova lestvica depresije Ham-D* (Hamilton, 1960) in *Youngova lestvica manije YMRS* (Young, Biggs, Ziegler in Meyer, 1978) in podlestvice *Lestvice notranjega počutja ISS* (*Aktivacija, Psihično blagostanje in Indeks depresivnosti;* Glick, McBride in Bauer, 2003), ki služijo samooceni izraženosti simptomatike, značilne za bipolarno motnjo. Za ugotavljanje vpliva emocionalnega konteksta na kontrolo kognitivne inhibicije smo sestavili in uporabili nov, računalniško voden *Emocionalni Go/No-Go test.*

Emocionalni Go/No-Go test je računalniško voden test za ugotavljanje kognitivne inhibicije pri procesiranju dražljajev z emocionalno valenco. Test je sestavljen iz več blokov, ki vključujejo dražljaje z emocionalno valenco (*neprijetni*, *nevtralni* in *prijetni*). Vsak blok vsebuje dve vrsti dražljajev z različno emocionalno valenco (npr. *prijetni – neprijetni*). Šest blokov tako predstavlja vse kombinacije emocionalnih parov. Naloga udeleženca je reagirati na v naprej določene tarčne dražljaje (Go) in inhibirati odgovor na distraktorje (No-Go). Udeleženec na dražljaj reagira s pritiskom na tipko. Beleži se število zadetkov (pravilnih odgovorov na Go dražljaj), napačnih odgovorov (izpuščeni odgovori in lažni alarmi) in povprečne reakcijske čase za pravilne odgovore na Go dražljaj glede na emocionalno valenco tarče oz. distraktorja ter skupni rezultat.



Slika 1. Primer naloge pri pogoju *prijetni* (Go) – *neprijetni* (No-Go).

3.3 Postopek

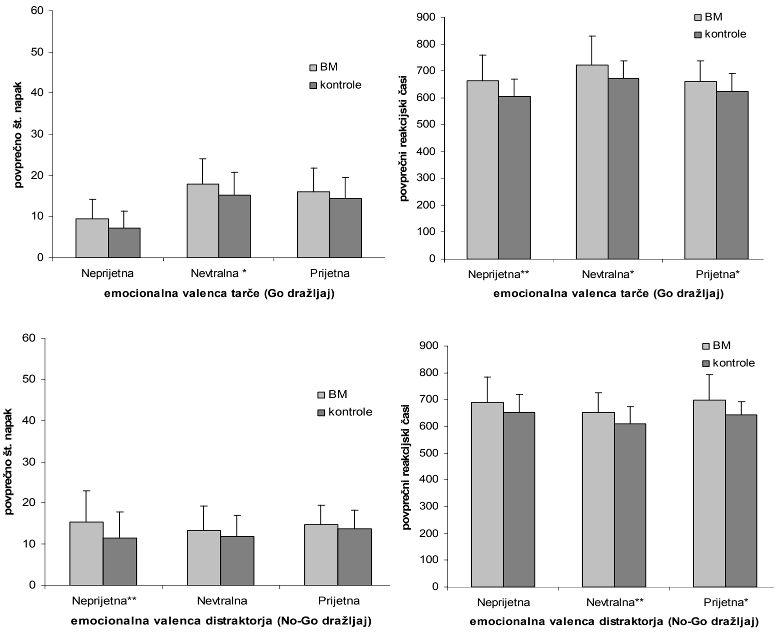
Psihiatrična ocena izraženosti depresivnih in maničnih simptomov v skupini oseb z bipolarno motnjo je bila opravljena s pomočjo lestvic Ham-D in YMRS. Udeleženci skupine oseb z bipolarno motnjo in kontrolne skupine so nato individualno reševali ISS lestvico in Emocionalni Go/No-Go test.

4.0 REZULTATI

V prvem delu analize rezultatov smo ugotavljali razlike v kontroli kognitivne inhibicije emocionalnih dražljajev pri osebah z bipolarno motnjo v primerjavi s kontrolno skupino s pomočjo Emocionalnega Go/No-Go testa.

Zgornja grafa slike 2 prikazujeta primerjavo rezultatov skupine oseb z bipolarno motnjo in kontrolne skupine glede na emocionalno valenco tarče (Go dražljaj), ne glede na emocionalno valenco distraktorja (No-Go dražljaj). Če primerjamo rezultate skupin, lahko ugotovimo, da ima skupina oseb z bipolarno motnjo večje število napak, ko je emocionalna valenca tarče *nevtralna* (Z=-1,983; p=0,047) ali *neprijetna* (*Z=-1,929;* p=0,054). Skupini se razlikujeta v povprečnih reakcijskih časih, ne glede na emocionalno valenco tarče (*neprijetna, nevtralna* in *prijetna*), pri čemer ima daljše reakcijske čase skupina oseb z bipolarno motnjo (Z_{nep}=-2,842; p_{nep}=0,004; Z_{nev}=-1,985; p_{nev}=0,047; Z_{pri}=-1,961; p_{pri}=0,050).
Primerjava skupin glede na emocionalno valenco distraktorja (No-go dražljaj), ne glede na emocionalno valenco tarče (Go dražljaj) je prikazana na spodnjih dveh grafih slike 2. Skupini se razlikujeta v številu napak, če je emocionalna valenca distraktorja *neprijetna*, pri čemer ima kontrolna skupina manj napak kot skupina oseb z bipolarno motnjo (Z=-2,759; p=0,006). Pri odgovarjanju na Go dražljaje ima skupina oseb z bipolarno motnjo daljše reakcijske čase kot kontrolna skupina v dveh pogojih, in sicer če je emocionalna valenca distraktorja *nevtralna* ali *prijetna* (Z_{nev}=-2,920; p_{nev}=0,004; Z_{pri}=-2,501; p_{pri}=0,012).

Skupini se razlikujeta tudi na skupnem rezultatu Emocionalnega Go/No-Go testa, pri čemer ima kontrolna skupina več pravilnih odgovorov kot skupina oseb z bipolarno motnjo (Z=-2,350; p=0,019).



Slika 2. Primerjava povprečnega števila napak in povprečnih reakcijskih časov (za pravilne odgovore na Go dražljaj) med skupinama za posamezne emocionalne valence tarče (oz. distraktorja); * $p<0{,}05$; ** $p<0{,}01$.

Tabela 1

Korelacije (Spearmanov ρ) med merami razpoloženjskih stanj in odgovori na Emocionalnem Go/No-Go testu za skupino oseb z bipolarno motnjo (N=39)

		Ham-D	YMRS	ISS-a	ISS-pb	ISS-id
Zadetki						
tarča	Neprijetna	0,172	0,100	-0,149	0,018	-0,077
	Nevtralna	-0,091	-0,161	-0,046	**-0,381***	**0,336***
	Prijetna	-0,071	-0,211	**-0,426****	**0,505****	**-0,454****
distraktor	Neprijeten	-0,204	-0,299	**-0,342***	0,011	-0,048
	Nevtralen	0,040	-0,048	**-0,414****	**0,339***	-0,259
	Prijeten	0,155	-0,067	0,037	-0,173	0,138
Napake						
tarča	Neprijetna	-0,206	0,007	0,149	**-0,345***	0,286
	Nevtralna	-0,018	0,035	0,176	0,231	-0,193
	Prijetna	-0,122	0,235	0,243	**-0,391***	0,290
distraktor	Neprijeten	0,023	0,221	**0,320***	-0,010	0,081
	Nevtralen	-0,206	-0,071	0,184	**-0,340***	0,178
	Prijeten	-0,225	-0,018	-0,017	-0,062	0,004
Skupaj		0,128	-0,122	-0,240	0,183	-0,168

Opombe. * $p<0{,}05$; ** $p<0{,}01$; *a – Aktivacija, pb – Psihično blagostanje, id – Indeks depresivnosti.*

V drugem delu analize rezultatov smo ugotavljali, kakšna je povezanost kontrole kognitivne inhibicije emocionalnih dražljajev z razpoloženjskimi stanji (manija, depresija, evtimija). Kot mero izraženosti depresivne in manične simptomatike smo uporabili rezultate lestvic Ham-D, YMRS in ISS.

Glede na rezultate lestvic Ham-D in YMRS je v skupini oseb z bipolarno motnjo šest udeležencev z blago izraženo depresivno simptomatiko in trije z mešano sliko, ostali udeleženci pa so v stanju evtimije.

Korelacije med posameznimi merami so prikazane v tabeli 1. Rezultati kažejo, da med merami razpoloženjskih stanj skupine oseb z bipolarno motnjo, dobljenimi s strani psihiatra in rezultati Emocionalnega Go/No-Go testa ne prihaja do statistično pomembnih povezav.

Nasprotno pa se slednji v veliki meri povezujejo z razpoloženjskimi stanji, dobljenimi s pomočjo samoocene. Največ korelacij je med podlestvicami lestvice ISS in *prijetno* tarčo, pri čemer imajo posamezniki z visoko *aktivacijo* in *indeksom depresivnosti* manj zadetkov, posamezniki z višjim *psihičnim blagostanjem* pa več zadetkov. Višje *psihično blagostanje* je povezano z manjšim številom napak pri *neprijetni* in *prijetni* tarči in *nevtralnih* distraktorjih ter manjšim številom zadetkov, ko je tarča *nevtralna.* Posamezniki z višjim *indeksom depresivnosti* imajo več zadetkov pri *nevtralni* tarči, posamezniki z višjo *aktivacijo* pa manj zadetkov, ko je emocionalna valenca distraktorja *nevtralna.*

Če si ogledamo kombinacije števila zadetkov in števila napak, lahko ugotovimo, da imajo posamezniki z višjim *psihičnim blagostanjem* več zadetkov in manj napak, ko imajo distraktorji *nevtralno* emocionalno valenco, posamezniki z višjo *aktivacijo* pa manj zadetkov in več napak, ko je emocionalna valenca distraktorjev *neprijetna*.

S skupnim rezultatom ne korelira nobena izmed mer razpoloženjskih stanj.

5.0 RAZPRAVA

V predstavljeni raziskavi smo v prvem delu ugotavljali, kakšna je kontrola kognitivne inhibicije emocionalnih dražljajev pri osebah z bipolarno motnjo, kar smo ugotavljali na podlagi razlik med skupino oseb z bipolarno motnjo in kontrolno skupino na Emocionalnem Go/No-Go testu. Rezultati kažejo, da ima skupina oseb z bipolarno motnjo slabše rezultate kot kontrolna skupina v pogojih *nevtralne* in *neprijetne* tarče ter *nevtralnega* distraktorja ter daljše reakcijske čase pri vseh pogojih, razen ko je emocionalna valenca distraktorja *neprijetna*. Slabše rezultate kot kontrolna skupina ima skupina oseb z bipolarno motnjo tudi na skupnem rezultatu omenjenega testa. Rezultati se skladajo z nekaterimi drugimi raziskavami (Simonsen in dr., 2008; Burdick, Endick in Goldberg, 2005), ki kažejo, da se kognitivni deficiti, še posebno na področjih spomina, pozornosti in izvršitvenih funkcij, pojavljajo tako v maničnih in depresivnih epizodah kot tudi v fazi evtimije.

Na podlagi korelacij med merami razpoloženjskih stanj in rezultati na Emocionalnem Go/No-Go testu smo ugotavljali, kakšna je povezanost kontrole kognitivne inhibicije emocionalnih dražljajev z razpoloženjskimi stanji (manija, depresija in evtimija). Raziskovalci (Lembke in Ketter, 2002, Elliott in dr., 2002) poročajo o usmerjenosti pozornosti (»attentional bias«) na pozitivne oz. negativne dražljaje tudi pri bipolarnih bolnikih, in sicer o usmerjenosti pozornosti na negativne dražljaje pri depresivnih bolnikih in usmerjenosti pozornosti na pozitivne dražljaje pri maničnih bolnikih. V predstavljeni raziskavi se mere kognitivne kontrole ne povezujejo niti z mero depresivne simptomatike Ham-D, niti z mero manične simptomatike YMRS, povezujejo pa se z nekaterimi merami, dobljenimi s pomočjo samoocene. Posamezniki z bolj impulzivnim vedenjem in pretiranimi reakcijami imajo slabšo kognitivno inhibicijo, ko je emocionalna valenca tarče *neprijetna*, posamezniki z dobrim počutjem in veliko energije pa izražajo boljšo kognitivno kontrolo tako *neprijetnih* kot *prijetnih* emocionalnih dražljajev. Rezultati raziskave se tako delno skladajo z izsledki drugih raziskav, verjetno pa se zaradi neuravnoteženih, maloštevilnih podskupin (glede na razpoloženjsko stanje) nekatere morebitne povezave ne pokažejo. Na odsotnost povezanosti med psihiatrično oceno razpoloženjskih stanj in merami kognitivne inhibicije bi lahko vplivala tudi časovna latenca med psihiatrično oceno razpoloženjskih stanj in preostalim delom testiranja. Tako je za oceno razpoloženjskih stanj v tem primeru morda bolj ustrezna ocena ISS lestvice, ki so jo udeleženci reševali neposredno pred testiranjem. Lestvica ISS predstavlja samooceno razpoloženjskega stanja, pri čemer bipolarni bolniki pogosto precenjujejo depresivno in podcenjujejo manično simptomatiko.

6.0 ZAKLJUČEK

V raziskavi smo ugotavljali, kakšna je kontrola kognitivne inhibicije emocionalnih dražljajev pri osebah z bipolarno motnjo in kako se le-ta povezuje z razpoloženjskimi stanji. Rezultati raziskave so pokazali, da je kognitivna inhibicija pri osebah z bipolarno motnjo zmanjšana. Psihiatrična ocena razpoloženja se sicer ne povezuje z merami kontrole kognitivne inhibicije, kar bi morda lahko pripisali nekaterim metodološkim omejitvam, vendar pa se slednje povezujejo s samooceno razpoloženjskih stanj. Povezava kontrole kognitivne inhibicije in razpoloženjskih stanj, dobljenih s pomočjo lestvice ISS, kaže na parcialni emocionalni bias na testu Emocionalni Go/No-Go. Novonastali inštrumentarij tako predstavlja potencialno uporaben pristop za klinično ocenjevanje kognitivnega funkcioniranja bipolarnih bolnikov ter spremljanje njihovega izboljšanja oz. poslabšanja v različnih fazah zdravljenja.

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PREPOZNAVANJE ČUSTVENIH IZRAZOV PRI OSEBAH Z BIPOLARNO MOTNJO RAZPOLOŽENJA V EVTIMIČNI FAZI

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POVZETEK

Študije na področju socialne kognicije, ki preučujejo okrnjenost funkcije prepoznavanja čustvenih izrazov pri osebah z bipolarno motnjo razpoloženja, ne dajejo enotnih rezultatov. Namen predstavljene raziskave je bil ugotoviti, ali se pri osebah z bipolarno motnjo razpoloženja, ki imajo dlje časa stabilno razpoloženje brez prisotnih kliničnih znakov manije in/ ali depresije (faza evtimije) pojavljajo težave v prepoznavanju obrazov in čustvenih izrazov. Rezultati so pokazali, da je pri osebah z bipolarno motnjo razpoloženja v evtimični fazi socialna kognicija, povezana s sposobnostjo prepoznavanja obrazov in čustvenih izrazov, primerljiva z zdravimi prostovoljci. Rezultati se skladajo z nekaterimi predhodnimi dognanji o relativno ohranjeni sposobnosti socialne kognicije pri osebah z bipolarno motnjo razpoloženja v fazi evtimije. Potrebna je nadgradnja raziskave, ki bo podrobneje pojasnila trend slabšega prepoznavanja neprijetnih čustvenih izrazov (strah, žalost, jeza) in nevtralnega izraza, ki smo ga zaznali pri osebah z bipolarno motnjo razpoloženja v evtimični fazi.

UVOD

Socialna kognicija predstavlja kompleksno sposobnost posameznika, ki mu omogoča prepoznavanje in ustrezno odzivanje na socialno relevantne dražljaje iz okolja. Poleg razvoja prosocialnega vedenja ima socialna kognicija evolucijski pomen tudi pri razvoju mehanizmov samozaščitnega vedenja, ki temeljijo na prepoznavanju potencialno ogrožujočih dražljajev (Adolphs, 1999). Pomemben vidik socialne kognicije predstavlja tudi sposobnost prepoznave čustvenih izrazov. Čustveni izrazi na obrazu se poleg ostalih dražljajev različnih zaznavanih modalitet pogosto uporabljajo v študijah, ki preučujejo nekatere značilnosti procesiranja čustev, kot so prepoznava posameznih značilnosti obraza, ocene čustva in intenzitete čustva, ki ga obraz izraža.

Za bipolarno motnjo razpoloženja so značilna nihanja v razpoloženju, ki v veliki meri prizadanejo socialno funkcioniranje posameznika (Goodwin in Jamison, 1990) tudi tako, da izzovejo neustrezno odzivanje tako na socialno pomembne (predvsem ogrožujoče) dražljaje kakor tudi na nepomembne (neogrožujoče) dražljaje. Nihanja razpoloženja pri osebah z bipolarno motnjo razpoloženja so odvisna od prisotnosti (hipo)maničnih in/ ali depresivnih epizod. Za evtimično fazo je značilno dalj časa stabilno razpoloženje brez prisotnih kliničnih znakov manije in/ali depresije. Nestabilno čustvovanje pri bipolarni motnji razpoloženja raziskovalci povezujejo tudi z nekaterimi nevrološkimi disfunkcijami kot je npr. prekomerna aktivacija subkortikalnih striatno – talamičnih (limbičnih) možganskih področij, ki določajo čustveno odzivnost, in slabše delovanje prefrontalnega režnja, odgovornega za uravnavanje čustev (Philips, 2003).

Prepoznavanje značilnosti obrazov, ki je sestavni del procesa prepoznavanja čustvenih izrazov, je glede na izsledke raziskav v glavnem ohranjeno v evtimični fazi pri osebah z bipolarno motnjo razpoloženja (Lembke in Ketter, 2002; Venn in dr., 2004). Na podlagi dosedaj opravljenih raziskav pa ni mogoče jasno zaključiti o obstoju in naravi težav s prepoznavanjem čustvenih izrazov pri osebah z bipolarno motnjo razpoloženja v različnih fazah motnje. Tako je bilo v manični fazi potrjeno slabše prepoznavanje čustev pri osebah z bipolarno motnjo razpoloženja (McClure in dr., 2003), medtem ko so raziskave različno poročale o težavah s prepoznavanjem čustev v evtimični fazi; nekatere so ugotovile slabše prepoznavanje čustev (Yurgelun- Todd in dr., 2000), druge pa njihovo ohranjeno sposobnost prepoznavanja (Venn in dr., 2004). Nekatere raziskave so poročale o slabšem prepoznavanju strahu (Yurgelun- Todd in dr., 2000) in gnusa (Lembke in Ketter, 2002), druge pa o slabšem prepoznavanju vseh osnovnih čustev (Getz in dr., 2003) pri osebah z bipolarno motnjo razpoloženja. V nasprotju z omenjenimi so v nekaterih raziskavah odkrili povečano prepoznavo gnusa (Harmer in dr., 2002), žalosti (Gur in dr., 1992) in jeze (McClure in dr., 2003) pri osebah z bipolarno motnjo razpoloženja. Nekatere študije poročajo tudi o tem, da so osebe z bipolarno motnjo razpoloženja nagnjene k razlagam nevtralnih dražljajev kot negativnih (Gur in dr., 1992), imajo težave z inhibiranjem čustvenih dražljajev (Murphy in dr., 1999) in kažejo pretirano aktivnost v limbičnih možganskih predelih med ocenjevanjem emocionalnega materiala, kar sproža neprimerne in/ ali ekstremne čustvene reakcije (Chen in dr., 2006).

NAMEN RAZISKAVE

Namen raziskave je bil ugotoviti, ali osebe z bipolarno motnjo razpoloženja v evtimični fazi slabše prepoznavajo čustvene izraze veselja, presenečenja, žalosti, strahu, jeze in nevtralni izraz. Cilja raziskave sta bila opredeliti vlogo procesiranja značilnosti obrazov pri prepoznavanju čustvenih izrazov in ovrednotiti oškodovanost socialne kognicije pri osebah z bipolarno motnjo razpoloženja v evtimični fazi v primerjavi z zdravimi prostovoljci.

METODA

1. Udeleženci

Sodelovalo je 26 oseb z bipolarno motnjo razpoloženja v evtimični fazi (12 moških, 14 žensk) in 26 priložnostno izbranih zdravih prostovoljcev (10 moških, 16 žensk). Povprečna starost oseb z bipolarno motnjo razpoloženja je bila 37,29 let (SD = 10,36), povprečna starost prostovoljcev pa 28,62 let (SD = 6,60). Osebe z bipolarno motnjo razpoloženja so se v povprečju šolale 14,23 let (SD = 2,08), prostovoljci pa 15,62 let (SD = 2,45). Osebe z bipolarno motnjo razpoloženja so bili statistično pomembno starejše ($t(50)$= 3,60, p = 0,001) in manj izobražene ($t(50)$= -2,19, p= 0,033) od prostovoljcev.

Vse osebe, diagnosticirane z bipolarno motnjo razpoloženja, so v času testiranja prejemale zdravila in so bile v ambulantni obravnavi. V povprečju so se zdravile 8,70 let (SD= 9,41). V času testiranja so bile po oceni psihiatrinje v evtimični fazi motnje.

2. Uporabljeni testi

Test prepoznavanja čustev (Ekman in Friesen, 1976) meri sposobnost pravilnega prepoznavanja osnovnih čustvenih izrazov (veselje, žalost, strah, jeza, presenčenje, nevtralni izraz) na ženskih in moških obrazih. Udeleženci so s pomočjo priloženega seznama čustvenih izrazov ugotavljali, katero čustvo izraža obraz na prikazani fotografiji. Beležili smo število pravilno prepoznanih čustvenih izrazov.

Test prepoznavanja obrazov (Benton in dr., 1994) je vidnoprostorski test, ki meri sposobnost prepoznavanja neznanih obrazov. Občutljiv je na morebitne desnohemisferne poškodbe. Naloga udeležencev je bila poiskati med šestimi fotografijami obrazov tisti obraz, ki je povsem enak obrazu iz referenčne fotografije. Obrazi so prikazani naravnost, s profila in v različnih osvetlitvah. Beležili smo število pravilno prepoznanih obrazov.

3. Postopek

Udeleženci so bili pred vključitvijo v raziskavo seznanjeni z njenim potekom in cilji ter so podali tudi pisno privolitev za sodelovanje v njej. Za vse udeležence smo zbrali osnovne demografske ter socialne podatke. Za osebe z bipolarno motnjo razpoloženja smo pridobili še podatke o bolezni in zdravljenju.

Udeleženci so reševali test prepoznavanja obrazov in test prepoznavanja emocij na prenosnem računalniku s pomočjo prilagojene tipkovnice. Pred testom so imeli možnost vaje. Prikazovanje dražljajev in beleženje odgovorov je potekalo preko programskega vmesnika Presentation 11.0 (Neurobehavioral Systems®, San Francisco). Rezultate smo analizirali s statističnim paketom SPSS 13.0. Kot mero statistične pomembnosti smo vzeli $p < 0,05$.

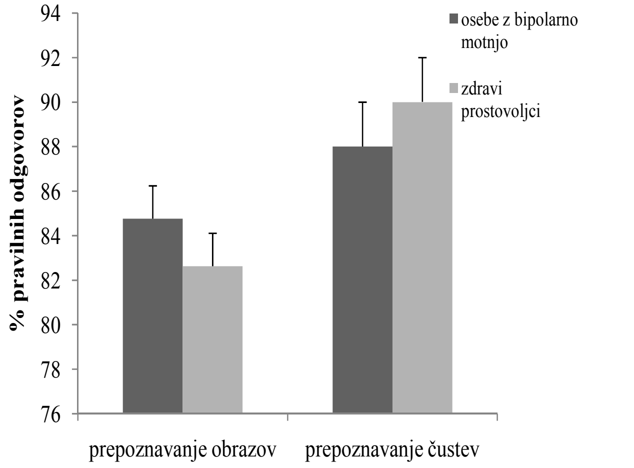
REZULTATI

Test prepoznavanja obrazov ni pokazal statistično pomembnih razlik v prepoznavi značilnosti obrazov med skupinama oseb z bipolarno motnjo razpoloženja v evtimični fazi in zdravih prostovoljcev.

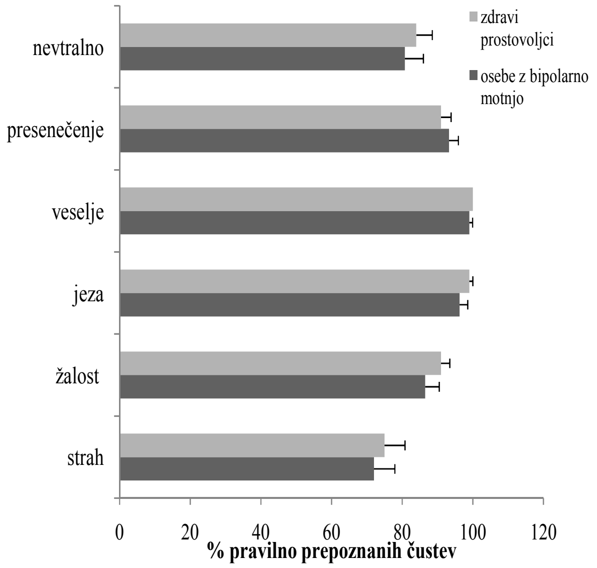
S testom prepoznavanja čustvenih izrazov smo ugotovili relativno ohranjeno sposobnost le- teh pri osebah z bipolarno motnjo razpoloženja v evtimični fazi v primerjavi z zdravimi prostovoljci (*slika 1*). Statistično pomembnih razlik med skupinama ni bilo ne pri prepoznavanju posameznih čustev niti pri skupnem skoru testa prepoznavanja čustev. Kljub odsotnosti pomembnih razlik med skupinama lahko iz *slike 2* razberemo, da se je pri zdravih prostovoljcih pojavila tendenca k boljšemu prepoznavanju neprijetnih, nevtralnih in prijetnih čustvenih izrazov v primerjavi z osebami z bipolarno motnjo razpoloženja v evtimični fazi. Obe skupini sta naredili največ napak pri prepoznavanju strahu in nevtralnega izraza. Nevtralni izraz sta najpogosteje zamenjevali z žalostjo in jezo, strah pa z jezo in presenečenjem.

Primerjave znotraj skupin so pokazale, da so tako zdravi prostovoljci kot osebe z bipolarno motnjo razpoloženja v evtimični fazi uspešno ločevale prijetne, neprijetne čustvene izraze in nevtralni izraz medseboj in ni prihajalo do zamenjav med posameznimi čustvenimi izrazi (za primerjavo med pari čustvenih izrazov je bil p = 0,00 pri obeh skupinah).

Kot mero velikosti učinka smo vzeli Pearsonov točkovno – biserialni koeficient korelacije, ki je bil nizek (najvišji r_{pb} je znašal -0,16) in je le potrdil zanemarljivo razliko med skupinama oseb z bipolarno motnjo razpoloženja v evtimični fazi in zdravih prostovoljcev v prepoznavi čustvenih izrazov.



Slika 1. Primerjava rezultatov testov prepoznavanja obrazov in prepoznavanja čustvenih izrazov med skupinama zdravih prostovoljcev in oseb z bipolarno motnjo razpoloženja v evtimični fazi. Prikazani so povprečni rezultati v deležih in standardne napake aritmetične sredine.



Slika 2. Primerjava posameznih pravilno prepoznanih čustvenih izrazov med skupinama zdravih prostovoljcev in oseb z bipolarno motnjo razpoloženja v evtimični fazi. Prikazani so povprečni rezultati v deležih in standardne napake aritmetične sredine.

DISKUSIJA

Namen raziskave je bil ugotoviti morebitno oškodovanost nekaterih vidikov socialne kognicije pri osebah z bipolarno motnjo razpoloženja v evtimični fazi. Osredotočili smo se na preverjanje sposobnosti prepoznavanja obrazov in prepoznavanja različnih čustvenih izrazov. Primerjave z zdravimi prostovoljci so pokazale adekvatno sposobnost prepoznave obrazov in relativno ohranjeno sposobnost prepoznavanja čustvenih izrazov pri osebah z bipolarno motnjo razpoloženja v evtimični fazi.

Različne študije sicer poročajo o ohranjeni sposobnosti prepoznavanja značilnosti obrazov pri osebah z bipolarno motnjo v evtimični fazi (Lembke in Ketter, 2002; Venn in dr., 2004), vendar ne dajejo jasnih in enotnih odgovorov na vprašanja obstoja in specifičnosti težav s prepoznavanjem čustvenih izrazov. Izsledki naše raziskave so skladni s tistimi študijami (Venn in dr., 2004), ki govorijo v prid neokrnjeni sposobnosti prepoznave čustev pri osebah z bipolarno motnjo v evtimični fazi. Na relativno ohranjeno sposobnost prepoznavanja čustvenih izrazov in s tem tudi na izboljšano socialno kognicijo pri osebah z bipolarno motnjo razpoloženja v evtimični fazi bi lahko vplivalo stabilno razpoloženjsko stanje brez kliničnih simptomov v času testiranja, relativno dolgo obdobje medikamentoznega zdravljenja (povprečno skoraj 9 let) in obiskovanje psihoterapije.

Kljub primerljivi sposobnosti prepoznavanja čustvenih izrazov glede na zdrave prostovoljce se je v skupini oseb z bipolarno motnjo razpoloženja pokazal tudi trend slabše prepoznave čustvenih izrazov z negativno valenco (strah, žalost, jeza) in nevtralnega izraza. Kar nekaj raziskav je poročalo o okrnjeni prepoznavi strahu (Lembke in Ketter, 2002; Yurgelun- Todd in dr., 2000), gnusa (Lembke in Ketter, 2002) in žalosti (Gur in dr., 1992), kar kaže na težave s slabšim ali povečanim prepoznavanjem neprijetnih čustev pri osebah z bipolarno motnjo razpoloženja. Značilno za to motnjo je tudi pripisovanje emocionalnega pomena nevtralnim dražljajem (Green in dr., 2007), ki v naši raziskavi ni bilo pomembno izraženo pri osebah z bipolarno motnjo razpoloženja v evtimični fazi glede na rezultate zdravih prostovoljcev. Zaznali pa smo trend interpretacije nevtralnih čustvenih izrazov kot negativnih (zamenjevanje z žalostjo in jezo) pri osebah z bipolarno motnjo razpoloženja v evtimični fazi, o čemer so poročale tudi druge raziskave (Gur in dr., 1992).

Lahko strnemo, da izsledki naše študije kljub nekaterim metodološkim omejitvam, kot so majhen vzorec, razlike v starosti in izobrazbi med kontrolno in skupino oseb z bipolarno motnjo razpoloženja in majhna statistična moč testa, da bi lahko odkrili v populaciji obstoječe razlike, govorijo v prid relativno neokrnjene socialne kognicije pri osebah z bipolarno motnjo razpoloženja v evtimični fazi. Ker smo v raziskavi zaznali trend slabšega procesiranja emocionalnih dražljajev z negativno in nevtralno valenco, bomo zaenkrat preliminarno raziskavo v prihodnosti dopolnili z večjim vzorcem in bolj uravnoteženimi skupinami.

ZAKLJUČEK

Rezultati predstavljene raziskave na skupini oseb z bipolarno motnjo razpoloženja v evtimični fazi so pokazali primerljivo sposobnost prepoznavanja obrazov in prepoznavanja čustvenih izrazov glede na zdrave prostovoljce. Nadaljnje raziskave s področja čustvovanja so nujne, da se razjasni, v kolikšnem obsegu in v katerih fazah motnje imajo osebe z bipolarno motnjo razpoloženja največ težav s prepoznavanjem čustev. Treba bi bilo ugotoviti, ali so morebitne težave s prepoznavanjem čustev odraz latentne ranljivosti oseb z bipolarno motnjo razpoloženja, ki se lahko manifestira pod vplivom stresa iz okolja. V primeru izraženih težav s prepoznavanjem čustev bi lahko z ustreznimi psihosocialnimi intervencami vplivali na razvoj in ohranitev socialnih veščin, socialne kompetentnosti in konstruktivnih strategij reševanja medosebnih problemov pri osebah z bipolarno motnjo razpoloženja.

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EMPATIJA V SPLETNEM UČNEM OKOLJU

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Povzetek

Iz družbenih, predvsem ekonomskih zahtev izvira potreba po večji učinkovitosti učenja. Raziskave kažejo, da k temu lahko veliko pripomore informacijska tehnologija. Pogoj za ustrezne rezultate pa je usmerjenost k učencu in upoštevanje njegovih značilnosti ter predvidevanje njegovih reakcij. Empatija je povezana s čustvi, ki jih različno opredeljujemo in na katere lahko vplivamo na različne načine. Pozitivne emocije podpirajo kognitivne procese. Udeležba čustev in empatije je pri učenju na spletu nujna.

V gradivu predstavljamo nekatere praktične izkušnje pri uvajanju empatije v spletno učno okolje, ki ji predstavljamo v luči ustrezne teorije.

Ključne besede
Empatija, spletno učno okolje, e-učenje, emocije, socialne interakcije, e-izobraževanje

Premiki v izobraževanju pod vplivom elektronskih tehnologij

Ko danes govorimo o uvajanju elektronske podpore izobraževanju, učenju in delu, imamo v mislih splet in ne samo računalnik kot pomagalo pri učnih ali delovnih opravilih. Internet, katerega storitev je splet, pa ni, kot nekoč, samo pripomoček za iskanje informacij. Na spletu se namreč učimo ali delamo. Določeno področje spleta, primerno obdelano, opremljeno in organizirano, je lahko učno okolje (e-okolje ali spletno okolje), kjer na današnji tehnološki stopnji že lahko zagotovimo pogoje, ki so potrebni za potek učnega procesa kot kognitivnega procesa in v podporo temu procesu.

Kot učenje na spletu v smislu tega prispevka razumemo samostojno učenje v virtualnem okolju, v fizičnem smislu od kjer koli in časovno kadar koli, ter brez neposredno prisotnega učitelja in večinoma brez sošolcev. Nekateri ugodni rezultati nakazujejo, da lahko učenje na spletu poteka učinkoviteje kot v klasičnem okolju šolske učilnice ali predavalnice z neposredno prisotnim učiteljem. Spletno okolje kot virtualni učni prostor lahko na spletu bolj bogato opremimo in ponudimo učna sredstva, ki jih v klasičnem ne moremo.

Za spletno učno okolje potrebujemo ustrezno tehnologijo, hkrati pa podporo pedagoškim, psihološkim, in drugim dejavnikom učenja, ki sodijo v »mehke vede«. Nekateri pedagogi nasprotujejo razmejevanju učenja in e-učenja, saj gre za en proces, ki poteka povsod poteka po določenih zakonitostih, zato moramo zanj zagotoviti pogoje. Vendar pa v prehodnem času, ko elektronsko podprto učenje še ni samoumevno, tako razmejitev potrebujemo, na primer klasično učenje in učenje na spletu, tiskane in elektronske učbenike ter klasično in spletno učno okolje. V prehodnem času je nujna ločena didaktična obravnava učenja na spletu.

Težnja po večji učinkovitosti izobraževanja in po večji kakovosti znanja je družbena, povezana z uspešnostjo družbe in s tem z ekonomijo. Znanje je ekonomski dejavnik, od vlaganja vanj pa pričakujemo dodano vrednost, kar velja tudi za vlaganje v učno tehnologijo. Izobraževalne organizacije so bolj kot v preteklosti izpostavljene zahtevam, ki veljajo za gospodarstvo, na primer po kakovosti in ekonomski upravičenosti. V gospodarstvu pa je znanje bistveni dejavnik uspešnosti in tržnih prednosti. Spoznanje, da z IT lahko dobimo več bolj kakovostnega znanja spodbuja razvoj pogojev tako v izobraževalnih kot v gospodarskih organizacijah.

V svoji praksi pri uvajanju informacijske podpore učenju in delu šol in v manjših podjetjih spoznavam nekatere probleme, ki so bolj kot s tehničnimi povezani z »mehkimi vedami«. Njihovo reševanje je pogosto odvisno od kakovosti sodelovanja med informatiki in pedagogi, oziroma psihologi.

Tako kot v preteklosti tehnološko podpiranje učenja spremljajo nekatere napačne predstave ali zmote. Prve tehnične učne podlage, imenovane tudi učne platforme in na njih pripravljena učna okolja so nastajala ob šibkem pedagoško psihološkem znanju. Veljale so za pedagoško nevtralne. To pomeni, da naj bi vsaka sodila v vsako okolje neodvisno od uporabnikov in psiholoških dejavnikov učenja. Na EDUCA-i 2006 smo lahko slišali dr. Thobna[1]: »Bojim se, da lahko govorimo o zastoju na področju e-izobraževanja, ker je produkcija obstala na tehnični ravni, psiholoških dejavnikov a strokovno nismo dorekli ali pa se nam doslej niso deli pomembni.«

Ni nevarnosti, da bi nam e-izobraževanje odmrlo kot nekoč »strojno učenje«, gre pa za tempo njegovega razvoja. Tako pretekli zelo smeli poskusi uvajanja učne tehnologije, ki bi omogočili učenje brez učitelja, se tudi pri e-učenju

[1] Thoben, K. D. (2006). Book of Abstracts, Use Cases for Teaching Strategic Manufacturing in Online Gaming, University of Bremen. Nemčija. Online Educa Berlin.

pojavljajo nekatere zmote, kot je opisana o uspešnem učenju brez upoštevanja psihologije. Napačna pa je tudi teza, da je splet sam po sebi neizmerno privlačno okolje za učenje. Privlači namreč vsako okolje brez obveznosti in odgovornosti, kjer »bivamo« v sanjskem svetu. Učenje pa vsebuje zahteve, odgovornosti, prizadevanja in napor, zato je potrebno za motivacijo poskrbeti, tako kot v vsakem drugem učnem okolju. Ko učenje podpiramo s tehnologijo, v prvi vrsti ne izboljšujemo učenca, ampak okoliščine za učenje, kar pomeni, da moramo, da tudi v e-okolju poteka kognitivni proces o enakih zakonitostih kot v klasičnem. Razvoj učenca, to je izboljševanje njegove učne učinkovitosti, pa je lahko pozitivna posledica kakovostnega učnega procesa.

Empatija in empatičnost

Empatija je v izobraževanju znana že dobro stoletje in sodi k temeljnim učiteljevim veščinam. Poznamo jo tudi izven izobraževanja na primer v menedžmentu. »Empathy« (emphaty sistem, solution, tehnology …) se v zadnjem času pojavlja tudi v imenih nekaterih proizvodov in v marketingu. Ne velja več, da morajo biti prodajalci »prijazni«, ampak »empatični«. Srečamo jo tudi v nekaterih prodajnih sloganih in kot označbo izdelkov, namenjenih ljudem.

Pojmovanje empatije se je s časom spreminjalo in razširjalo. »Čustvovanje v drugega« so poznali že na začetku 20. stoletja, kasneje pa je ta potreba dobivala različne praktične in teoretske podlage, večinoma utemeljene na biologistični pedagogiki. »Strojno učenje«, programirani pouk in končno učenje z računalnikom, vsi so slepe ulice, so predhodniki današnjega in jutrišnjega e-izobraževanja, ki so prinesli nekatere dobre didaktične izkušnje in omogočili tudi učenje na napakah. Vsi imajo med drugimi skupno slabost, da ne upoštevajo učenca kot osebnosti, da premalo upoštevajo učenje kot kognitivni proces in da ne omogočajo vstopa emocij. Čeprav učečega s tehnologijo lahko razvijamo, ga »delamo boljšega učenca«, pa so zmotna pričakovanja, da se bo to zgodilo avtomatično. Priporočilo, ki sta ga leta 1990 izdala Eisenberg in Fabes, da je potrebno diferencirati jaz in drugo osebo in izhajati iz emocionalnega stanja druge osebe, oziroma svoj jaz identificirati z drugo osebo, je za današnje potrebe preozko. Težko je namreč uresničiti zaznavno dimenzijo (Davis, 1994) empatije, za katero bi morali drugo osebo bolje poznati, ta pa je pri učenju v ospredju.

Empatičnost je lahko gensko dana lastnost, če ni, pa je je treba naučiti, ker je nujna socialna veščina. Zahteva bogate socialne izkušnje zato je ne moremo osvojiti zgolj prek teorije. Prav tako je ne moremo uresničevati samo po »receptih«. Potrebna je razvita intuicija, zato »so vaje v tovrstni intuiciji« eden od načinov, kako razvijamo čut in tehnike zanjo.

Razen vživljanja v tuja čustva in opazovanja problemov skozi očala drugega, je empatija predvsem zmožnost predvidevanja, kako po ravnal drugi ob nekem izzivu in sposobnost ustvarjanja takih izzivov, da se bo drugi ustrezno in optimalno odzval za osnovni namen neke dejavnosti. S tem postaja empatija bolj kompleksni pojem in zahteva bolj sistematično in poznavalsko pripravo takih izzivov.

Empatija v luči potreb v spletnem okolju

Vprašamo se lahko, zakaj se ob krepkejši tehnološki podpori učenja in izobraževanja ponovno vračamo k empatiji, ki je v klasičnem, to je tehnološko manj podprtem učnem okolju samoumevna in pogoj, da učni proces po danes veljavnih merilih poteka najmanj zadovoljivo.

Pri vzpostavljanju pogojev za e-izobraževanje se moramo torej zavedati psiholoških dimenzij in problemov. Poznati in razumeti moramo interakcijsko delovanje vseh dejavnikov, ki vplivajo na uspešnost učenja. Empatičnost je eden od teh dejavnikov, ki sodi med socialne dejavnike in sooblikuje mrežo interakcij[2] med udeleženimi v vsakem učnem okolju, tudi na spletu. Teoretiki poudarjajo pomen ne le kognitivnih stilov spoznavanja, mišljenja in učenja[3] ampak tudi čustvovanja[4].

Bolj kot razvoj elektronske učne tehnologije v smeri atraktivnosti, nas danes zanima njen učinek in učinkovitost učenja nasploh. Za pospeševanje učenja pa moramo delati na potrebah uporabnika, ki pa so osebnostne, socialne, čustvene in druge. Empatija tudi ni prilepek ali začimba v vsebini in pogojih za učenje. Empatično je lahko »skoraj vse«, struktura učnega okolja, vsebina, tudi učno gradivo in njegovi dodatki, kot so animacije ali slike, pa tudi podkrepitveni elementi, ki pripomorejo, da se učeči med učenjem čustveno ugodno počuti.

Z razvojem izobraževanja empatija dobiva na veljavi in se povezuje z individualnimi značilnostmi učečega med drugim tudi z emocionalnimi potrebami, s pravico do izbire v procesu izobraževanja in s splošno demokratizacijo učnega procesa. Pogosta ovira za razvoj empatije pa je prepričanje, da drugi čustvujejo enako kot mi. V spletnem okolju pa pogosto »pozabimo«, da človek deluje na človeka tudi tedaj, ko je ta oddaljen ali ju povezuje komunikacijski medij, kot je internet. V primeru komunikacije na daljavo je učinek še posebej močan in se v drugega ugnezdi. Učinka informacije, ki vedno ob sporočilu vsebuje tudi konotacijo, ni mogoče popravljati, kot lahko to lahko storimo z dodatnim pojasnjevanjem ali z gestiko, kadar smo fizično blizu in zaznamo, kako je delovala na sprejemnika. V e-okolju je torej empatiji potrebno posvečati več pozornosti kot v klasičnem, saj je učinek težko popraviti, posledice pa so lahko destruktivne.

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[2] Bratanić, M. (1990). Mikropedagogija, interakcijsko-komunikacijski aspekt edukacije. Školska knjiga. Zagreb.
[3] Marentič Požarnik, B. (2000). Psihologija učenja in pouka. DZS. Ljubljana.
[4] Goleman, D. (1997). Emocionalna inteligenca. MK: Ljubljana

»Čustvovanje v drugega« so poznali že na začetku 20. stoletja, kasneje pa je ta potreba dobivala različne praktične in teoretske podlage, večinoma utemeljene na biologistični pedagogiki. »Strojno učenje«, programirani pouk in končno učenje z računalnikom, vsi so slepe ulice, so predhodniki današnjega in jutrišnjega e-izobraževanja, ki so prinesli nekatere dobre didaktične izkušnje in omogočili tudi učenje na napakah. Vsi imajo med drugimi skupno slabost, da ne upoštevajo učenca kot osebnosti, da premalo upoštevajo učenje kot kognitivni proces in da ne omogočajo vstopa emocij. Delno je vzrok slabo poznavanje učenja na strani tehnikov, delno pa nizka razvojna stopnja tehnologije, ki več ni zmogla.
Iz prakse lahko trdim, da se ta napaka, to je zanemarjanje kognicije, osebnosti in emocionalnosti nadaljuje v dobo izobraževanja na spletu, čeprav je tehnologija zmogljivejša, oziroma jo znamo izdelati. Potrebno je torej ozaveščanje vseh, ki se ukvarjajo z e-izobraževanjem in organizacijo e-učenja, omogočiti sodelovanje pedagoško psiholoških strokovnjakov in tehnikov ter jih usklajeno interdisciplinarno povezovati.

Zavedajoč se današnje potrebe po interdisciplinarnem povezovanju različnih ved in njihovih področij, kljub različnim zornim kotom, razlikam v raziskovalni metodologiji in terminologiji ne bi smeli imeti tovrstnih težav pri e-izobraževanju. Moje izkušnje kažejo, da jih dejansko ni, če so vsi predstavniki ved v multidisciplinarnem timu, ki ga uvaja, ustrezno ozaveščeni in motivirani za čim višjo kakovost procesa učenja in pogojev zanj. Multidisciplinarni pristop izključuje dominanco ene vede nad drugo, na primer informatike nad pedagogiko ali obratno, ampak zahteva komplementarnost obeh[5]. Kljub pomislekom, da posebej o učnem e-okolju ni potrebno razpravljati, saj mora vsebovati spodbude kot vsako drugo, pa se je potrebno zaradi nekaterih praktičnih težav, ki pomembno ovirajo razvoj e-izobraževanja, pri tem vendarle zaustaviti.

Čustva in njihovo izzivanje na spletu

Empatična reakcija je pogosto definirana kot lastnost emocionalne reakcije, zanjo so torej značilna čustva ter sočutje in naklonjenost (Batson 1995). Do empatije pride, če spreminjamo svojo perspektivo v perspektivo drugega zaradi percepcije tega drugega.

Danes vemo, da moramo za kakovostno učenje in za kakovostno delo dovoliti udeležbo čustvom. Čustva so do neke mere lahko sredstvo, s pomočjo katerih blažimo probleme ali dvigamo motivacijo. Med opisi čustev se zdi za našo temo uporaben Eliasov[6], po katerem so čustva produkt naučenega in izzvanega, doživljamo pa jih v družbenem kontekstu.

[5] Rebolj, V. (2006). E-gradivo. Priročnik za izdelavo. Inter-es. Ljubljana.
[6] Elias, N. (1978). The Civilizing Process 1, The History of Manners, Oxford

V učno situacijo učenec prinese odtis preteklih doživetij (neodvisna spremenljivka), hkrati pa ga v njej izzivamo k čustvovanju (odvisna spremenljivka). Seveda nas v e-okolju zanima predvsem čustvovanje kot odvisna spremenljivka in odgovor na vprašanje, kako spodbujati pozitivna čustva. Tudi spoznavanje (učenje) namreč lahko sproži čustva, tudi negativna, na primer zaradi strahu pred določeno osebo, kot posledica priklica neprijetnega dogodka iz spomina ipd. Z empatičnim pristopom in poznavanjem učečih lahko minimaliziramo take izzive, hkrati pa sistematično vključujemo izzivalce pozitivnih čustev.

Teoretiki poudarjajo, da je empatičnost tem višja, čim višja je raven pozitivnega razpoloženja, ki ga določa količina pozitivnih emocij. Poskrbeti moramo za prisotnost in ugodno sinergijo psihosocialnih dejavnikov. Izbor teh je velik[7], skoraj brezmejni in zahteva ustvarjalnost. Nedosegljiv cilj je učno okolje, v katerem ne bi bilo izzivanja negativnih čustev, iritirajočih situacij, frustriranja, vzbujanja neprijetnih asociacij, vendar pa jih veliko že v fazi priprav lahko delno izločimo.

Še posebej dobre možnosti imamo pri e-izobraževanju za izzivanje pozitivnih čustev v predlogični fazi učenja. Kot predlogično fazo učenja Uletova[8] pojmuje čas miselne priprave in seznanjanja z učno vsebino ali obliko. Tedaj vzpostavimo do njiju odnos: lahko nam je zanimivo, blizu, simpatično. Lahko se z vsebino identificiramo ali jo podoživljamo. To poveča motivacijo za učenje in stimulira mišljenje, vodi k višji kakovosti znanja. Za dobro delovanje uma je potreben čustveni podporni sistem. Pri e-učenju je zelo pomembna zgradba in razvejanost učnega gradiva, priprava uvoda v posamezne vsebine, predtesti (testi in kvizi pred učenjem) povezovanje teoretskih in praktičnih vsebin, različne aktivnosti ali na primer virtualno sprehajanje po različnih spletnih okoljih.

Čustva kot odvisna spremenljivka so plod sinergije različnih dejavnikov, ki jih sestavljajo učni pogoji in učna klima ter »učna kemija«. V učni klimi so udeleženi drugi ljudje in gre torej za medosebne odnose na individualni in skupinski ravni. Sestavine te »kemije«, možnosti za njeno vzpostavljanje in spreminjanje ter njen učinek na učenje, kadar poteka na spletu, so odvisne od interakcij v učnem procesu. Kot zatrjuje Whalley[9], splet interakcij ustvarja sodelovalno (kolaborativno) učno okolje. Med sodelujočimi se prenašajo informacije, znanja spodbude, lahko si medsebojno pomagajo. To dvigne potencial učenja. Okrepi se delovna energija. Lahko pride do inkubacije idej: ideje učencev sprožajo nove ideje drugih učencev, kar med drugim ustvarja učne užitke.

[7] Rebolj, V. (2008). E-izobraževanje skozi očala pedagogike in didaktike, Didakta. Radovljica.
[8] Ule, M. (1993). Psihologija vsakdanjega življenja. Znanstveno in publicistično središče. Ljubljana.
[9] Whalley, Peter. 2002. The Knowledge Web. Collaborative learning in networked simulation environments. Kogan Page. London. Velika Britanija.

Kolikor je mogoče, je potrebno zagotoviti visok nivo teh interakcij, tako med učenci, med učenci in učitelji in kot tudi vsakega posameznega učenca z vsebino. Vzpostaviti moramo torej socialno komponento učenja, ki je vezana na druge udeležence v učnem procesu.
Za vzpostavitev vsakršnih interakcij sta potrebna skrbno načrtovanje učnega okolja in procesa ter začetni pospešek, nato pa jih moramo vzdrževati v toku in na potrebni ravni. Potrebna je tudi tehnična podpora, to je izbira takega programja, ki nam omogoča ustrezne kakovost interakcij.

Z uvajanjem e-izobraževanja se tradicionalne vloge učenca, učitelja, učne tehnologije in učne vsebine premeščajo. Nekoč je bil učenec osredotočen na učitelja, ta je bil pretežno odgovoren, da je učenec osvojil vsebine. Pri e-izobraževanju se učenec med e-učenjem s pomočjo tehnologije osredotoči na vsebino, učitelj pa pomaga in usmerja in pri tem, glede na nekdanjo vlogo, stopi v ozadje. Pri klasičnem izobraževanju je učenec v interakciji predvsem z učiteljem. Pri izobraževanju na spletu pa je v interakciji predvsem z učno vsebino. Znotraj interakcije učenca z učno vsebino pa ima svojo vlogo tudi učitelj. Če ima učenec tutorja, vzpostavi interakcijo tudi z njim, tutor pa tudi z učiteljem. Da učitelj in tutor delujeta kot spodbujevalca ugodne sinergije, ju je potrebno dodatno usposabljati ter v tem smislu ozaveščati, kar je pomembno pri pripravi informatiziranega pouka.

V obdobju »učenja z računalnikom«, in v prvem obdobju uporabe interneta pri učenju, so pedagogi izpostavljali problem osamljenosti, oziroma socialne izključenosti, ki sta veljala za pomembno oviro med učenjem. Domnevali so, da e-učenje ni primerno za vsakogar, saj se nekateri učenci brez prisotnosti drugih ne morejo učiti. Danes vemo, da je socialna izključenost pri e-izobraževanju mnogo manj problematična, kot če pride do tega v klasičnem izobraževanju, to je do izključitve ali nevključitve posameznika v učečo se skupino. Socialne elemente v spletnem okolju moramo ustvarjati umetno, ker fizičnih dejavnikov socialne vključenosti nimamo.

V pogovorih z dijaki in študenti v zadnjih letih tega problema nisem zaznala. Dijaki, ki so kot e-učenje izvedli posamezne krajše naloge, so dejali, da se, obratno, počutijo kot del velikega sveta, v veliki družbi, čeprav delajo naloge na svoji šoli. Ker vedo, da so opazovani, imajo občutek večje odgovornosti, a se ne počutijo neprijetno nadzorovani. Študenti programa Komercialist, ki so na spletu študirali predmet Poslovna matematika s statistiko[10] in ki smo jih po izpitu anketirali, so prav tako večinoma zanikali (86 %), da je osamljenost med študijem moteča, navedli so tudi nekatere prednosti. Glede na to, je bolj smiselno vprašanje, kakšen vpliv na učenje ima socialna vključenost? Kako jo lahko ustvarimo na daljavo s pomočjo računalnika in interneta? Domnevamo, da ima v fizičnem smislu socialno vključeni učenec manj skrbi z upravljanjem časa, ima stalno pomoč in lahko komunicira s sošolci, ki mu oddajajo spodbudne signale[11]. Po Clarku ima vključeni učenec daljšo motivacijo in zato redkeje potrebuje spodbude.

Vzpostavljanja socialne komponente izobraževanja se moramo lotiti premišljeno in načrtno. To pomeni, da bomo nekatere gradnike v e-okolje umestili prav zato, da jo bomo vzpostavili. Kljub navidezno individualnemu položaju je pomembno, da ima učenec tudi občutek pripadnosti določeni skupini, to je sklopu posameznikov, ki so drug z drugim v nekem odnosu in imajo drug na drugega vpliv.

Omogočimo na primer možnost za imitiranje, prenos sugestij, za vzpostavljanje simpatij in antipatij, identifikacije, socialnega pritiska, podpore in tudi medsebojnih ovir. Učeči naj vidi, kaj delajo sošolci. Naj ima priložnost, da jih oceni ali posnema. Naj tekmuje z njimi. Dobro je, če lahko sproščeno in neomejeno tudi zasebno komunicira. Tehnologija navedeno omogoča. Ker pri nas v formalnem izobraževanju govorimo predvsem o kombiniranem učenju nam preostane tudi možnost, da socialne stike vzpostavljamo v času kontaktnega učenja, med e-učenjem pa jih predvsem ohranjamo.

V klasičnem učnem okolju posameznik čuti ali ga okolje sprejema. V e-okolju pa mu moramo ustvarjati vtis, da ga sprejema in v ta namen oddati dovolj ustreznih sporočil. Komunikacija z drugimi naj bo dovolj pogosta in enostavna. Če sam ni pobudnik, ga je potrebno izzvati. Komunikacija naj vzbuja pozitivna čustva.

Učenčeve socialne potrebe med učenjem so med drugim odvisne od zadovoljenosti njegovih potreb izven e-učenja. Pomembno je, kakšne so njegove socialne izkušnje, kako zadovoljuje svoje socialne potrebe izven šole in tudi kakšna je šola, koliko sproščenih odnosov dovoljuje in kolika je njena permisivnost oziroma represivnost. Informatizacija šole vedno zahteva nekatere spremembe v klasičnih razmerjih, to je v fazi priprave na informatizacijo, kar oblikujejo dober temelj tudi za učenje na spletu.

Empatičnost okolja učečih je pomembna tudi zato, da bodo sami postali bolj empatični in da bodo po tem začutili potrebo. Kot uspešni sodelavci usposobljeni za predvidevanje in za in prepoznavanje potreb, ustvarjati priložnosti za sodelovanje različnih ljudi. Kot vodje morajo razen tega skrbeti za razvojno rast drugih. V praksi je težko priti do relevantnih podatkov o učečih ali zaposlenih, ki jih potrebujemo pri snovanju empatičnega okolja.

Snovanje empatičnega okolja za učenje na spletu

Empatija na široko zajema odnose med ljudmi v nekem procesu, zato lahko o njej govorimo v učnem okolju (empatičnost učnega okolja), in tudi med delovanjem

[10] Rebolj, Vanda. 2005. Etapna evalvacija spletnega študija. B2, d.o.o., Višja strokovna šola. Ljubljana.

[11] Clarke, Alan. 2002. Online Learning and social exclusion. NIACE. Velika Britanija.

(učenjem) v tem okolju, ko gre za odnose med pari ali skupinami sodelujočimi. Pri uvajanju študija na daljavo tudi pri nas ponekod pred in med študijem uporabljajo inštrumente, s katerimi kontaktno in spletno spoznavajo študente, vendar pa poglobljeno to na daljavo ni mogoče. Nekoliko laže odkrivamo kognitivno dimenzijo empatije - spoznavanje stališča in namene učečih. Za celostno sliko o posamezniku, to je spoznavno, kognitivno in čustveno pri izobraževanju na daljavo potrebujemo več časa. Če nam sliko uspe izpopolniti, je dobljena podoba posameznika mnogo boljša, kot če bi se nam sam predstavil. Pravzaprav ne gre več za vživljanje v tuja čustva ampak za predvidevanje in razumevanje, kako se bo posameznik v neki situaciji odzval.

Leonard in Rayport[12], ki sta mnogim družbam pomagala pri vzpostavljanju empatičnega reklamiranja izdelkov, sta prepričana, da najbolje spoznamo ljudi, če jih opazujemo v njihovem lastnem okolju pri delu ali rabi izdelkov, torej pri njihovih dnevnih rutinah. Tako raziskovanje, pravita, je podobno etnološkemu, saj se je treba voziti po terenu in opazovati ljudi. Do neke mere to lahko opravi učitelj v razredu, ko pri računalnikih opazuje učence in tako dobi podatke za načrtovanje spletnega učnega okolja. Za splošno rabo pa je potrebno posredno zbiranje podatkov.

Pri načrtovanju e-učnega okolja z vidika pedagogike, andragogike, psihologije in sociologije in drugih humanističnih ved je torej zelo pomembno poznavanje bodočih uporabnikov. Težko bi si zamislili, da lahko isti model uporabimo tako v večjem podjetju npr. gradbene stroke, kot v manjšem, ki se ukvarja s poslovnim svetovanjem. Razlikujejo se tudi šole po razvojni stopnji učečih, vsebini in učnih ciljih. Prav tako se razlikujejo šole iste vrste po viziji, vrednotah, v kulturnem smislu ali po strukturi učečih. Preden se lotimo načrtovanja je potrebno napraviti posnetek stanja, med katerimi je tudi poznavanje zaposlenih in njihovega vodstva. Kar praviloma nimamo možnosti, da bi organizacijo neposredno opazovali, nam posebni vprašalnik in usmerjeni intervjuji do neke mere pomagajo razkriti to sliko, pa tudi tisto, česar nam neposredno ne bi povedali. Kljub dobrim informacijam o učečih pa nam bo ostala množica unikatnih problemov, ki jih z empatičnostjo ne bomo rešili. Predvideti moramo način njihovega reševanja, na primer s kontaktnim posredovanjem učitelja ali tutorja.

Ne glede na količino in relevantnost podatkov o učečih ali drugih uporabnikih pa se moramo zavedati, da gre pri empatičnem e-okolju za to, da je v središču človek (user-centered) in ne učni oziroma delovni proces (process-centered).

Pri načrtovanju e-izobraževanja in pogojev zanj naletimo na ovire, ki jih lahko le delno rešujemo z univerzalnimi vzorci e-okolja, pretežno pa s spoznavanjem konkretnih uporabnikov tega okolja. Univerzalne vzorce lahko izdelamo s pomočjo teorije o empatiji, uporabnike pa spoznavamo diagnostično, to je pred učenjem in med učenjem.

Pot do empatičnega okolja opisujejo nekateri viri[13], ki predvidevajo naslednje faze.

1. Zbiranje informacij o uporabnikih

Pri nas v šolah praviloma uvajamo kombinirano (blended) e-izobraževanje, kar pomeni, da med klasični pouk uvrščamo spletno izvedene teme. Možnosti za opazovanje učencev imamo dovolj, učitelje začetnike pa moramo opozoriti, kateri podatki so pomembni za načrtovanje empatičnega e-okolja. Kadar informatiziramo delo in izobraževanje v podjetju, dobimo najbolj kvalitetne informacije, če zaposlene opazujemo pri delu, zaradi kasnejše analize pa tudi filmamo. Opazujemo aktivnosti, odzive, interakcije med sodelavci in neartikulirane potrebe. Žal je pri nas za to težko dobiti dovoljenje, zato podatke zbiramo posredno z usmerjenim intervjujem vodij in z anketiranjem zaposlenih.

2. Izdelava podobe

Opredelimo najpomembnejše podatke, za organizacijo izdelamo diagram delovnega toka. Prediskutiramo jih z učitelji ali z vodji organizacije. Opredelimo ekstremne primere. Opišemo bistvene potrebe ljudi. Opredelimo prave učne potrebe.

3. Iskanje rešitev

Nujno je, da v iskanje rešitev vključimo predstavnike organizacije ali učečih, vendar se nekateri ne želijo vključiti. V tej fazi pretehtamo detajle, ki so gradniki empatičnega e-okolja in odbiramo najprimernejše za določene uporabnike oziroma učeče.

4. Razvoj prototipa

Množica predhodnih ugotovitev pripomore k izdelavi najboljšega približka empatičnega e-okolja.

5. Uporaba in evalvacija

Končni izdelek eksperimentalno preizkusimo in po odzivih dopolnimo. Naslednje dopolnitve sledijo po periodičnih evalvacijah.

O pristnih stikih z drugimi: komunikacija

Kljub fizični odsotnosti drugih pa spletno okolje omogoča žive stike, saj po internetu lahko komuniciramo. Potrebujemo ustrezne programe, na primer za forume, pomenkovalnico in klepetalnico ter za različne konference, ko te je na primer spletna konferenc, ki omogočajo sočasno ali nesočasno komunikacijo. Razen dejavnikov, ki prispevajo k ugodnemu razpoloženju in empatičnosti, moramo ponuditi dovolj možnosti za komuniciranje, vzpostaviti red in protokole ter moderiranje prometa sporočil. Kljub resnobnosti učenja omogočamo in

[12] Leonard, D., Rayport, J. (2008). Spark Innovation Throug Empatic Desegn. Harvard Business School. www.elarningpost.com/articles/archives/empathic:instructional_design/2.7.2008

[13] Driving Innovation and Creativity through Customer Data. User Interface Engineering;
User.Centered Design. IBM
Emphatic Design. Funderstanding

spodbujamo tudi zasebno in neformalno ter po potrebi zaupno komunikacijo.

Večinoma učeči niso dovolj pripravljeni na ustrezno komunikacijo na spletu, zato je potrebno uvajanje in ozaveščenje. Pri tem ne gre toliko za uporabo programov in pripomočkov, kot za stil, izbor besed, projekcijo lastnih emocij, oblikovanje enopomenskih sporočil, tudi empatičnost do sprejemnika sporočila ter za denotacijo in konotacijo. Potrebna je tudi pozitivna komunikacija na strani vseh udeleženih, zato je pomembna izbira besed ter prava mera, ne preveč ne premalo, pohval in spodbud na strani učitelja oziroma organizacije. Kratek, praktično usmerjeni seminar lahko pripomore, da pridobijo to veščino, katere pomanjkanje je lahko moteče. Vsebuje vaje v prepoznavanju lastnih emocij in emocij drugih, upravljanje z emocijami in usmerjanje reakcij na primeren način, vzpostavljanje dobrih medsebojnih odnosov ter tehnike komuniciranja na spletu.

Preprečevanje izvorov anksioznosti v luči načela empatičnosti

Doslej smo se v tem prispevku posvečali predvsem vzpostavljanju empatičnosti, poznati pa moramo tudi zaviralce empatije in drugih emocionalno ugodnih občutij na strani učečih. Ti so na primer:

- **Pomanjkanje sočutja, skrbi in naklonjenosti v težavah**

V spletno okolje lahko vgradimo mnoge gradnike, ki uporabniku sporočajo, da razumemo njegove težave, ki so nekaj normalnega in niso usodne, ponudimo mu izbiro in pomoč in ga presenetimo z ugotovitvijo »na kaj vse smo mislili« - zanj!

- **Pomanjkanje učne pomoči**

Učna pomoč pri učenju je lahko avtomatska – kot nasvet računalnika za nadaljnje učenje, ali živa v obliki rednih, znanih in kakovostnih stikov z učitelji ali učnimi pomočniki. Zaradi pomanjkanja učne pomoči se učni napredek zaustavi, kar deluje stresno in za motivacijo zaviralno.

- **Slabo delovanje ali okornost učnega programja**

Razvito učno programje bi morali biti večkratno testirano in plod dolgotrajnega razvoja, to je preizkušeno na različnih učencih in dopolnjevano po izsledkih preizkusov. Rabo razvitega programja učeči hitro avtomatizira ter se tako pretežno posveča vsebini, v nasprotnem primeru se učni napor poveča, učenje pa je iritirajoče.

- **Nekonsistentnost in nelogičnost spletnega okolja**

Značilnosti spletnega okolja moramo povezati s kognitivnimi značilnostmi in izkušnjami določene skupine učečih, kar zahteva ustrezno organiziranje in razmeščanje vsebin in navigacije ter optimalno pripravo procesov glede na kognitivne. Navigacija mora ubirati enake miselne poti, kot jih usmerjajo možgani, potrebna je njihova nestopničasta povezanost ipd.

- **Odsotnost ukrepov za sproščanje nastalih napetosti**

Poznamo mnoge izvore učnega stresa, vemo, katere vsebine so za učence težke in večinoma lahko napovemo, kje se lahko zatika v medsebojnih odnosih, kljub temu pa vseh dejavnikov ne moremo zajeti. Zdi se najpreprosteje, če za to pripravimo sodelavce, ki v takih primerih kontaktno ali spletno posredujejo, odsotnost posredovanja pa lahko povzroči učinek snežne kepe, katere destruktivnost težko popravimo.

- **Zanemarjanje načela recipročnosti**

To načelo opozarja, da se drugi vedejo do nas, kot mi do njih. To velja tudi za razmere v spletnem okolju. Če je urejeno, dorečeno, etično, humanistično, strokovno in didaktično na visoki ravni, bodo taki tudi njegovi uporabniki, torej naši učenci in obratno.

Za izvedbo informatizacije šole ali podjetja potrebujemo multidisciplinarni tim, ki ob enakopravnosti in medsebojnem spoštovanju vseh ved in disciplin ter članov, deluje od začetka projekta dalje. Običajno tehnično okolje pripravijo na izdelani podlagi, ki jo dopolnijo glede na potrebe, zahteve in značilnosti naročnika in njegovih uporabnikov. Načelo empatičnosti je potrebno upoštevati od začetka snovanja, informacije o uporabnikih pa moramo zbrati že pred začetkom dela.
Pri našem delu smo razvili tabelo, ki v prvem stolpcu vsebuje podrobni seznam funkcij, ki jih bomo informatizirali, te pa so bile v stolpcih opisane s tehničnega, organizacijskega in psihološkega vidika ter z vidika empatičnosti. Taka tabela ob začetku projekta pomeni dogovor, kaj želimo, med izvajanjem in še posebej na zaključku pa služi preverjanju, kaj smo uresničili. Tako ničesar ne pozabimo ali zanemarimo, nič ni obrobno. Za vsako polje tabele pa obstaja odgovor, kako smo vpisano zahtevo uresničili.

Zelo pomembno je tudi, da informatizacija zajame vso organizacijo, kar pomeni, da naj se vsakogar vsaj dotakne, čeprav v prvi fazi ni sredstev, da bi na spletnem okolju zajeli vso njeno dejavnost. Tako nimamo črnih lukenj, ki bi nam ohromile prizadevanja tudi za psihosocialne odnose in empatičnost. Pomembno je, da sodeluje vodstvo, to je v šoli ravnatelj, ki ima nasploh pomembno vlogo pri vzpostavljanju učne klime, vodenje pa je v bistvu tudi empatična dejavnost.

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SCHOPENHAUER REVISITED: LOOKING FOR CONCEPTS OF EMBODIED COGNITION IN SCHOPENHAUER’S THEORY OF MIND

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ABSTRACT

Embodied cognition has become a buzzword in Cognitive Sciences for the last 10 years. Some scientists understand this theory as path to the ultimate answer of all questions about human thinking while others consider it as ultimately useless. In this paper I would like to revisit the basic concepts of this theory and why there are some objections against it current formulation.

Special about my approach is that I am going to develop the argument that the discussion of embodied and situated cognition versus off-line cognition is also immanent in the German 19th century philosopher Arthur Schopenhauer's theory of mind. My claim is that by introducing the term embodiment nothing new was added to the traditional mystery of human mind and thinking. If I'm right we won't have to deal with a new problem. Far more we can relate and find inspiration from the highly developed history of Schopenhauer receptions and those philosopher who were influenced by his work: Nietzsche, Wittgenstein, Popper, and Heidegger.

1 THEORY OF EMBODIED COGNITION

By the invention and wide-spread use of computer systems in the second half of the last century a new paradigm appeared in cognitive sciences: the computational metaphor of the mind. The working hypothesis was, that human thinking could be reduced to information processing, internal Turing-like computations or the so-called computer functionalism. The new research field of artificial intelligence was believed to solve the problems of understanding reasoning once and for all.

This paradigm proved to be unstable when confronted with John Searle‘s *Chinese Room Argument* (Searle, 1980): Just because a system responds to a designated input with an adequate output does not imply that this system understood the input and its own doing and therefore acted in an intelligent, reasonable way. Another nail in the coffin was the publication of the AI and robotics expert Rodney Brooks (Brooks, 1990): the ability of playing chess doesn‘t make a computer intelligent because it‘s nothing more than rule following in an artificial environment. On the other hand an elephant, that never meant to play chess at all, can navigate and operate within its environment in a reasonable way and therefore being more intelligent than the smartest AI device ever designed. And finally, Gibson‘s ecological psychology (Gibson, 1979) became popular, introducing the notion of *affordances* - the sum of all potential interactions of an agent within its environment.

These new insights brought up the shift in perspective that thinking is deeply rooted in the bodily senso-motoric reality of the individual agent. Therefore it‘s not only floating around in an abstract space reacting to whatever input may come, but characterized by this very dynamical interplay of brain processes, body and environment. In a word: no mind without body: “Biological brains are first and foremost the control systems for biological bodies. Biological bodies move and act in rich real-world surroundings.” (Clark, 1998)

In the light of evolution it also makes sense to assume that the basis of all thinking is the appropriate perception, conception, and action of the individual‘s body and environment. For it is the key criterion for survival and successful reproduction.

Margaret Wilson elaborated - and reflected on - six key concepts and claims of embodied cognition theory (Wilson, 2002):

I. <u>Cognition is situated.</u>

While cognition takes place, the processing of motor and sensory data does not stop and therefore always interfering with current mental processes. Being situated means dynamically responding to changes in the environment, relevant for the task and the survival of the individual (e.g.

reacting to obstacles in the path of the designated movement direction, stopping the current action to avoid predators).

II. Cognition is time-pressured.

Further on, cognition is not only situated in locality and functionality, but also in time. Thinking usually does not occur in distinct steps of building-up a representation of the current situation and off-line processing of the acquired model afterwards, but as a dynamical process of creating efficient behavior quickly and cheaply. Sometimes - or always? - there is just not enough time and free intellectual capacity to build up a complete mental model of the situation you are in (e.g. returning a ball in tennis) (Beer, 2000)

III. We Off-Load Cognitive Work onto the Environment.

The problem of the limited possibility (by time-pressure and cognitive limitations) to derive a full-blown concept of the epistemic reality is called *representational bottleneck*. One strategy to overcome this constraint is to off-load or leaving information in the environment to reduce the cognitive load by not completely encode them (e.g. calculating using pen and paper, where you‘re not required to memorize all needed operations and numbers at the same time – or all other forms of writing information down for later retrieval).

IV. The Environment is Part of the Cognitive System.

Cognition can only be explained when observed and modeled within its complete situated setting. That is because cognition is not always only motivated by the individual’s internal motives. It’s more often there to cope with specific situated interactions with body and environment. This argument leads further to studies on *distributed* and *social cognition*.

V. Cognition is for Action.

Next, characteristics and constraints of cognition should only be considered in the light of their operative functions for the cognizer’s behavior (e.g. vision for improved motor control (Churchland, Ramachandran, & Sejnowski, 1994), memory for perceiving and acting within environment (Glenberg, 1997)

VI. Off-Line Cognition is Body-Based.

Finally, all different kinds of abstract cognitive activities can be traced back to senso-motoric simulations (e.g. counting as using one’s fingers covertly (Wilson, 2002) and logical values as grasping an object or not)

2 THE OTHER SIDE OF EMBODIMENT

So called on-line cognition is all that is stated in arguments I. to V. where “the mind can be seen as operating to serve the needs of a body interacting with a real-world situation.” (Wilson, 2002). Those aspects are indeed situated, time-pressured and the environment is highly integrated in task-oriented problem solving activities.

But Margaret Wilson points out in her reflection on the above-mentioned claims that there is more to human cognition than can be accessed by methods based on these assumptions.

Thinking does not always take place focused on a task happening in this very moment (cf. I.). Far more “one of the hallmarks of human cognition is that it can take place decoupled from any immediate interaction with the environment.” (Wilson, 2002) If one neglects this position it surely is impossible to fit things as day dreaming, mental imagination, planning of future events completely irrelevant for the current situation, art, morality and culture into the proposed model of mind.

Those kinds of off-line activities usually take place when there is liberal amount of mental spare-time and the agent is not crammed with multiple demanding tasks that have to be attended instantly. Relieved from time-pressure (cf. II.) “we often behave in a decidedly off-line way: stepping back, observing, assessing, planning, and only then taking action.” (Wilson, 2002)

Along the same line is Wilson’s statement on the shortcomings of reducing cognition to the activity of only serving immediate action (cf. V.) This view would completely neglect the capabilities of all species with higher developed brain functions of finding alternative and more flexible strategies for problems, by using acquired knowledge and understanding that prior – at the time of consolidation – had no obvious functional value: “A creature that encodes the world using more or less veridical mental models has an enormous advantage in problem-solving flexibility over a creature that encodes purely in terms of presently foreseeable activities.” (Wilson, 2002)

Finally she draws attention to the necessary consequences for off-line thinking, when accepting the embodied cognition theory (cf. VI.). When activated from internal motives mental imagery and the memory systems would use the same senso-motoric brain areas, as they would use when processing external stimuli mediated by our senses. Even reasoning and problem solving make use of well-tried senso-motoric pathways to simulate spatial relations (Windischberger, Lamm, Bauer, & Moser, 2003) and authors quoted in (Wilson, 2002) or to bring down abstract challenges to simpler concrete analogies. In the end we also use mental simulation to imitate and understand behavior of fellow creatures by mapping expressions isomorphically on the own body, to easier sense what it feels like. It’s important to mention that these ideas are not only theoretical conclusions but also state of the art working assumptions in empirical sciences and therefore experimentally confirmed (Wilson, 2002).

Wilson also discusses the problems of including the agent’s environment (cf. III. and IV.) into the model. Since they are of no relevance for my argumentation I will exclude them from this paper. More important for my hypothesis is: (a) her clear distinction of action-oriented on-line aspects and abstract, maybe rational, facets of cognition and (b) the commitment that off-line cognition is, although a different kind of phenomenon, rooted in our embodied way of perceiving the world.

3 SCHOPENHAUER’S NOTION OF UNDERSTANDING AND REASONING

Arthur Schopenhauer (1788 in Danzig - 1860 in Frankfurt am Main) was a German philosopher and one spearhead of German Idealism. Most influential for his concepts were Kant, Plato and ancient Indian philosophers (Janaway, 1999), some ideas can also been traced back to Democritus, Lucretius and Spinoza. His main concern was to give a complete metaphysics of the world and to gain full understanding of human intelligence, motivations and the ultimate meaning of life. Unfortunately, what he managed to find out turned out to be neither rational, nor good, but vastly absurd, polymorphous and hungry (Janaway, 1999). His particular style of addressing topics is not to the liking of modern analytic philosophers, because he preferred a rather rhetorical prose to a levelheaded presentation of thoughts, and made dogmatic claims when arguments were weak or missing. Nonetheless, the positions he decided to take are still or again prominent in contemporary discussions in philosophy of mind and therefore to consider.

In the next paragraphs of this section I will refer to Schopenhauer‘s main work The World as Will and Representation (1819, 1844) or his dissertation The Fourfold Root of the Principle of Sufficient Reason (1813, 1847).

<u>Understanding (Verstand)</u>
<u>and intuitive representations of the world.</u>

Being an idealist, Schopenhauer states everything that can be perceived by a subject depends on the nature of the perceiving subject itself. The world is the sum of all perceptions and therefore a subjective representation of an empirical reality. Knowledge about this reality is based on our body properties, the limitations of senses and the way our brain is organized to process the received data. Therefore he concludes the apriori existence of prerequisites and conditions for all intuitive understanding of things: our principles of space, time, and causality.

The senses of living beings deliver data about the material environment in the dimensions of space and time. From this raw data stream our Understanding derives our intuitive representation of the world by concluding from the effects (sensory data) to their adequate causes. When we perceive color, for example, we don‘t actually see color entering our retina, but have light detected by various receptors, sensitive to different wavelengths (sensory data). Cortical brain regions responsible for vision and association process this input. From a neurological perspective, this is where qualia, feeling or representation of the percept arises.

This world, created by the Understanding‘s methods of interpreting sensory data in terms of cause and effects (causality), is completely real and “what it seems to be“ [§5]. These intuitive and concrete representations are the building blocks of the empirical reality of humans, and animals alike, that are also equipped with similar ways of understanding causality based on given effects. Doubt about the truth and sufficiency of the empirical reality can only arise, when investigated by the reflective tools of Reasoning.

<u>Reasoning (Vernunft)</u>
<u>and abstract representations of the world.</u>

In contrast to animals, human cognition doesn‘t stop at the level of sensation and intuition of the current situation (Understanding) but gets enriched by the capabilities of Reasoning: thinking and knowing.

Schopenhauer compares his theory with the front view of a house: the ground floor is the intuitive representation of things (Understanding), while the higher floors are abstract representations or concepts built on the more concrete levels below (Reasoning). It enables us to elaborate complex plans and collaborations (e.g. by language use), logical conclusions and reflexion, whereas Understanding remains in making sense of the here-and-now and performing actions.

As explained by the house metaphor, it‘s an important issue to understand, that reasoning is nothing more than an abstraction of concrete things: it doesn‘t come up with new content, but enriches the already existing world with more general and not situation-dependent concepts. Therefore his conception of off-line cognition is at the very end grounded in the properties of Understanding of what is sensed and therefore body-based.

Next, action can‘t be mediated by Reasoning but falls into the domain of Understanding. To use just one of Schopenhauer‘s examples: it‘s sufficient for an adept billiard player to use her concrete and immediate perspective to perform a successful game move. She would not need the abstract knowledge of physical laws of a scientific mechanic to do it.

Further, Reasoning can only be used for abstract plans during contemplation and to deny the crudest forms of egoism and bestiality. It is by itself powerless to act and decisions derived from reflexion get easily overthrown by - maybe unwanted - behavior in the heat of the current situation. Virtue, therefore, can never arise as a consequence of abstract thinking. It has to be deeply embedded into the intuitive way of personal acting.

That‘s why, for Schopenhauer, the feeling of psychological free will is an illusion based on misunderstanding the scope and possibilities of reasoning. When reflecting, all action possibilities seem equally possible to convey. However, when confronted with a real world situation, our unchanging character would take over and determines the way of our acting, leaving reasoning behind as a stunned spectator.

4 DISCUSSION

The first issue important to me in Schopenhauer‘s theory of mind is his strong commitment to the ideas of embodied cognition. Actions take place in situations at certain times and our Understanding allow us to act and react in an adequate way (c.f. I., II. and V.). Our off-line cognition, our Reasoning, is based on nothing else than our intuitive understanding of the world. Therefore it‘s based on concrete body sensations and the very special characteristics of their coming-about (c.f. VI.) If seen as polarities, instead as contradictory positions, Schopenhauer‘s notion of Understanding and Reasoning would nicely match with the terms on-line and off-line cognition, that are currently in state of discussion. If that claim is rights, we could reuse those terms, along with others from philosophy, and refine them, instead of introducing more of them and reinventing the wheel.

My other concern is: how does situated acting and off-line thinking relate to each other? Where is the link between abstract Reasoning and concrete Understanding?

Off-line aspects of cognition and Reasoning must have an influence on situated cognition and therefore acting. It is clearly obvious that on-line capabilities are requited to fulfill motives derived from abstract plans, but they can’t be responsible for all our behavior, because – as Wilsons also states in her paper –: “Yet one of the hallmarks of human cognition is that it can take place decoupled from any immediate interaction with the environment.” (Wilson, 2002) Our special capabilities of problem solving, abstract thought, handling mental conflicts and changing strategies so unique in the organization of the human brain might be the reason for that.

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EMPATIJA IN PREPOZNAVANJE DEPRESIJE V KLINIČNI PRAKSI

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Povzetek

Ljudje smo socialna bitja in naše preživetje ter uspešnost sta odvisna od naše sposobnosti prilagajanja kompleksnim socialnim situacijam. Velikokrat ljudje v tovrstnih situacijah odreagiramo z depresivnostjo, ki se lahko stopnjuje v klinično sliko depresije. Po drugi strani pa bolezen kot je depresija, ki je lahko del številnih psihiatričnih motenj, predstavlja kompleksno socialno situacijo. Glede na to, da je depresija, kljub veliki pogostosti, še vedno vse prepogosto neprepoznana, pa se sprašujemo koliko lahko pri odkrivanju in zdravljenju pomaga empatija. Glede na to, da se njeni zametki kažejo že v prvih mesecih življenja, jo lahko pojmujemo kot eno osnovnih človeških lastnosti, ki je sicer prisotna tudi pri drugih primatih. Za bolj celostno pojmovanje empatije pa so poskrbele tudi nevrološke slikovne raziskave, ki so pokazale, da jo omogoča sistem zrcalnih nevronov. Na polodprta anketna vprašanja o pomembnosti in vlogi empatije pri diagnosticiranju in zdravljenju depresije, so odgovarjali specialisti psihiatrije zaposleni na Psihiatrični kliniki Ljubljana in v Psihiatrični bolnici Idrija. Odgovori so pokazali, da se jim zdi empatija ključna pri delu s pacienti na vseh nivojih obravnave ter da jim večkrat pomaga pri prepoznavanju manj tipičnih oblik depresije, ko standardni diagnostični kriteriji odpovedo.

1. UVOD

1.1. Depresija

Depresija je ena najbolj razširjenih bolezni, njena prevalenca se v zadnjih 50-ih letih stalno povečuje (Seligman et al, 1995), zelo pogosto se ponovi (Coryell et al, 1994) in ima življenjsko prevalenco 17,1% (Blazer et al, 1994).
Depresija je prisotna v večini psihiatričnih motenj (MKB-10), tako znotraj različnih razpoloženjskih motenj, prilagoditvenih motenj, psihotičnih motenj, osebnostnih motenj in vedenjskih motenj. Simptomi depresije se spreminjajo z resnostjo bolezni. V grobem jo opisujejo naslednji simptomi: znižana, depresivna razpoloženjska lega, občutki utrujenosti, nemoči, ničvrednosti, krivde, pomanjkljiva sposobnost uživanja, izguba interesa, motnje apetita in spanja, negativistično, pesimistično razmišljanje, motnje koncentracije in pozornosti, neodločnost, znižano socialno in delovno funkcioniranje, motorična agitacija ali retardacija, samomorilne misli ipd. Glede na široko in raznoliko sliko, ki jo lahko pokaže depresija ter glede na novejše študije, ki opozarjajo, na dodatne pomanjkljivosti dosedanje klasifikacije, smo se na osnovi kliničnih izkušenj, odločili za drugačno razvrstitev depresij. Tako smo jo razmejili na:

- Anksiozno depresijo; Najbolj jo označujejo anksioznost, strah, čustva nevrednosti, pesimizem, prekomerna zaskrbljenost in prekomerni občutki krivde. Poleg tega so zanjo značilni še anhedonija, zmanjšan apetit, motnje spanja (zlasti pogostejšega prebujanja), nemirnost, psihomotorna agitacija, pomanjkljiva kontrola impulzov. Ljudje s to vrsto depresije so neobičajno občutljivi za telesne občutke in imajo tudi pogostejše stranske učinke zdravil. Pod stresom odreagirajo z introvertiranostjo, umikom ter imajo C osebnostni stil.
- Atipično somatsko depresijo; Za to je značilno, da pacienti večinoma sploh ne poročajo o čustveni komponenti oz. depresivnosti, ampak v veliki meri navajajo glavobol, tiščanje v prsih, bolečine v sklepih, bolečine v mišicah, bolečine v križu, telesno šibkost, težave pri hoji, omotico, občutek dušenja, razbijanje srca, tremor in izgubo apetita. V manjši meri pa še pozabljivost, razdražljivost, nespečnost in občutek nemoči.
- Melanholično depresijo; Opisujejo jo: anhedonija, nesposobnost reagiranja na dražljaje ugodja, pomanjkanje apetita, izguba teže, nespečnost (najpogosteje prebujanje zgodaj zjutraj),upočasnjenost v gibanju oz. agitacija. Pri tem stanje povečane vzburjenosti in strahu pogosto izhaja iz lastnih občutkov ničvrednosti in pesimizma glede prihodnosti. Težave s koncentracijo so razvidne predvsem pri kompleksnih nalogah. Značilno je tudi, da dlje kot traja, manjša je verjetnost, da bodo na njen potek vplivali zunanji stresni dejavniki.
- Moško depresijo; Prepoznamo jo po znižanem nivoju tolerance, ekstravertiranem reagiranju, agresivnem vedenju, znižani kontroli impulzov, antisocialnemu vedenju, regresiji, znižanem občutku samospoštovanja, nezadovoljstvu, večji dovzetnost za zlorabe aktivnih substanc, depresivni vsebini misli, suicidom.
- Depresijo pri starostnikih; Starostniki pogosto manj poročajo o znižani razpoloženjski legi, vendar moramo na depresijo pomisliti ob višji stopnji anksioznosti, apatiji, somatskih simptomih, motnjah spanca in apetita, utrudljivosti,

kognitivnemu upadu ter ob psihotičnih simptomih (zlasti paranoidnih in hipohondričnih).

Glede na povezavi depresije z empatijo, pa je zanimiv tudi vidik ego-psihologije, kjer pojmujejo depresijo kot posledico pomanjkanja zgodnjih prepoznav in podpore, ki se jih sicer potrebuje za zdrav in varen občutek jaza.

1.2. Empatija

Človekovo preživetje je odvisno od njegove sposobnosti učinkovitega funkcioniranja v socialnem kontekstu. Osnova za uspešne socialne interakcije je sposobnost razumevanja namer in prepričanj drugih. Ta kapaciteta reprezentacije mentalnih stanj se pojmuje "teorija uma" ali sposobnost mentalizacije (Premack, 1978). Nasprotno pa ser empatija, v širšem pojmovanju nanaša na sposobnost razumevanja občutenj drugih, ne glede ali gre za čustvena ali senzorna stanja (Frith & Frith, 2003).
Čeprav so empatijo obširno preučevali filozofi in socialni znanstveniki, pa je šele v zadnjih letih nanjo postala pozorna tudi nevroznanost. Pod vplivom modela zaznava-aktivnost motoričnega vedenja in imitacije sta Preston in de Waal (2002) predlagala model empatije, ki vključuje večino teoretičnih postavk kot tudi empiričnih dognanj. Ključen predlog je, da opazovanje ali imaginacija druge osebe v določenem čustvenem stanju avtomatično aktivira reprezentacijo takšnega stanja v opazovalcu ter s tem povezanim avtonomnimi in somatskimi odgovori. Avtomatično se ob temu nanaša na procese, ki ne zahtevajo zavestnega procesiranja, vendar so lahko kljub temu inhibirani ali kontrolirani. Filozofinja Langer pa je to opisala kot ne-voljen most individualnega ločevanja (1988).
V psihoterapevtski praksi se še vedno najpogosteje uporablja Rogersovo (1957) definicijo empatije, saj je on vpeljal empatijo v tovrstno obravnavo. Razume jo kot sposobnosti terapevta, da čim točneje dojame doživljanje klienta, ter da to razumevanje odraža. V raziskavi smo jo dopolnile z Borkejevim (1971) in Piagetovim (po Lamovec, 1988) razumevanjem, ki jo označujejo kot zmožnost in točnost razločevanja, določanja, presojanja in napovedovanja emocionalnih stanj ter vedenja drugih. Ključne sestavine empatije so torej:

- sposobnost imaginacije,
- obstoj dostopnega jaza (zavedanje samega sebe),
- obstoj dostopne druge osebe (zavedanje drugega, prepoznavanje zunanjega sveta),
- obstoj dostopnih čustev, želja, idej in reprezentacij akcij ali njihovih izidov tako v jazu, ki je empatičen kot pri drugih, ki so objekti empatije,
- zadostna občutljivost.

Prava empatija je možna, samo kadar oseba izhaja iz predpostavke, da so ljudje različni in kadar poskuša odkriti drugačnost drugega. Samo kadar je oseba sposobna odkriti osnovno logiko drugega, njegova prepričanja o sebi, drugih in o svetu, si lahko predstavlja, kako je drugemu in lahko približno doživi tisto, kar doživlja drugi. Glede na to, je sposobnost empatije dober ključ za razumevanje in dekodiranje ne samo čustev drugega, ampak tudi njegovega referenčnega okvirja. Morris (1996), nadalje razlaga, da je empatija ekvivalentna resonanci v fizikalni znanosti. Vendar pa nimamo načina kako zagotoviti identično 'valovno dolžino' takšne resonance pri obeh subjektih. Z drugimi besedami, nimamo načina kako verificirati, da so čustva ali občutja sprožena pri dveh (ali več) subjektih ena in ista. Barve imajo posebno, enoznačno, neodvisno izmerljive lastnosti. Še vedno pa ne more nihče dokazati, da tisto kar jaz vidim kot 'rdeče' tudi tisto kar drugi imenujejo 'rdeče' (kot je primer pri Daltonistih). Če to drži za 'objektivno' merljive fenomene, še toliko bolj drži za čustva ali občutja. Značilnost empatija je tudi njena povezanost z neverbalno komunikacijo, ki je v precejšnem deležu nezavedna. Pri tej običajno uporabljamo številne signale, ki jih lahko razvrstimo v: parajezik, stik s pogledom, izraz obraza, drža, kretnje, dotik in obleka (Davitz & Davitz, 1961).

2. EMPATIJA IN NEVROLOŠKI KORELATI

2.1 Razumevanje dejanj

Kako se dejanja prepoznajo? Za to obstajata dve glavni hipotezi. Prvi, tradicionalni pogled, pravi, da sloni prepoznava dejanja izključno na vizualnem sistemu. Razumevanje dejanja drugega posameznika je odvisno od aktivnosti višjih nivojev vizualnegih področij in zlasti, področij superiornega temporalnega sulkusa, kjer se nevroni selektivno aktivirajo z biološkim gibanjem.
Druga hipoteza pa je, da je dejanje prepoznano, kadar aktivira, v možganih opazovalca, temu analogno motorično reprezentacijo. Opazovalec ne izvede tega dejanja, ker kontrolni mehanizmi preprečijo njegovo očitno pojavljanje, vendar pa sprovocirana motorična reprezentacija (»motorično znanje«) omogoča, da razume kar je videl.
Prva opisuje »tretje oseben« odnos med opazovalcem in opazovanim dejanjem, ter omogoča predvsem diferenciacijo ene dejavnosti od druge. »Motorična » hipoteza pa opisuje »prvoosebno« razumevanje tega kar opazovalec vidi. Opazovana dejavnost vstopi v opazovalčevo motorično reprezentacijo in prikliče njegovo podobno izkušnjo. To je empatična prepoznava, zaradi katere opazovalec deli izkušnjo z akterjem.
Motorično hipotezo podpirajo dognanja o zrcalnih nevronih. MEG in EEG študije so pokazale, da pride do desinhronizacije motoričnega korteksa, sicer značilne za aktivno gibanje, tudi ob opazovanju dejavnosti drugih. Opazovanje dejanj drugih aktivira, poleg vizualnih področij, dve kortikalni področji: inferiorni parietalni reženj in spodnji del precentralnega girusa (ventralni premotorični korteks) s posteriornim delom inferiornega frontalnega girusa. Ti dve področji formirata ogrodje sistema zrcalnih nevronov. Dejanja drugih se lahko prepozna skozi različne mehanizme. Dejanja, ki pripadajo motoričnemu repertoarju opazovalca so označena v njegovem motoričnem sistemu. Dejanja, ki ne pripadajo motoričnemu repertoarju, pa so v bistvu

prepoznana na vizualni osnovi. Tako v prvem primeru, motorična dejavnost prevede vizualno izkušnjo v empatično, prvoosebno znanje, medtem ko v drugem primeru tovrstno znanje primanjkuje.

Razumevanje čustev

Kateri mehanizmi nam pomagajo razumeti kaj drugi čutijo? Tudi za razumevanje emocij obstajata dva bazična mehanizma, ki se konceptualno razlikujeta med sabo. Prvi vsebuje kognitivno elaboriranje senzornih vidikov čustvenega vedenja drugih. Drugi pa vsebuje direktno včrtanje senzornih vidikov opazovanega čustvenega vedenja na motorične strukture, ki pri opazovalcu določajo doživetje opazovanega čustva.

Ti dve poti prepoznavanja čustev sta izkustveno radikalno drugačni. S prvo, opazovalec razume izraženo čustvo drugega, vendar ga ne čuti, temveč ga razlaga. Določen obrazni ali telesni vzorec pomeni strah, drugi srečo ipd. Drugače pa je pri senzorno-motoričnemu zapisih. V tem primeru pride do prepoznave, ker opazovano čustvo sproži občutek enakega čustva pri opazovalcu. To je prvo osebna prepoznava. Čustvo drugega prodre v čustveno življenje opazovalca in sproži v njemu, ne samo opazovano čustvo, ampak tudi sorodno čustveno stanje in nianse podobnega doživetja. Slikovne študije možganov so pokazale intenzivno aktivacijo v insuli (anteriorno levo), tako ob doživljanju gnusa kot ob opazovanju nekoga, ki ga doživlja.

Hipoteza, da dojemamo čustva drugih z aktivacijo enakega čustva pri nas samih, so podprli različni avtorji (Phillips et al., 1997; Adolphs 2003; Damasio 2003a; Calder et al. 2000; Carr et al. 2003; Goldman in Sripada 2003; Gallese et al. 2004). Pri tem je posebno vpliven Damasio s sodelavci, ki trdijo, da je nevrološka baza empatije aktivacija »kot-če zanke«, katere ključna struktura je insula (Damasio 2003). Pri tem imajo vlogo tudi somato-senzorna področja kot sta SI in SII.

Rankin (2006) povzema najnovejše študije, ki so se spuščale v odkrivanje nevroloških osnov empatije. Vse ugotavljajo, da je v procesiranje čustev vpletena desna frontotemporalna mreža možganskih regij in pri reguliranju kompleksnih socialnih interakcij poudarjajo vlogo desnega temporalnega pola in inferiorno frontalnih/ striatnih regij. Predvsem naj bi bile desne anteriorne temporalne in medialno frontalne regije ključne za resnično empatično vedenje.

3. RAZISKAVA

V raziskavi nas je zanimalo kako razumejo in kako pomembna se zdi vloga empatije, zdravnikom, specialistom psihiatrije, pri prepoznavanju in obravnavi depresije oz. različnih oblik le-te. V ta namen je bil sestavljen anketni vprašalnik s pol odprtimi vprašanji, ki so zajemala tako vprašanja o empatiji sami, o diagnostiki depresije, diferencialni diagnostiki in kombinaciji vsega omenjenega. Po principu intervjuja, so odgovarjali psihiatri zaposleni v Psihiatrični kliniki Ljubljana, na Kliničnem oddelku za klinično psihiatrijo in tisti zaposleni v Psihiatrični bolnici Idrija.

3.1 Rezultati

Velika večina psihiatrov meni, da je empatija zelo pomembna in priporočljiva tako pri obravnavi kot pri diagnosticiranju depresivnih stanj in da je kvečjemu popolno pomanjkanje te ovira za delo z ljudmi. Kljub temu pa opozarjajo, da je zlasti pri melanholični depresiji velika nevarnost, vzpostavljanje previsoke stopnje empatije, kar lahko povzroči slabše zdravljenje, kot bi ga imel bolnik ob večji distanci. Predvsem psihiatri z daljšim delovnim stažem poročajo, da jim večkrat ravno empatija pomaga pri diagnosticiranju motenj, zlasti kadar je slika teh ne tipična. Največ težav pri prepoznavanju povzroča t.i. moška depresija, ker jo pogosto tudi moški sami težko sprejmejo in posledično prekrivajo na različne načine, kot je npr. alkoholizem.

3. ZAKLJUČEK

Empatija je v zadnjih letih postala področje, ki ga obravnava vse več različnih znanstvenih disciplin. V klinični praksi je dobila svoje mesto s psihoterapijo C. Rogersa, vendar pa je od takrat ostala nekako v ozadju. Omenjen prispevek poskuša opozoriti in pokazati, da je kljub temu, stalno prisotna in zelo pomembna v delu z ljudmi ter da se tega vse premalo zavedamo. To so potrdili tudi rezultati raziskave, saj psihiatri poročajo, da je empatija stalnica v obravnavi depresivnih motenj in pomembna zlasti pri prepoznavanju njenih netipičnih oblik. Hkrati pa poudarjajo, da se lahko adekvatno uporabi empatijo v klinični praksi samo ob polnem zavedanju njenih vplivov.

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EMPATIJA: LOGIČNI POGOJI MOŽNOSTI

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empathy

[*tr. German* Einfühlung *(T.Lipps* Leitfaden der Psychologie *1903), ad. Gr.* ἐμπάθεια]

The power of projecting one's personality into
(and so fully comprehending) the object of contemplation.

Oxford English Dictionary, 2nd Ed. 1989

POVZETEK:

Prvi del pričujoče razprave obravnava empatijo v okviru predpostavke, da ta obstaja. V polju jezika je le-ta sicer očitno, ne pa hkrati tudi univerzalno veljavna, saj je njen obstoj vezan zgolj na po-samezne, določene jezike; psihološko vzeto je obstoj empatije kot nejezikovne dejanskosti po-gojen s subjektivno presojo posameznika. Drugi del teksta raziskuje logične pogoje možnosti empatije.

___ ___ ___

Neposredni pogoj možnosti *empatije* je *impatija*.

***.

Preden se lahko lotimo opredelitve *impatije*, moramo predpostaviti, da *empatija* (E):

a) *je nekaj* (N), ter da

b) *nekaj označuje*.

Skratka: *predpostavimo, da empatija obstaja*.

**

a) je najprej *logična trditev* in je kot taka tavtološka. Formalno vzeto zatrjuje le identiteto: E=empatija=nekaj=N. Kolikor je lahko tu govora o *obstoju*, gre za goli obstoj *spremenljivke, znaka, imena* v nekem *poljubnem jeziku*, kar je trivialno. *Empatija* tam obstaja na način, kot obstaja *x*, *E*, *kentaver*, skratka kot *karkoli*, kar je v *določen jezik* postavljeno.

Nadalje je *empatija* kategorija nekega *konkretnega jezika* (*jezikov*), v katerega je bila postavljena in – za razliko od *impatije*, ki je zaenkrat *zgolj* postavljena – tudi sprejeta v uporabo. Ta jezik običajno imenujemo *naravni jezik*, t.j. »jezik, v katerem se *sporazumevamo in mislimo*.«[1]

Ker je jezikovni izraz *nekaj* najuniverzal-nejša kategorija našega ter cele vrste nam bližnjih jezikov, ta zaobjame tudi *empatijo*; jezikovno-logični vidik trditve, da »empatija je nekaj« najverjetneje podpirajo vsaj gramatike indoevrop-skih jezikov.[2] Kljub temu, da bi težko našli koga, ki se s tem ne bi strinjal, gre tu le za *pravilo določenih jezikov*, ne pa za obstoj reči same.

*

Iz sfere *formalne logike*, kjer so pravila trdna, znana in nujna, smo tako že prešli v *dialektično logiko*, ki pa jo tu pojmujmo kar dobesedno, torej kot *logiko nekega jezika*,

[1] Ule, A., *Mali leksikon logike*, Ljubljana: Tehniška založba Slovenije, 1997; gsl. *naravni jezik*. Nadaljevanje opisa gesla: »Naravni jezik je lahko *opisni jezik* samemu sebi, to pa nujno vodi v različne semantične *antinomije*.« Ko govorimo o naravnem jeziku, moramo imeti pred očmi, da gre tu dejansko za *množico različnih jezikov*, ki vsi izpolnjujejo drugi del opredelitve, prvi del pa bi bilo potrebno – če smo nekoliko pikolovski – popraviti, in sicer v »jezik, v katerem se *neka skupnost sporazumeva in misli*.« (V kompleksno problematiko razmerja med jezikom in mišljenjem se tu seveda ne moremo spuščati.)

[2] Če bi izjava »empatija je nekaj« v, denimo, kakih kitajskih prevodih morda ne zvenela tako preprosto in samoumevno, gre to predvsem na račun udomačenosti izražanja kategorije, ki bi ustrezala našemu *nečemu*, v običajnem, vsakdanjem jezikovnem sporazumevanju tamkajšnjih ljudstev.

dialekta,[3] *določene jezikovne igre*.[4] Jezikovni izrazi zdaj ne vstopajo več le v medsebojne formalne ali *sintaktične* odnose, temveč običajno napotujejo na nekaj, kar obstoji tudi zunaj jezika; pripisana jim je *semantična* vrednost, *pomen*.

*

Trditev b), da namreč »empatija nekaj označuje«, je na prvi pogled identična trditvi a), »empatija je nekaj«. Da bomo lažje uvideli razliko, si pomagajmo z znano Magrittovo sliko pipe, na kateri piše »To ni pipa.« Gre za to, da je pipa na platnu le *odslikava* (*refleksija*) prave pipe. Enako je beseda empatija le jezikovna odslikava, *oznaka* prave empatije.[5]

Vzemimo zdaj sliko, v kateri je umetnik želel odslikati idejo empatije. Če nanjo zapiše »To ni empatija«, je njen pomen v kulturološkem kontekstu Magrittove pipe jasen: gre za napotitev na stvar samo preko negacije njene podobe. Gledalec je tako seznanjen, da slika slika empatijo, ki pa se sama nahaja nekje zunaj nje.[6]

Kaj torej označuje *empatija* in kje jo je iskati? V osnovi gre za prilagoditev grške besede *ἐμπάθεια*, ki pa je v angleščino ter kasneje v mednarodno uporabo prešla kot prevod pojma *Einfühlung* Lippsovega dela *Leitfaden der Psyhologie* (1903). Tudi nemška beseda je le nekaj desetletij starejša skovanka, pomeni pa najprej sposobnost estetskega vživljanja v kak predmet, Lipps, katerega delo je še posebej cenil Freud, pa med te predmete všteje tudi ljudi. Tako je (z)možnost empatije (*Eifühlungsvermogen*) za Freuda pogoj možnosti psihoanalize, v filozofski perspektivi pa rešuje problem, ki je v sodobni filozofiji duha znan kot '*the other minds problem*'.

Empatija torej označuje neko psihično zmožnost človeka, glede katere pa ni konsenza, če je sploh možna.

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Po tej jezikovno-logično-historični analizi predpostavke, da *empatija obstaja*, prehajamo k opredelitvi pogojev njene možnosti nasploh. Ob tem bomo sledili shemi prvega dela razprave.

**

Logično vzeto je pogoj možnosti nečesa – v našem primeru je to *empatija* – najprej negacija tega nečesa, torej njegovo drugo. In negacija nečesa je tudi sama nekaj; v našem primeru smo ta drugi nekaj poimenovali *impatija*. Četudi se sicer zdi, da *empatija* predhaja *impatiji*, saj druga sploh še nima pozitivne opredelitve, je to le videz;[7] reči namreč – npr. *empatija* – vstopajo v dejanskost iz nekega nediferenciranega ozadja.

Empatija – in sploh vsak jezikovni izraz, pa tudi reči same, skratka, *nekaj* – tako preide v polje določenega jezika, v nek *kontekst*. Pojasni-tev se zdaj vrši v okviru tam že poprej obstoječih izrazov, svoj pomen pridobiva v odnosu do že po-prej obstoječih reči.

A te reči, ta kontekst ni nekaj univerzal-nega, nujnega; je le element določene *jezikovne igre*, ki ga je za svojega vzela neka *življenjska oblika*.[8] V našem primeru so

[3] Dialektična logika je v prvi vrsti logika nekega naravnega jezika tudi za Hegla, ki njen formalni izraz nahaja v gramatiki: »Kdor pa neki jezik obvlada in obenem zna primerjati z njim druge jezike, šele ta lahko v gramatiki jezika nekega ljudstva začuti njegovega duha in omiko; ista pravila in forme imajo poslej izpolnjeno, živo vrednost. V gramatiki lahko povsod prepozna izraz duha nasploh, logiko.« (Hegel, *Wissenschaft der Logik, Erster teil. Die objektive Logik. Einleitung.*; str. 48 v citiranega prevoda.)

[4] Gre za izjemno pomemben Wittgensteinov koncept, katerega ta ob vpeljavi naveže predvsem na naravni jezik: »Lahko si tudi zamislimo, da je celoten proces uporabe besed v §2 nekakšna igra, preko katere se otroci učijo svojega maternega jezika. Te igre bom imenoval 'jezikovne igre', včasih pa bom kot o jezikovni igri govoril tudi o kakem primitivnem jeziku.« (Wittgenstein, *Philosophische Untersuchungen*, §7)

[5] Tu naletimo na staro, jezikovno-kulturno pogojeno težavo: da sta namreč *pipa* in – če na mesto *empatije* najprej vstavimo staroselca tovrstnih razprav – *kentaver* pač bistveno različna; da pipa *je*, kentavra pa *ni*. Vzemimo sliko kentavra, na kateri piše »To ni kentaver.« Konotacija je v tem primeru nekoliko drugačna kot pri pipi, saj je tisti kentaver na sliki bolj pravi kot pravi kentaver, ker pravega kentavra pač ni. A tudi pipa je do tega, da *je*, prišla preko *ideje* pipe: je *iz-umljena*, prav kakor kentaver; in empatija. Da *nekaj določenega je*, je pač *stvar dogovora, določitve*. Kentavra po splošnem prepričanju ni, pipa po splošnem prepričanju je, glede empatije pa so mnenja nekoliko deljena. Kaj je pipa je znano, ker ta je; za kentavra se ve, kaj je, ker se ve, da ga ni; empatija je predmet raziskave. Vse to skupaj pa poteka znotraj določenih jezikovnih iger, katerih pravila usmerjajo logične parametre raziskovanja.

[6] Stopnjujmo to smer razmisleka do skrajnosti, ki je v našem primeru kar *nekaj*. Vzemimo serijo slik *pipa, kentaver, empatija, nekaj*, na katerih piše, da niso tisto kar predstavljajo; na zadnji tako piše »To ni nekaj«. Prva ima za seboj jasno idejo, ki obstaja tudi v materiji. Ideja druge je prav tako jasna, a v materialnem svetu nima ustreznice. Tretja ideja je sicer nejasna, a je v nasprotju s kentavrom predmet znanstvene obravnave in torej pretendira tudi na svoj odraz v materiji. Zadnja je popolna abstrakcija, meja, točka odboja, refleksije. Vsaka slika je slika nečesa, a nobena slika ni slika nečesa samega: *nečesa ni v podobi*.

[7] Da bi tu bralčevega potrpljenja ne preizkušali preveč, lahko že vnaprej povemo, da se bo na koncu izkazalo, da sta empatija in impatija vzajemno soodvisni; da sta druga drugi pogoj.

[8] Wittgenstein pojem jezikovnih iger navezuje na 'življenjske oblike': »Izraz 'jezikovna igra' naj tu izpostavi, da je govorjenje del neke dejavnosti oziroma neke življenjske oblike.« (*Philosophische Untersuchungen*, §23)

bili to najprej psiho-logi, s časom pa je izraz *empatija* vsaj v večini evropskih jezikov prešel tudi v splošnejšo rabo.

*

Iskanje semanične vrednosti izraza *empatija* naj bo torej v izhodišču psihološka raziskava, zatem pa lahko izsledke tudi posplošimo.

*

Psihološko vzeto je *empatija* neko *gibanje*. Lahko bi jo sicer opredelili tudi kot *stanje*, a bi ji v tem primeru odrekli sámo možnost razvoja: mogoč bi bil le skok iz stanja *ne-empatije* v stanje *empatije*.[9]

V prvem delu razprave smo v tej točki s pomočjo primere iz slikarstva ugotovili, da se empatija nahaja nekje zunaj svoje podobe ali izraza. Če ponovimo: »Gledalec je tako sezna-njen, da slika slika empatijo, ki pa se sama nahaja nekje zunaj nje.«

Nadalje se je izkazalo, da nam je *empatijo* iskati ravno v gledalcu samem; v tem smislu je tudi – zgodovinsko vzeto – skonstruirana sama beseda. Četudi je v logičnem kontekstu *impatija* nekam boren izraz za *negacijo empatije*, pa se bo ta v psihološkem smislu izkazal kot ustrezen.[10]

Empatija je torej »neko gibanje«, ki ga je iskati »v gledalcu samem«. Gledalec je sicer tudi sam gibanje in je v tem pogledu identičen empatiji, a ker mu *empatija* ni prezentna, ker jo *išče* v sebi samem, se sam nahaja zunaj sebe. Če jo najde, se od samega sebe popolnoma odtuji, s tem pa se povsem odtuji tudi od empatije, saj je le-ta opredeljena kot *zmožnost projekcije (in s tem vključitve) lastne osebnosti v objekt kontempla-cije*.

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Impatija, ki naj bo pogoj možnosti *empatije*, je zdaj postavljena kot gibanje v nasprotni smeri gibanja *empatije*. Posameznik kot nosilec zmož-nosti se nahaja v nekje med idejo sebe in idejo drugega. In če nekdo nečesa ne razume v sebi, tega ne more razumeti niti v drugem; empatija se udejani le tedaj, ko *jaz postane jaz, ki smo mi*, kot je bil ta v bistvu logični princip izražen v nemški klasični filozofiji. A gola ugotovitev logične nujnosti možnosti nečesa za nekoga le-tega seveda še ne privede tudi v konkretno dejanskost; tja mora pač vsak sam. Ponuja sicer neko upanje, upanje pa, kot pravijo, umre zadnje.

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[9] *Gibanje* kot proces znanosti ni neposredno dosto-pen, saj lahko le-ta v poštev jemlje zgolj *stanja*. Rešitev je seveda v tem, da gibanje jemlje kot spremembo stanj, ali drugače: *jemlje gibanje kot stanje*. Zanjo se torej nek objekt nahaja *v stanju gibanja*. Meritev nekega stanja lahko po-kaže na trenutno prisotnost nekaterih elementov empatije, ter na odsotnost drugih. To potem v znanstvenem jeziku šteje kot *delna prisotnost empatije*, četudi je, logično vzeto, empatija dejansko odsotna, saj ne vsebuje vseh elementov lastne pojmovne opredelitve. Tu gre sicer za enega pomembnejših vidikov znanstvene podobe sveta, ki pa ga na tem mestu ne moremo podrobneje obravnavati.

[10] *Im*patija je ustrezen izraz tudi v jezikovno-logičnem smislu. Predpona *em-* izraža predlog *na* ali *v*, im- pa po eni strani izraža negacijo (v tem primeru se navezuje na latinščino), po drugi pa je večkrat v uporabi tudi v smislu predpone em- (kjer se navezuje na grški jezik). *Empatija* je udejanjena, ko je presežena njena možnost, ko iz možnosti preide v dejanskost; in to se zgodi v trenutku, ko se s svojo negacijo *odpravljena* združi v *simpatijo*.

MENTALNI TRENING: SPREMINJANJE BAZIČNEGA STANJA ZAVESTI IN BAZIČNEGA STANJA MOŽGANOV

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POVZETEK

Članek se ukvarja z vprašanjem ali je možno spreminjati bazično stanje zavesti (čustva, pozornost, zavedanje) in bazično stanje možganov (električno, kemično, strukturno). Eksperimenti z meditacijo kažejo na to, da lahko s tehnikami budistične meditacije dolgoročno spreminjamo bazična stanja in gojimo različne 'pozitivne' mentalne sledi: povečamo pozitivna čustva in zavedanje, gojimo sočutje, spreminjamo način pozornosti in mentalne navade. Spremembe v mentalnem delovanju se odražajo tudi v spremembah delovanja možganov ali njihovi strukturi. Izkušnja in možgansko delovanje tako nista fiksni in determinirani entiteti, ampak sta podvrženi spremembam, o katerih lahko do določene mere zavestno odločamo. Tudi mistične izkušnje vodijo v spremembe v vedenju in doživljanju sveta. Vplivi teh specifičnih izkušenj sicer niso bili dobro eksperimentalno preverjeni, a opisi so tako pogosti, da jih moramo omeniti.

1. UVOD

Ali lahko spreminjamo navade, čustvene odzive, način pozornosti in nasploh naše doživljanje sveta? Ali lahko spreminjamo različne dele našega mentalnega sveta in možganskega delovanja tudi dolgoročno in ne le za določeno kratko obdobje? Ali je v naši moči, da se zavestno odločimo spremeniti določene poteze, za katere se nam zdi, da nas omejujejo v naših življenjih? Ali tudi enkratne izjemne izkušnje dolgoročno vplivajo na naše vedenje in doživljanje sveta? Različni nevroznanstveniki, ki se ukvarjajo s temi vprašanji, so poizkusili odgovoriti na ta vprašanja in v svoje laboratorije povabili budistične menihe, ki se že dalj časa ukvarjajo z meditacijo. Pogledali so, kaj se dogaja z njihovimi možgani med in po meditaciji in kako se njihove izkušnje doživljanja sveta razlikujejo od oseb, ki ne meditirajo.

2. BAZIČNO STANJE ZAVESTI

Tart *(2000)* pravi, da obstaja za vsakega posameznika neko bazično (osnovno) stanje zavesti (BSZ) *(base consciousness)* (kar je normalno za nekoga je posebno za drugega). Vsako stanje zavesti (SZ) je tudi okno v specifično mentalno delovanje z določenim znanjem in uvidi ki določajo, kako posameznik ali družba vidita svet in kako dojemata resnico. Vsako 'normalno' stanje zavesti (ponavadi družbeno sprejeto stanje) pa je vedno le nek konsenz realnosti *(consensus reality)*, ki določa vedenje ljudi, njihove čustvene odzive in nasploh njihovo doživljanje sveta. Najbrž pa za vsakega posameznika obstaja tudi neko bazično možgansko stanje (BMS) (specifična frekvenca, v kateri deluje določen del možganov posameznika, količina proizvajanja nevrotransmiterjev, itd.), ki korelira z mentalnim doživljanjem in BSZ posameznika.

Bazičnost *(baseline)* najlaže konceptualiziramo kot zmožnost organizma, da obdrži svojo identiteto ne glede na nihanja, ki nanj vplivajo *(Lutz et al: 2007)*. Ta osnoven pomen homeostatske identitete služi kot osnova za različne tipe bazičnosti. V kontekstu meditacije je ideja bazičnosti pomenska v smislu 'povišanja bazičnega stanja' z razvijanjem določenih sledi, ki vztrajajo tudi izven meditativnega stanja. V psihološkem kontekstu bazično stanje pomeni stanje mirovanja v nasprotju s stanjem, v katerem opravljamo specifično nalogo, v še širšem smislu psihologi poskušajo identificirati regularnosti ali sledi v povprečju kontinuiranih stanj individuuma (razpoloženje, osebnost). V bioloških sistemih lahko govorimo o bazičnih stanjih glede na to, da nekaj ostaja konstantno skozi čas,: na ravni celice (električni naboj nevrona), imunskega sistema (odziv na cepivo) ali celega organizma (stopnja glukoze v krvi, temperatura telesa).

3. SPREMENJENO STANJE ZAVESTI (SSZ)

BSZ in BMS nista fiksna, determinirana in nespremenljiva, ampak sta fluidni entiteti, ki ju lahko z določenimi tehnikami[1] spreminjamo in s tem gojimo določene značilnosti (sledi) (pozitivno čustveno naravnanost, sočutje, zavedanje, pozornost, itd.) in tako spreminjamo SZ. Za Charles T. Tarta je SSZ *»Kvalitativna sprememba v*

[1] Omejil se bom na meditacijske tehnike, vendar lahko BSZ in BMS spreminjamo tudi z z drugimi mentalnimi tehnikami. Z nevrofeedbackom lahko npr. zmanjšujemo pogostost in moč epileptičnih napadov *(Egner&Sterman: 2006)*, s kognitivno behavioralno terapijo lahko npr. spreminjamo regionalni možganski metabolizem pri pacientih z močno depresijo ali obesivno-kompulzivnimi motnjami *(Paquett et al.: 2003)*, s hipnozo različne vedenjske odzive *(Spiegel&Spiegel: 2004; iz Warren 2007)* in podobno.

splošnem vzorcu mentalnega delovanja, ko izkušamo, da naša zavest funkcionira (radikalno) (oklepaje dodal avtor) drugače od normalnega funkcioniranja. Spremenjeno SZ tako ni definirano v smislu določene vsebine zavesti ali specifičnega vedenja ali fiziološke spremembe, ampak v smislu splošnih vzorcev psihološkega delovanja.« (Tart: 1972) Splošni vzorec mentalnega delovanja pa vpliva na vsebine zavesti, vedenje in fiziologijo. Podobno bi lahko spremenjeno možgansko stanje (SMS) definirali '*kot kvantitativno spremembo v splošnem vzorcu delovanja možganov*'.

4. SPREMENJENO STANJE IN SPREMENJENA SLED

Spremenjeno stanje pomeni prehodno spremembo v določenem zavestnem stanju organizma (enkratno spremenjeno stanje BSZ ne spreminja dolgoročno), medtem ko spremenjena sled zavesti pomeni dolgoročno SSZ in njenih delov *(Warren: 2007, Fontana: 2007b)*. Meditatorji različnih tradicij poročajo o določenih dogodkih – spremenjenih stanjih *(altered states)* (emocionalnih, kognitivnih, fizičnih), ki naj bi se zgodili z uporabo določene tehnike in o pridobitvi določenih značilnosti – spremembi določenih sledi *(altered traits)* (emocionalnih, kognitivnih, fizičnih), ki se zaradi meditacije prenesejo tudi v prostor izven meditacije) *(Lutz et al.: 2007)*. Sprememba SZ je cilj vsake meditativne prakse, ki poizkuša transformirati bazično stanje mentalnega delovanja in izbrisati razliko med meditativnim in postmeditativnim stanjem. Različne meditativne tehnike preko ponavljanja določenih izkušenj (z izvajanjem določene tehnike) omogočajo spreminjanje sledi, ki ostajajo prisotne tudi v postmeditativnem stanju in se ne kažejo le med samim izvajanjem določene tehnike. Dolgotrajno urjenje v meditaciji sočutja naj bi ošibilo egocentrične sledi in spremenilo bazično čustveno stanje. Budistična meditacija zavedanja *(mindfulness meditation)* teži k izkušanju tekočega trenutka in spreminja osnovno bazično stanje pozornosti (način pozornosti) tako, da zmanjšuje različne distrakcije ali misli podobne dnevnemu sanjarjenju. Meditativne prakse skratka težijo h gojenju določenih značilnosti mentalnega stanja, ki vztrajajo v času, relativno neodvisno od somatosenzornih in zunanjih dogodkov.

5. MEDITACIJA

Meditacija ima v angleščini *(Shear: 2006)* dva različna pomena, ki predstavljata dva različna tipa mentalne aktivnosti. Prvi pomen meditacije je globoko razmišljanje o nekem predmetu (temi). V drugem pomenu pa meditacija pomeni določeno proceduro (izvajanje določene tehnike), ki umu *(mind)* omogoči, da se izprazni vseh misli in izkusi svoj notranji (iz)vir (bit) ter iz tega stanja izide poživljen, obnovljen in včasih celo predrugačen *(Shear: 2006)*. Tradicionalne meditativne tehnike se med seboj razlikujejo glede na mentalne zmožnosti, ki jih uporabljajo (pozornost, občutek, razum, vizualizacija, spomin, zavedanje telesa, itd.), način, kako so te zmožnosti uporabljene (brez napora, z močjo (naporom), aktivno, pasivno) in glede na objekt v katerega so usmerjene (misli, podobe, koncepti, notranja energija, dihanje, subtilni vidiki telesa, ljubezen, bog) *(Shear: 2006)*.

V budistični tradiciji obstajata dva najširša tipa meditacije *(Lutz et al., 2007)*. Śamatha oz. eno-točkovna koncentracija omogoča sposobnost intenzivnega in vzdrževanega fokusa na en objekt in omogoča stabilnost, vendar sama zase ne vodi do vseh želenih sprememb v SZ. Zato jo mora spremljati meditacija vpogleda *(insight meditation)* oz. vipaśyanā, ki omogoči praktikantu, da doseže jasnost, tj. vpogled v navade in predpostavke svoje identitete in čustev. V splošnem vpogled vključuje realizacijo, da sebstvo ne obstaja *(selflesness)*, kar meditatorju omogoči vpogled v zmotnost prepričanja v fiksno, esencialno identiteto in mu pokaže, da so čustvene navade, ki odražajo to prepričanje, zmotne. Brez združitve teh dve komponenet v dolgoročni praksi je napredovanje meditatorja nepopolno.

Tri različna stanja (tehnike), ki jih opisuje tibetanski budizem izhajajo iz śamathe in vipaśyane. Fokusirana pozornost *(focused attention)* se nanaša na mentalno stanje, v katerem je um *(mind)* miren in čisto fokusiran na en sam objekt (eno-točkovna koncentracija). V odprtem zavedanju *(open presence)* se meditator ne fokusira na objekt in ne poskuša zatreti ali kultivirati določene mentalne vsebine, ampak odprto spremlja dogajanje v svoji zavesti. V stanju odprtega zavedanja se meditator zaveda čistosti zavedanja *(clarity of awareness)*, ki omogoča vsakršno kognicijo. V začetku meditator razvija koncentracijo na objekt, potem uporabi tehniko, ki kultivira zavedanje subjektivnosti in na ta način zmanjšuje poudarek objekta. Meditator tako dobi dostop do refleksivnega zavedanja. Temu sledi zmanjševanje poudarka subjektivnosti, ki še bolj odpre dostop do refleksivnega zavedanja. Na koncu meditator poskuša priti do točke, ko je nespremenljiv aspekt zavedanja popolnoma realiziran v meditaciji. Meditacija nenanašajočega sočutja *(non-referential compassion)* predstavlja stanje, ki je vedno usmerjeno v druga bitja, vendar nima specifičnega objekta ali fokusa, kot je oseba ali skupina ljudi. Zato ima ta oblika meditacije dva aspekta: gojenje sočutja in gojenje brezobjektnega oz. odprtega zavedanja *(open presence)*, s katerima poizkuša vzpostaviti specifično emocionalno stanje, intenziven občutek ljubezni in odsotnosti trpljenja *(loving-kindness)* drugih bitji.

6. EKSPERIMENTI Z BUDISTIČNO MEDITACIJO

Različni nevroznanstveniki ugotavljajo, da meditacijske tehnike trajno spreminjajo možgane in mentalne vzorce meditatorjev, ki redno meditirajo. Značilnost, da izkušnje spreminjajo možgane nevroznanstveniki imenujejo nevroplastičnost *(nevroplasticity)*. Izkušnje niso toge, predeterminirane in omejene entitete, temveč fleksibilni procesi, ki jih lahko spreminjamo tako, da z določenimi tehnikami gojimo te določene izkušnje in tako spreminjamo delovanje in strukturo možganov.

Davidson et al. *(2003)* so ugotovili, da so osebki, ki so imeli večjo aktivnost levega prefrontalnega dela, pokazali večji odziv protiteles na cepivo *(Davidson et al.: 2003)*. Vprašali so se ali lahko mentalni trening izboljša odziv imunskega sistema. Najprej so opazili povečanje odziva imunskega sistema (več protiteles na cepivo) pri osebkih, ki so 8 tednov meditirali po *mindfulness-based stress reduction* programu (oblika meditacije zavedanja; *mindfulness meditation*). V naslednji študiji so ugotovili *(Davidson et al.: 2004; iz Warren: 2007)*, da se po le 14 urah! budistične 'meditacije ljubezni in odsotnosti trpljenja drugih' *(loving-kindness meditation)* aktivacija premakne iz desne proti levi strani prefrontalnega korteksa (večja aktivacija na levi strani pomeni več pozitivnih čustev, kot sta entuziazem in veselje), učinki pa trajajo dalj časa. V naslednjem zanimivem eksperimentu *(Lutz et al.: 2004)* so ugotovili, da so pri izkušenih meditatorjih, ki so izvajali budistično brezobjektno meditacijo *(objectless meditation)* gama ritmi z zelo visoko amplitudo veliko bolj prisotni kot pri nemeditatorjih. Čas meditacije je prav tako koreliral z nekaterimi oscilatornimi lastnostmi možganskega bazičnega električnega stanja. Spremenilo se je tudi bazično EEG stanje po koncu meditacije, kar nakazuje na kratkoročne vplive meditacije na BMS. Našli so tudi razlike v bazičnem stanju dolgoročnih meditatorjev in začetnikov *(Lutz et al.: 2004)*, kar nakazuje na učinek dolgoročnega meditiranja na BMS. Večja amplituda gama ritmov se je pojavljala pri bolj izkušenih meditatorjih. Večja amplituda med izvajanjem meditacije je korelirala tudi z močnejšim in 'čistejšim' občutkom zavesti. Teorija pravi, da gama aktivnost preprečuje, da bi se nevroni udeležili v kakršnemkoli procesiranju informacij, zato je izkušnja zavesti toliko močnejša pri večji gama aktivnosti in tudi s toliko manj vsebine[2]. Pri različnih tehnikah meditacije se je povečana gama aktivnost pojavlja v različnih možganskih centrih. Pri tehnikah, ki uporabljajo vizualizacijo zadaj desno, pri tehnikah ki uporabljajo verbalizacijo, levo sredinsko in pri tehnikah, ki imajo za cilj raztopitev jaza spredaj desno. Lazar *(2005; iz Warren: 2007)* so v naslednjem eksperimentu ugotovili, da meditacija spreminja tudi strukturo[3] možganov. Področja korteksa, ki so odgovorna za pozornost in procesiranje čutnih informacij, so bila pri osebkih, ki so meditirali povprečno 9 let po 40 minut na dan budistične meditacije vpogleda *(insight meditation)* debelejša kot pri ljudeh, ki se meditacije ne poslužujejo.

[2] To bi lahko bil možen vzrok za 'brezvsebinsko' stanje čiste zavesti (glej Mistične izkušnje).

[3] Možgani ekspertov nekega področja so funkcionalno in strukturno drugačni od možganov neekspertov. Londonski taksisti imajo npr. večji posteriorni hipokampus glede na kontrolno skupino in glede na to, koliko časa so opravljali to delo *(Maguire et al.: 2000; iz Lutz et al.: 2007)*.

7. MISTIČNE IZKUŠNJE

Mistične izkušnje, kot jih opisujejo različni mistiki, lahko prav tako popolnoma spremenijo pogled človeka na svet in vodijo v dolgoročne spremembe vedenja in prepričanja. Ljudje, ki so doživeli takšno izkušnjo, poročajo o občutku globljega pomena in uvida v resničnost, občutku skrivnosti, razširjene percepcije, občutku, da ima vse, kar zaznavajo pomen in namen, neopisljivo spoštovanje, občutek enotnosti, itd. *(James: 1901-1902, Fontana: 2007b)*. Nekatere ali pa vse izmed teh lastnosti se prenesejo tudi v vsakdanje življenje, v prostor, kjer mističnega izkustva ne doživljamo več. Mistične izkušnje se velikokrat pojavljajo pri osebah, ki meditirajo in velikokrat prav med meditacijo (lahko pa se pojavijo tudi popolnoma spontano brez izvajanja določenih tehnik). Primer mistične izkušnje je izkustvo čiste zaveti, ki jo različne meditativne tradicije imenujejo čisto bitje *(pure being)*, čista ničnost ali čisto sebstvo (*Shear: 2007)*. Za stanje čiste zavesti je značilna *(Shear: 2007)* popolna odsotnost vseh zvokov, okusov, misli, občutkov, vizualnih podob in vsega, kar si lahko zamislimo, nerazlikovanost objekta in subjekta. Ostane le zavedanje, brez vsebine[4]. Obstaja veliko tehnik za doseganje tega stanja (nenaporna ali intenzivna koncentracija, ki lahko vključuje pomene misli ali pa ne, zavedanje telesa in tehnike, ki so zgolj mentalne). Vse tradicije pa trdijo, da je mogoče doseči stanje, v katerem vsakršna empirična vsebina izgine, a obenem ohranimo budnost in zavest, ki ju občutimo močneje in čisteje kot v normalnem SZ. Čista zavest naj bi počasi začela spremljati druge izkušnje in nazadnje postala temelj in izvor vseh izkušenj in dejanj *(Shear: 2007)*. Izkušnja čiste zavesti pa na bi bila tudi nujna za popolno razumevanje in razvoj človeške zavesti, saj naj bi predstavljala optimalno osnovo za prvoosebno raziskovanje subtilnih komponent in dinamike zavesti.

Nevroznanstveniki so raziskovali nekatere značilnosti mističnih izkušenj in ugotovili *(Ramachandran&Blakeslee: 1998, iz Fontana: 2007b)*, da izpostavljenost besedam ali idejam, ki imajo religiozno ali spiritualno konotacijo, v frontalnih režnjih cerebralnega korteksa poveča možgansko električno aktivnost na raven, ki je primerljiva z epileptičnimi napadi. Epileptični napadi v temporalnem korteksu so znani, da včasih vzbudijo podobna stanja mističnim izkustvom, npr. močno svetlobo, vizije, očiten božanski uvid in občutek enosti. Ramachandran *(1997)* je pokazal, da stimulacija določenih delov temporalnih režnjev z magnetnim poljem inducira mistična izkustva tudi pri ljudeh, ki niso epileptiki. Zaradi takšnih rezultatov sta Ramachandran in Pesinger najbolj aktiven predel temporalnega režnja pri takih izkušnjah poimenovala 'Božja

[4] Postavlja pa se vprašanje ali je to stanje tudi v resnici popolnoma brez vsebine ali pa je izkušnja tako 'fina' in abstraktna, da se nam to le zdi. Če bi pogledali možgansko aktivnost, bi v kortikalnih delih možganov po vsej verjetnost našli dele, ki so aktivni. Je pa res, da možganska aktivnost ne pomeni nujno zavestne vsebine.

točka' oziroma 'Božji modul'. Ne vemo pa prav dobro ali mistična stanja, ki se pojavljajo pri epileptikih ali pa so magnetno stimulirana, prav tako vodijo do dolgoročnih sprememb v vedenju in doživljanju sveta.

8. ZAKLJUČEK

Različni eksperimenti nakazujejo, da je možno spreminjati BSZ in BMS. Preko ponavljanja določenih izkušenj lahko kultiviramo mentalno blagostanje, načine pozornosti, razmerje med pozitivnimi in negativnimi čustvi in se naučimo le te prenesti v vsakdanje življenje. Meditacija, kot primer takšnega postopka, omogoča pridobitev določenih sledi (emocionalnih, kognitivnih in fizičnih), ki se prenesle tudi v prostor izven meditacije. To potrjujejo tudi nekateri nevroznanstveni eksperimenti z meditacijo. Res pa je, da različne tehnike in načini meditiranja velikokrat niso povsem definirani, opredeljeni in kontrolirani, zato je potrebno v tej smeri še naprej razvijati metodologijo preučevanja človeške zavesti in še bolj in bolje povezati tretjeosebno znanstveno preučevanje s prvoosebnimi poročili in uvidi (Richard Davidson je npr. v interpretacijo in izdelavo eksperimentov vključil tudi same meditatorje). Združitev preučevanja vpliva različnih mentalnih tehnik na delovanje možganov odpira možnost za večje razumevanje tega, kako lahko ljudje spreminjamo nekatere naše najbolj zakoreninjene sledi SZ. Zmožnost spreminjanja teh sledi pa vsekakor pomeni večjo kontrolo nad našim notranjim življenjem, vedenjskimi odzivi in zmožnostjo odločanja o tem kaj smo in kaj želimo postati. Pomeni večjo svobodo.

Reference

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RAZVOJ EMPATIJE, TEORIJE UMA IN METAREPREZENTACIJE: INTERDISCIPLINARNI POGLEDI

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POVZETEK

V prispevku se bomo osredotočili na problematiko empatije, kot jo vidijo kognitivna razvojna psihologija in različne discipline nevroznanosti. Med obema področjema obstaja tesno sodelovanje. V prispevku so predstavljene raziskave s področja razvoja empatije, teorije uma in metareprezen-tacije ter vloga izvršilnih (eksekutivnih) in govorno-jezikovnih funkcij. Omenjene raziskave kognitivno-razvojne psihologije so pomembne za razumevanje socialne kognicije. Dopolnjujejo jih raziskovalna dognanja s področja socialne nevroznanosti, kot so npr. študije zrcalnih nevronov.

1 UVOD

Področje empatije je eno tistih področij zavesti, na katerem se uspešno srečujejo različne discipline kognitivne znanosti. Filozofske razprave in psihološke raziskave imajo že dolgo tradicijo pri obravnavi tega čustveno-kognitivnega vidika zavesti in so se jim v zadnjem času pridružile še nevroznanosti.

V okviru filozofije se je pojav empatije obravnaval predvsem s fenomenološkimi pristopi. Fenomenologija ima poleg analitične filozofije pomembno mesto v kognitivni znanosti. Različni vidiki zavesti, ki so predmet fenomenoloških razprav, npr. intersub-jektivnost, intencionalnost, "utelešenje" ('embodi-ment') kognicije, samozavedanje in prvoosebna perspektiva, so ključnega pomena za razumevanje empatije in teorije uma. Z njimi tudi vstopajo v dialog z drugimi disciplinami kognitivne znanosti. Značilen primer je opredelitev empatije in teorije pojmovanja intersubjektivnosti (npr. "teorija-teorija" in simulacijska teorija), ki imajo vzporednice v drugih vedah, kot je npr. kognitivna psihologija. Veliko število disciplin kognitivne znanosti, ki vstopajo v raziskovanje širše problematike empatije, to so fenomenologija, razvojna kognitivna psihologija, kognitivna socialna psihologija, kognitivna antropologija, kognitivna razvojna nevroznanost, socialna nevroznanost, omogoča poglobljeno razumevanje tega področja.

V prispevku se bomo zaradi omejenega prostora osredotočili na problematiko empatije, kot jo vidijo kognitivna razvojna psihologija in različne discipline nevroznanosti. Med obema področjema obstaja tesno sodelovanje. Kognitivna psihologija razlaga kognicije oz. kognitivne reprezentacije kot diskretne in simbolične ("amodalne"), medtem ko kognitivna nevroznanost mentalne reprezentacije raziskuje neposredno v smislu možganskih struktur in funkcij. S sodelovanjem obeh disciplinarnih področij je omogočeno boljše razumevanje kognitivnih reprezentacij in njihovega razvoja. V novejšem času opažamo, da nevroznanosti pomembno vplivajo na spremembe v tradicionalnih pristopih k razumevanju kognitivnega razvoja in ponujajo nove teoretične okvire za raziskovanje v kognitivni razvojni psihologiji, kot sta nevrokonstruktivizem in konek-cionizem.

2 EMPATIJA IN TEORIJA UMA

<u>Empatija</u> in <u>teorija uma</u> imata zelo pomembno vlogo na področju socialne kognicije in socialnega vedenja ter pomenita preseganje faze egocentrizma, značilnega za razvojno nižja obdobja v otrokovem razvoju.

<u>Empatijo</u> običajno opredelimo kot sposobnost razumevanja čustev drugih ljudi in odzivanje nanje z ustreznimi čustvi. Razvoj empatije je tesno povezan s sposobnostjo zaznavanja in kognitivnega zavedanja mentalnih stanj drugih oseb in zavzemanja njihove perspektive. Zato se neredko empatijo pojmuje širše in sicer kot sposobnost razumeti čustva in misli drugih ljudi. Tako je empatija povezana s konceptom <u>teorije uma</u> (TU), ki jo opredelimo kot zmožnost razumevanja oz. pripisovanja (atribucije) mentalnih stanj sebi in drugim ljudem. TU pomeni, da posameznik pojmuje sebe in druge ljudi kot mentalna bitja, ki imajo svoja prepričanja, želje, namere, čustva in interpretacije sveta.

Razumevanje mentalnih stanj drugih ljudi nam omogoča, da predvidevamo njihovo vedenje. Omogoča nam analizo psihološke vzročnosti, od katere je odvisna ustreznost socialnih interakcij, seveda v primeru, da drugim pripisujemo kognitivna in afektivna stanja, ki so resnična, in vedenje, ki je racionalno (Goswami, 2008). Ljudje smo izrazito socialna bitja in zmožnost razumeti prepričanja, namere, čustva in druga mentalna stanja drugih ljudi je ključnega pomena za socialne odnose. V novejši literaturi in raziskavah se srečujemo z nekoliko drugačno razmejitvijo med empatijo in TU, kot to velja za tradicionalno pojmovanje, in s katero je bolj poudarjena njuna medsebojna povezanost. Gre za delitev empatije na afektivno ('hot') in kognitivno ('cold') ali pa za delitev TU na empatično ('hot') in kognitivno ('cold') (Saxe, Baron-Cohen, 2008b).

Podobnost oz. razlika med obema konceptoma je bila predmet raznih raziskav, s katerimi so skušali določiti mehanizme, ki so v njuni osnovi. Da gre vsaj deloma za različne mehanizme, je mogoče sklepati že iz tega, da bo zaznavanje intenzivnega čustvenega stanja imelo močnejši vpliv na opazovalca kot zaznavanje prepričanja ali namere. Tako bo zaznavanje močnega čustva strahu pri opazovalcu povzročilo kongruentno čustveno stanje. V primeru, da opazovalec gleda nekoga, ki išče izgubljeni predmet, je manj verjetno, da bo razumel njegovo mentalno stanje npr. napačnega prepričanja. Druga razlika se kaže tudi v tem, da čustva sporočamo neposredno z obraznim izražanjem, medtem ko bolj kognitivne vsebine (npr. prepričanja) niso izražena z nekim enostavnim in jasnim vedenjskim vzorcem. Kot bomo videli, je z nevroznanstvenimi raziskavami uspelo identificirati razlike med kognitivnimi in afektivnimi komponentami empatije oz. TU.

Shamay-Tsoory s sodelavkama (Shamay-Tsoory, Tibi-Elhanany, Aharon-Peretz, 2008) je ugotovila, da je razumevanje čustev drugih oseb odvisno od drugačnih mehanizmov kot razumevanje drugih mentalnih vsebin (npr. prepričanj). Z obsežno raziskavo so ugotovili, da je mehanizem za razumevanje čustev lociran v ventralno-medialnem prefrontalnem korteksu (VMPFK). S funkcionalno magnetno resonanco je bilo tudi ugotovljeno, da je socialno-emocionalna odzivnost v neposredni socialni interakciji povezana z aktivnostjo VMPFK. V nasprotju s temi raziskavami, ki kažejo empatijo kot koherentno enoto, pa je Chakrabarti s sodelavcema (Chakrabarti, Bullmore, Baron-Cohen, 2008) našel, da različna možganska področja korelirajo s posameznikovimi specifičnimi emocijami, čeprav so našli tudi skupni substrat empatije za bazične emocije v levem inferiornem frontalnem girusu.

3 RAZVOJ TEORIJE UMA IN META-REPREZENTACIJE

Razvojni kognitivni psihologi so skušali tudi pojasniti, kako se razvija TU, kateri so njeni predhodniki ('precursors'), od katerih vidikov kognitivnega razvoja je odvisna in kakšne so faze njenega razvoja.

Mnogi mehanizmi, ki omogočajo socialno-kognitivno razumevanje in jih pojmujemo kot predhodnike empatije in TU, se razvijejo že v prvih dveh letih življenja. Mednje štejemo sledenje pogledu druge osebe, skupno pozornost, spremljanje k cilju usmerjene dejavnosti in kontroliranje namer.

Že nekaj mesecev star otrok sledi pogledu druge osebe, da bi ugotovil, kaj je pritegnilo njeno pozornost. Skupna pozornost s socialnim partnerjem (npr. materjo) tudi igra pomembno vlogo v socialni kogniciji in se kaže npr. tako, da otrok pokaže na nek objekt. Ta aktivnost ima izrazito komunikativni namen. Kazanje kot sredstvo za vzpostavljanje skupne pozornosti, ki ga včasih spremlja tudi vokalizacija, je podobno kot pri sledenju pogleda druge osebe pomemben indikator razumevanja, da druge osebe "posedujejo" neka mentalna stanja, ki niso vidna na zunaj in na katera je v primeru skupne pozornosti mogoče vplivati.

TU se razvija z otrokovim spoznanjem, da druge osebe delujejo na osnovi mentalnih stanj. Že pri 15 mesecih se kaže tudi neka oblika zmožnosti metareprezentacije, ki se v kasnejših obdobjih še izpopolnjuje. Sposobnost metareprezentacije je v bistvu zmožnost razumeti mentalna stanja drugih oseb in uporabiti to znanje o mentalnih stanjih za napovedovanje njihovega vedenja.

Ta zmožnost metareprezentacije se pri otrocih razvija predvsem iz treh virov. To so imitacija, razvoj otrokove simbolne igre (igra pretvarjanja) in razvoj govorno-jezikovnih zmožnosti.

Že Leslie (1987) je izpostavil pomembno zvezo med razvojem TU in simbolno igro, igro pretvarjanja. Pri igri pretvarjanja (npr. otrok se igra, da je banana telefonska slušalka) se mora "razkleniti" primarna reprezentacija, ki je neposredna reprezentacija nekega objekta (otrok vidi in tipa banano) in ki jo posreduje senzorični sistem (je rumena in jo je mogoče pojesti), od pretvarjajoče reprezentacije (telefonska slušalka). Pretvarjajoča reprezentacija ni reprezentacija objektivnega sveta, je bolj reprezentacija reprezentacije, t.j. metareprezentacija. Ker tako pretvarjanje v igri pogosto poteka v sodelovanju z drugimi otroci (npr. igra pretvarjanja pri zdravniku), je videti, da otroci razumejo mentalni akt pretvarjanja tudi pri drugih osebah. Torej razumejo, da imajo tudi druge osebe metareprezentacije.

Podobno ima tudi imitacija pomembno vlogo v razumevanju reprezentacij. Imitacija omogoča razvoj koncepta lastnih in mentalnih stanj drugih oseb. Najmočnejši dokaz, da je imitacija bistvena za zmožnost razumevanja mentalnih stanj in reprezentacij, sta podala Meltzoff in Decety (2003). Ugotovila sta, da že majhni otroci ne samo, da so zmožni imitiranja drugih oseb, ampak se tudi zavedajo, da jih drugi imitirajo. Na tej osnovi avtorja ugotavljata, da ko otrok vidi druge, ki delujejo "kot jaz", spozna, da imajo drugi otroci enako mentalno izkušnjo, ki se sklada s tem vedenjem. Otrok spozna, da med "videnim" in "občutenim" obstaja povezava. To otroku omogoča povezati vidno vedenje oseb v njihovimi mentalnimi stanji, npr. namerami. Omenjena avtorja ugotavljata, da je analogija osnova empatičnega vedenja in identifikacije z drugimi. Seveda se empatičnost razvija dalj časa in zahteva dodatne izkušnje in nadaljnji razvoja metareprezentacijske zmožnosti.

4 NAPAČNA PREPRIČANJA IN MENTALNA REPREZENTACIJA

Raziskovalci se strinjajo, da metareprezentacija ni prisotna od rojstva in se razvija zelo počasi. Omenili smo, da je simbolna igra (igra pretvarjanja) zgodnja manifestacija otrokove vedno večje zmožnosti metareprezentacije, npr.

substitucija objekta v igri pretvarjanja (uporaba banane kot telefonske slušalke), ki zahteva sposobnost, da si otrok začasno zamisli dva kontradiktorna modela realnosti.

Druge vrste metareprezentacijskega razumevanja so bolj kompleksne. Tak primer je rezoniranje, ki omogoča uspešnost reševanja ti. naloge napačnih prepričanj (NP). Spoznanja, da imajo lahko drugi ljudje prepričanja, ki so napačna, so bila predmet vrste raziskav TU v razvojni kognitivni psihologiji, danes pa so tovrstne raziskave vedno bolj prisotne tudi na področju socialne nevroznanosti kot tudi na področju sodelovanja obeh disciplin kognitivne znanosti. Rezoniranje o NP drugih oseb naj bi bil najbolj prepričljiv dokaz sposobnosti pripisovanja (atribucije) mentalnih stanj drugim osebam.

Primer naloge NP. Tovrstne naloge se prezentirajo v obliki zgodbe. Glavna oseba zgodbe je npr. deček Marko, ki je dal čokolado v skodelico X. Potem se je šel ven igrat. Med njegovo odsotnostjo je mati premestila čokolado v skodelico Y. Sledi vprašanje otroku "V katero skodelico bo Marko najprej pogledal za čokolado, ko se bo vrnil?". Uspešnost na nalogi NP je odvisna od razvitosti TU. Šele 4-6 letni otroci so sposobni uspešno rešiti te naloge, kaže na pomembne spremembe v njihovem kognitivnem razvoju. Za pravilen odgovor mora otrok ločiti svoje lastno prepričanje glede resnične lokacije čokolade (skodelica Y) od Markovega napačnega prepričanja (skodelica X).

Razvoj TU poteka postopoma. Wellman (2002) je za starost 2-5 let opisal 3 stopnje. Že dvoletni otroci imajo razvito TU, ki jo je poimenoval psihologija želja. Otroci razumejo, da je posameznikovo obnašanje pod vplivom želje. Dejstvo, da se sposobnost razumeti notranje stanje želje pojavi bolj zgodaj kot sposobnost razumeti notranje stanje prepričanja, kaže, da je iz obnašanja lažje sklepati na želje drugih oseb kot pa na prepričanja. Pri 3 letih se pojavi druga stopnja razvoja TU, ki jo je avtor poimenoval psihologija prepričanja – želje, ker gre za interakcijo med prepričanji in željami. Otrok razume mentalna stanja reprezentacije. Avtor ugotavlja, da prepričanja slonijo na metareprezentaciji, kar za želje ne velja. Za razumevanje prepričanj druge osebe je potrebno razumeti misli kot entitete – reprezentacije reprezentacij. Za razumevanje želja drugih oseb je potrebno razumeti le primarne reprezentacije (objekta in obnašanja). V tej drugi stopnji je otrok sposoben predvidevati obnašanje drugih oseb, ki je povezano z njihovimi prepričanji, in razume, da so mentalna stanja reprezentacije. Medtem ko dvoletnik lahko razume in predvidi obnašanje in čustva drugih glede na mentalno stanje – želje, triletnik lahko razume, zakaj se dve osebi z isto željo toda nasprotnim prepričanjem lahko vedeta v isti situaciji na drugačen način. Ker pa na tej stopnji otrok razume reprezentacije (prepričanja) kot posnetke realnosti in ne njene interpretacije, ima težave z razumevanjem napačnih prepričanj. V tretji stopnji, ki jo avtor imenuje prepričanja kot interpretacije in reprezentacije in se pojavi v obdobju 4-6 let, otroci že zmorejo razumeti mentalna stanja kot interpretacije (mentalne entitete so reprezentacije, ki jih ustvarja um). Z razvojem metareprezentacijskih sposobnosti otrok namen povezuje z mentalnim stanjem in ne z obnašanjem. Za razumevanje NP oz. za razumevanje, da imajo ljudje lahko napačna prepričanja, mora imeti otrok razumevanje prepričanja kot interpretacije in reprezentacije (reprezentacijska TU). Reprezentacijske sposobnosti se še nadalje razvijajo. Dani primer naloge NP vključuje prepričanja prvega reda ("jaz mislim, da X misli"). Prepričanje drugega reda je bolj zahtevno in se pojavi kasneje. Vključuje razumevanje, da ima druga oseba prepričanja o tretji ("jaz mislim, da X misli, da Y misli").

5 IZVRŠILNE FUNKCIJE IN TU

V zadnjih desetih letih je bila izvedena množica raziskav, s katerimi so skušali preveriti povezanost med zavedanjem lastne kognicije (metakognicija) in razvojem reflektivnega zavedanja kognicije drugih oseb (teorija uma). Raziskave so se osredotočale pretežno na razvojni vidik povezanosti med izvršilnimi funkcijami in TU (Perner, Lang, 2000). Raziskave so vključevale izvršilne funkcije, kot so delovni spomin, inhibitorna kontrola, načrtovanje in kognitivna fleksibilnost (fleksibilnost pozornosti). Raziskave so potrdile, da obstajajo pomembne korelacije med dosežki na testih izvršilnih funkcij in dosežkih na testih TU, kot je npr. naloga NP. Zanimiva je ugotovitev, da inhibitorna kontrola in delovni spomin kažeta močno povezanost z NP. To potrjujejo tudi raziskave pri otrocih z motnjo pozornosti in hiperaktivnostjo (ADHD) ter pri otrocih z avtizmom, za katere je značilen primanjkljaj v izvršilnih funkcijah (Hughes, 2002).

Izgleda, da naloga NP zahteva sposobnost inhibicije irelevantnega dražljaja in sposobnost slediti kognitivno reprezentiranemu cilju – NP (inhibitorna kontrola) ter sposobnost hkrati držati v spominu obe perspektivi (delovni spomin).

Da bi preverili, ali je za uspešnost na nalogi NP pomembna sposobnost hkrati držati v delovnem spominu dve "tekmujoči" reprezentaciji, so razvili nalogo, ki ne vključuje mentalne reprezentacije temveč "nementalno" (slikovno) reprezentacijo. To so naloge "napačne fotografije" (NF). Pri tej nalogi so otroci najprej s polaroidno kamero posneli fotografijo predmeta A na lokaciji X. Nato je bil predmet prestavljen na lokacijo Y. Zatem so otroka vprašali, kje (na kateri lokaciji) je predmet A na fotografiji. Pravilen odgovor je seveda "lokacija X". Ugotovljeno je bilo, da so te naloge za 3 in 4 letne otroke veliko lažje in so bili otroci uspešnejši kot pri nalogi NP. Slaughter (1998) je tudi ugotovil, da sta mentalna in slikovna reprezentacija razvojno neodvisni.

Nedavno je Zelazo predlagal, da je potrebno ločiti med 'cool' in 'hot' izvršilnimi funkcijami (Zelazo, Mueller, 2002). Medtem ko so 'cool' izvršilne funkcije vključene v izrazito kognitivne naloge, se 'hot' izvršilne funkcije vključujejo v odločanje o dogodkih, ki so pomembni za emocionalno področje

6 JEZIKOVNO-GOVORNE SPOSOBNOSTI , METAREPREZENTACIJA IN TU

Jezikovno-govorne zmožnosti in diskurz imajo pomembno vlogo v razvoju metareprezentacij. Jezikovno-govorne sposobnosti omogočajo izmenjavo informacij o prepričanjih, željah, namerah, čustvih in s tem prispevajo k socialnemu razumevanju. To potrjujejo raziskave pri gluhih otrocih. Gluhi otroci, ki so se pozno naučili znakovnega jezika in ga njihovi starši ne obvladajo dobro, kažejo zaostanek v razumevanju mentalnih stanj, ki se kaže tudi v manjši uspešnosti na nalogah NP v primerjavi s slišečimi otroci in tistimi gluhimi, ki so se zgodaj naučili znakovnega jezika in ga tudi njihovi starši (gluhi) zelo dobro obvladajo. Zanimivo, da ni bilo dobljenih razlik med vsemi tremi skupinami otrok v nalogi napačnih fotografij (slikovna reprezentacija). Očitno se ta ne razvija s konverzacijo. Pogovor o abstraktnih mentalnih stanjih je pomemben za razvoj teorije uma. Gluhi otroci se tudi ne udeležujejo iger pretvarjanja s sorojenci in vrstniki in so tako ovirani pri pridobivanju razumevanja mentalnih stanj.
Pomen komunikacije dokazujejo tudi ugotovitve, da so otroci iz večjih družin uspešnejši na nalogah TU. Zanimiva pa je tudi ugotovitev, da je v razvoju teorije uma pomembno, da starši pojmujejo otroka kot mentalno bitje, ter da upoštevajo in so pozorni na njegova mentalna stanja.
Raziskave kažejo, da so jezikovno-govorne sposobnosti dober prediktor uspeha na nalogah NP, neodvisno od starosti. Podobne korelacije so dobljene pri normalno razvijajočih se otrocih kot tudi pri tistih z avtizmom in drugimi razvojnimi motnjami. Raziskave oseb z afazijo so pokazale, da odrasle osebe z že izoblikovano TU lahko uspešno rešujejo naloge NP kljub afaziji (Apperly, Samson et al., 2008). Ti podatki podpirajo pomen komunikacije v razvoju TU.

7 NEVROZNANOST, TEORIJA UMA IN ZRCALNI NEVRONI

Ali obstaja nevronski substrat za TU oz. empatijo in ali je uspeh na nalogah TU odvisen od razvoja specialnih ali splošnih mehanizmov vključno s perceptivnimi, jezikovnimi (verbalnimi) prezentacija-mi nalog TU, delovnim spominom in motoričnimi reprezentacijami odgovora, so pomembna vprašanja, s katerimi se ukvarjata socialna nevroznanost in kognitivna razvojna nevroznanost. Raziskave na področju nevroznanosti so šle v dve smeri.
Ena smer raziskav je z uporabo nalog TU, ki vključujejo pripisovanje namer ali emocij drugim osebam, skušala preveriti, ali obstajajo možganska področja, ki predstavljajo nevrološki substrat za TU. Različne študije snemanja možganske aktivnosti so pokazale več možganskih področij, ki se aktivirajo pri teh nalogah. To medialni prefrontalni korteks (MPFK), superiorni temporalni sulkus (STS) in temporo-parietalni stik (TPS).
Druga smer raziskav empatije in TU se je osredotočila na percepcijo motorične dejavnosti v luči odkritij sistema zrcalnih nevronov. Raziskave, ki skušajo ugotoviti, kako je motorična dejavnost reprezentirana v možganih in kako so povezane gibalna dejavnost, imitacija in namere, so videti zelo obetavne za razumevanje nevrokognitivnega razvoja metareprezen-tacije.
Prelomnico na tem področju predstavlja odkritje zrcalnih nevronov za reprezentacijo motorične dejavnosti. Raziskovalci so odkrili, da se zrcalni nevroni (nevroni v ventralnem predelu premotorične skorje) aktivirajo, ko izvajamo določene gibe in tudi tedaj, ko samo opazujemo druge osebe pri gibanju. Dejavnost zrcalnih nevronov je bila opisana pri opicah (npr. Rizzolati, Craighero, 2004) in pri človeku (npr. Molnar-Szakacs, Iacoboni et al., 2005). Zrcalni nevronski sistem je torej substrat za imitacijo gibalne dejavnosti.
Da bi preverili, ali imajo zrcalni nevroni pomembno vlogo tudi v kodiranju namenov (namer), je Iacoboni s sodelavci zasnoval vrsto sistematičnih eksperimentov, v katerih se spreminja kontekst za izvrševanje povsem identične gibalne akcije. Raziskovalci so ugotovili, da se je desni inferiorni frontalni predel zrcalnih nevronov pri enakem prijemanju skodelice odzival drugače glede na to, ali je bila akcija prijemanja skodelice vključena v kontekst pitja ali pospravljanja (Iacoboni, Molnar-Szakacs et al., 2005). Glede na to, da je informacija o namerah lahko dobljena tudi s samim načinom akcije prijemanja, npr. pri pitju običajno izvedemo bolj natančen gib prijemanja ročaja skodelice, je bila izvedena še ena raziskava s funkcionalno magnetno resonanco, kjer so osebe opazovale natančen gib prijemanja za ročaj in gibe prijemanja skodelice s celo dlanjo v kontekstu pitja ali pa v kontekstu pospravljanja, ko je zajtrk končan (Kaplan, Iacoboni, 2008). Rezultati so pokazali višjo aktivnost desnega inferiornega frontalnega predela zrcalnih nevronov pri opazovanju natančnega giba v kontekstu pitja. Avtorja sta prišla tudi do zanimive ugotovitve, da so spremembe signalov v desnem inferiornem frontalnem področju zrcalnih nevronov tudi pomembno korelirale z rezultati na skali za merjenje emocionalne empatije testa *Indeks interpersonalne reaktivnosti*. Ti podatki kažejo, da zrcalni nevroni "uporabljajo" informacijo o kontekstu in tipu motorične dejavnosti prijemanja za predvidevanje namenov drugih oseb. Avtorja tudi sklepata, da so zrcalni nevroni tesno povezani s socialno kompetenco.
Ugotovitve o percepciji gibanja in kodiranju namena so potrjene tudi z raziskavami, ki kažejo, da se zrcalni nevroni aktivirajo samo pri opazovanja biološkega gibanja (gibanje človeka) ne pa pri opazovanju nebiološkega gibanja, npr. gibanja robota (Tai, Scherfler et al., 2004). Avtorji so zaključili, da je sistem zrcalnih nevronov biološko pogojen. Zanimivo je tudi, da se pri dojenčkih kaže, da imitirajo gibanje roke človeka, in je videti, da tudi "preberejo" njegov namen, ne bodo pa "prebrali" namena gibanja mehanične roke, ki izvaja isto gibanje (Meltzoff, 1995).
Rizzolati in Craighero (2004) sta naredila nekaj zanimivih raziskav na področju zrcalnih nevronov glede imitacije gibanja ter obraznih izrazov in jezika. Rizzolati in Arbib (1998) domnevata, da so zrcalni nevroni nevrofiziološki

mehanizem, iz katerega se razvije jezik. Ugotovila sta, da je "semantika" zrcalnih nevronov inherentna v gestah, uporabljenih v komunikaciji, in da je z evolucijo pomen gest zelo verjetno prenesen k abstraktnim glasovnim vzorcem (besedam).

Zanimivo je tudi, da razvojno psihološke raziskave kažejo, kot smo omenili že pri razvoju teorije uma, da obstaja medsebojna povezanost pretvarjanja (simbolna igra), imitacije in govorno-jezikovnega področja. To povezanost bi verjetno lahko razložili s sistemom zrcalnih nevronov (Goswami, 2008).

Vlogo zrcalnih nevronov v razvoju socialne kognicije so raziskovali tudi pri mladostnikih z avtizmom, ki imajo izrazite težave pri identifikaciji emocij in drugih mentalnih stanj pri drugih osebah in imajo zato tudi velike težave v razumevanju njihovega vedenja. Njihovo obnašanje je videti kot, da gre za "slepoto uma" ('mind blindness'), in tudi niso zmožni pripisovanja mentalnih stanj (čustev, namer, prepričanja ipd.) drugim osebam ter imajo pomanjkljivo TU. Raziskave imitacije pri mladostnikih z avtizmom in mladostnikih z normalnim razvojem so pokazale velike razlike med obema skupinama mladostnikov. Preiskava možganskih aktivnosti pri imitaciji obrazne mimike je pri mladostnikih z avtizmom pokazala, da zrcalni nevroni niso bili aktivni (Dapretto, Davies et al., 2006).

Kljub tesni povezanosti mentalnih procesov z aktivnostjo zrcalnih nevronov jih ne bi smeli reducirati nanjo. Saxe (2005) opozarja, da študije snemanja možganske aktivnosti kažejo, da so pri nalogah pripisovanja (atribucije) mentalnih stanj aktivna tudi druga možganska področja izven sistema zrcalnih nevronov. Ta področja so amigdala, obe temporalni polji in medialno-prefrontalni korteks.

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KO FUNKCIJA NI DOVOLJ: KVALITATIVNI EPIFENOMENALIZEM KOT NADGRADNJA KLASIČNEGA FUNKCIONALIZMA[i]

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POVZETEK

V članku obravnavam nadgradnjo klasičnega funkcionalizma s strani kvalitativnega epifenomenalizma. Slednji kot glavni razlog za nezvedljivost duševnih pojavov na fizične navaja njihov subjektivni značaj. Najprej predstavim razloge za nezadostnost funkcionalizma, nato pa očrtam glavne poteze Chalmersovega naturalističnega dualizma kot (trenutno) najbolj dodelane različice kvalitativnega epifenomenalizma.

1. UVOD: KLASIČNI FUNKCIONALIZEM

Klasični funkcionalizem se je razvil kot kritika identitetne teorije. *Identitetna teorija* je problem duha in telesa rešila tako, da je duševne pojave poistovetila s fizičnimi pojavi. Njena ontologija je sledeča: svet sestoji iz vse bolj kompleksnih skupkov osnovnih gradnikov. Lastnosti teh skupkov niso avtonomne, temveč so *zvedljive* na lastnosti osnovnih delcev in njihovih medsebojnih razmerij. Vse, kar obstaja, lahko v zadnji instanci zvedemo na in razložimo s *fiziko*. Če duševni pojavi obstajajo, potem velja, da jih lahko zvedemo na nevrofiziološke (fizične) pojave. To pa pomeni, da psihologija, ki preučuje duševne pojave, ne more biti avtonomna znanost, temveč je (v načelu) zvedljiva na fiziko.

Glavni argument, ki so ga klasični funkcionalisti navajali proti redukcionizmu identitetne teorije, je *argument iz večvrstne realizacije*. Ta pravi, da je lahko neko duševno stanje realizirano v velikem številu različnih fizičnih struktur, zaradi česar ga ne moremo poistovetiti z eno od le-teh. Čeprav lahko *primerek* duševnega stanja zvedemo na *primerek* fizičnega stanja, pa ne moremo *vrste* duševnega stanja zvesti na *vrsto* fizičnega stanja. Ker duševnih pojavov ne moremo reducirati na fizične, pride do dualizma lastnosti: duševne lastnosti so avtonomne in realne, saj jih ni moč razložiti s spodaj ležečimi fizičnimi lastnostmi.

To, kar duševnim pojavom daje identiteto, za funkcionaliste ni uprimerjenost v uniformnem substratu, temveč njihova *vloga* ali *funkcija*. Duševni pojmi so *funkcionalni pojmi*: opisujejo nalogo, ki jo duševni pojavi, na katere se nanašajo, opravljajo. Funkcionalni pojem označuje vzročni mehanizem, ki se na določeno množico *inputov* odzove z določenimi *outputi*, in nek fizični pojav velja za primerek nekega duševnega pojava, če in samo če uprimerja ta ustrezni vhodno-izhodni mehanizem.

2. KVALITATIVNI EPIFENOMENALIZEM

Tako kot razvoj klasičnega funkcionalizma sloni na kritiki identitetne teorije, sloni razvoj kvalitativnega epifenomenalizma na kritiki klasičnega funkcionalizma. Kvalitativni epifenomenalisti očitajo klasičnim funkcionalistom v prvi meri to, da njihovo pojmovanje duševnosti ni nič drugega kot redukcionizem v preobleki. Videli smo, da je po klasičnem funkcionalizmu narava duševnih stanj opredeljena z njihovo funkcijo, le-ta pa je po nujnosti vselej udejanjena v nekem fizičnem stanju. Toda če to drži, se zdi, da ni nobenega razloga, zakaj duševnih stanj ne bi v zadnji instanci zvedli na fizična stanja. Ta redukcija bo nemara resda drugačna od redukcije, ki jo zagovarja identitetna teorija, a to niti ni bistveno; kar šteje, je to, da v funkcionalizmu duševna stanja, ločena od njihove fizične realizacije, nimajo *nobene vsebine* in potemtakem ni jasno, zakaj naj bi jih šteli kot dejanske dodatki k ontologiji sveta.

Če lahko namreč naravo duševnih stanj opisno izčrpamo z njihovim vzročnim mehanizmom, le-ta pa je vselej zamejen na njihovo fizično realizacijo, je težko razumeti, zakaj naj bi duševna stanja dejansko obstajala. Ker funkcionalist ne omenja nobenih specifično duševnih karakteristik, se zdi, da lahko realnost duševnih pojavov utemeljuje samo z dozdevno pristno novimi vzročnimi močmi, ki naj bi jih posedovale duševne lastnosti. Toda izkaže se, da so vzročne moči funkcionalno opredeljenih duševnih pojavov zamejene le na njihove vzročne realizacije[ii], zato je videti, da so duševna stanja »gola« oz. »brez vsakršne vsebine«, tako da ni nobenega razloga, zakaj jih ne bi izenačili z njihovimi fizičnimi uprimeritvami.

Kvalitativni epifenomenalisti poudarjajo, da so bili klasični funkcionalisti v svoji analizi duševnih pojavov prekratki, saj so prezrli njihovo edinstveno *subjektivno* oz. *fenomenološko* naravo: njihov zavestni značaj, ki jih dela pristno duševne in zato avtonomne ter nezvedljive na fizične pojave. Poglejmo, za kaj gre.

3. KVALIJE ali TAKŠNOSTI

Thomas Nagel v članku »Kako je biti netopir?« dokazuje, da redukcija duševnega na fizično ni možna. Njegova kritika sloni na trditvi, da duševnega ni moč istovetiti s fizičnimi ne na ravni vrst (identitetna teorija) ne na ravni primerkov (funkcionalizem), in kot glavni razlog za nezvedljivost navaja *zavedanje* oz. *zavest* (Nagel, 1991, str. 400). To, da je nek organizem zavesten, zanj pomeni, da obstaja nekaj takšnega, kot je »*biti ta organizem*«: »[O]rganizem [ima] zavedajoča se mentalna stanja tedaj in le tedaj, če obstaja nekaj takšnega, kot [je] *biti* ta organizem« (str. 401). Ta *subjektivni* značaj izkustva je specifičen za duševne pojave in ga ni moč zajeti v kakršnikoli redukcionistični analizi, ki sloni na *objektivnem* fizičnem izrazju.

Razcep med *subjektivnim* in *objektivnim* prikaže na primeru netopirjev. Ker so netopirji sesalci, se bodo najbrž vsi strinjali, da jim lahko pripišemo zavestna izkustva. To, da imajo zavestna izkustva, pa pomeni, da obstaja nekaj takega, kot je *biti netopir*. Večina netopirjev zaznava zunanji svet s sonarjem: spuščajo visokofrekvenčne krike in prestrezajo odboje zvočnih valov od predmetov znotraj njihovega dosega. Njihovi možgani so oblikovani tako, da impulze, ki jih oddajajo, povezujejo z njihovimi odmevi, kar jim omogoča natančno določiti oddaljenost, velikost, obliko, gibanje in teksturo predmeta (str. 402).

Netopirski sonar predstavlja posebno vrsto zaznave, a ni po svojem delovanju podoben nobenemu od naših čutil. Zato ni nobenega razloga, da bi bila netopirjeva zaznava podobna čemurkoli, kar lahko izkusimo sami. Tudi če si skušamo predstavljati, kako bi bilo, če bi na rokah imeli krila, imeli zelo slab vid itd., bi nam to povedalo le, kako bi bilo *nam*, če bi se vedli kot netopir; ne bi pa bili zmožni ugotoviti, kako je *netopirju biti netopir* (*prav tam*). Izkusiti subjektivni značaj izkustva ne pomeni nič manj kot *biti organizem, ki ta značaj doživlja*. Kot zavestna bitja smo vezani na lastno subjektivnost: tako kot nihče drug ne more razumeti, kako je biti jaz, tudi sam ne morem izkusiti subjektivnosti nekoga ali nečesa drugega (izkusim lahko le to, kako bi bilo zame, če bi se vedel kot ta drugi organizem).

Vse to pa močno govori proti redukciji. Glavni postopek pri redukciji je namreč takšen, da subjektivno naravo nekega pojava zvedemo na njegovo objektivno naravo. Denimo, *subjektivno* naravo toplote (to, kako toploto *občutimo*) zvedemo na njegovo *objektivno* naravo (povprečna molekulska energija); *subjektivno* naravo bliska (to, kako blisk vidimo) zvedeno na njegovo *objektivno* naravo (električna razelektritev) (str. 405). Pri zavestnih izkustvih pa tega ne moremo storiti, saj njihov subjektivni značaj izčrpa njihovo celotno naravo: še tako natančno poznavanje delovanja možganov nam ne more pomagati razumeti, kakšno je neko stanje *za* organizem, ki ga izkuša..

Jackson v članku »Epiphenomenal Qualia« Nagelovo zamisel podkrepi z dvema zanimivima miselnima poskusoma (oba ponazarjata t.i. »argument iz vednosti«, ki trdi, da s pomočjo subjektivnih stanj izvemo pristno nova dejstva o svetu). V prvem poskusu srečamo osebo z imenom Fred, ki ima izjemne sposobnosti razlikovanja med barvami. Tam, kjer ostali vidimo rdečo barvo, vidi Fred ne eno, temveč *dve* različni barvi (rdeča$_1$ in rdeča$_2$). Rdeča$_1$ in rdeča$_2$ pa nista le odtenka *iste* barve, temveč sta dve povsem *različni* barvi: med seboj se razlikujeta kot modra in rumena. Fred je skušal razliko med rdečo$_1$ in rdečo$_2$ svojim prijateljem razložiti že večkrat, a pri tem ni bil uspešen: naj se je še tako trudil, mu ni uspelo pokazati, kako sam zaznava omenjeni barvi (Jackson, 2002, str. 274).

Toda ne le, da Fred ne more razložiti svojih izkustev rdeče$_1$ in rdeče$_2$, temveč o tem izkustvu preostali svet ne more izvedeti ničesar niti s še tako natančnim poznavanjem Fredovih možganov in optičnega sistema. Četudi bi imeli popolno znanje o njegovi nevrofiziologiji, bi ne vedeli vsega o Fredu. Edino, kar bi nam res omogočilo razumeti, kakšna izkustva doživlja Fred, ko vidi rdečo$_1$ ali rdečo$_2$, je to, da bi *dejansko postali Fred* (*prav tam*).

V drugem miselnem poskusu namesto Freda srečamo Mary. Mary je odlična nevrologinja: do potankosti pozna vso nevrofiziologijo barvnega zaznavanja. Njena posebnost pa je ta, da je odraščala v črno-belem okolju, tako da kljub poznavanju informacij o nevrofiziologiji barvnega zaznavanja, sama ni bila še nikoli izpostavljena dejanskim barvam. Poraja se vprašanje, kaj se zgodi, ko Mary dobi v dar televizor z barvnim ekranom? Bo Mary ob prižigu televizorja zvedela kaj novega o svetu ali pa so podatki, ki jih je o zaznavi pridobila tekom študija v črno-belem okolju, dovolj? Jackson je prepričan, da bo gotovo zvedela nekaj novega: zvedela bo, kako je, ko dejansko izkusimo neko barvo – kakšen je kvalitativni značaj barve. Poznavanje fizičnih dejstev ne more zaobjeti subjektivnega izkustva, ki ga bo doživela, saj ne more opisati takšnosti oz. kvalij, ki spremljajo zaznavo neke barve. Na osnovi tega je razvidno, da je fizikalizem nezadosten, saj nam ne more dati zaključene slike o duševnih pojavih (str. 275).

Izsledke Nagelove in Jacksonove kritike lepo zaokroži Joseph Levine v članku »Materialism and Qualia: The Explanatory Gap«. Levine se vpraša, po čem se fizična redukcija (npr. »Toplota je identična povprečni kinetični energiji molekul.«) razlikuje od psihofizične redukcije (npr. »Bolečina je identična vzdraženosti živčnih vlaken B.«).[iii] Fizična redukcija predstavlja identiteto (toplota = povprečna kinetična energija molekul), ki je *razlagalno popolna*: razlaga toplote s povprečno kinetično energijo ne izpusti ničesar pomembnega. Pri psihofizični redukciji pa so stvari drugačne, saj je predlagana identiteta (bolečina = vzdraženost živčnih vlaken B) *razlagalno nepopolna* oz. v njej zeva *razlagalna vrzel* (Levine, 2002, str. 354 – 356).

Fizična redukcija pojasni, kateri mehanizem udejanja vzročne funkcije, ki jih povezujemo s pojavom toplote (to, da pojav toplote zaznavamo z izkustvom topline/mrazu, da zvišuje ali znižuje raven živega srebra v termometru itd.). Za takšno razlago pravimo, da je popolna, ker nam naše fizično-kemijsko znanje omogoča razumeti, zakaj gibanje molekul tvori »bistvo« toplote: pojem toplote namreč izčrpa vzročna vloga, ki jo toplota igra v svetu.

Res je, da ima tudi bolečina neko vzročno vlogo, toda glavna razlika med pojmoma toplote in bolečine je v tem, da je pri slednjem prisoten nek *presežek*, ki ni zvedljiv na vzročno vlogo. Bolečina ima poleg vzročne vloge, za katero skrbi njena fizična realizacija (vzdraženost živčnih vlaken B), tudi *kvalitativni značaj* (»kako se občuti«) in prav ta presežek ostane pri psihofizični redukciji nepojasnjen: vzdraženost živčnih vlaken B ne razloži, zakaj bolečino občutimo tako, kot jo občutimo. Iz tega sledi, da bodo vsi poskusi razlage duševnosti s fizičnim izrazjem *nujno nezadostni*: vedno bo ostal nek kvalitativni presežek, ki ga fizična razlaga ne more zaobjeti (str. 356).

4. NATURALISTIČNI DUALIZEM (CHALMERS)

Kvalitativni epifenomenalizem je našel najbolj sistematično ubeseditev v delu Davida J. Chalmersa, *The Conscious Mind: In Search of a Fundamental Theory*. Za razliko od predhodnikov (Nagel, Jackson, Levine) Chalmers kvalitativnega epifenomenalizma ne utemeljuje le *negativno* – z dokazovanjem, da sta redukcionistično-funkcionalistični pristop nezadostna –, temveč tudi *pozitivno* – skuša mu priskrbeti teoretske temelje. Videli bomo, da njegov sistem ni odmik od funkcionalizma, temveč njegova nadgradnja: z vpeljavo kvalitativnega značaja priskrbi duševnosti tisti presežek, ki ji je umanjkal v klasičnem funkcionalizmu.

Chalmers svojo ekspozicijo s postavljanjem ločnice med dve pojmovanji duha. Prvo je *fenomenalno* pojmovanje: duh je razumljen kot *zavestno izkustvo* (»kako ga občutimo«) neko duševno stanje pa kot stanje, ki ga zavestno izkusimo. Drugo je *psihološko* pojmovanje: duh je razumljen kot *vzročna* ali *razlagalna osnova vedênja* (»kaj počne«), neko duševno stanje pa je vzročno (funkcionalno) stanje – stanje, ki igra ustrezno vzročno vlogo pri proizvodnji ali razlagi vedênja. (Chalmers, 1996, str. 11).

Chalmers pravi, da je eno od dejstev naravnega sveta, v katerem živimo, to, da fenomenološki in psihološki značaj duševnih pojavov *nastopata skupaj* (str. 16 – 17). To seveda ne pomeni, da sta v vseh pojavih prisotna v istem razmerju. Obstajajo izrazito fenomenološka (npr. zaznava), izrazito psihološka stanja (npr. intencionalna stanja) in stanja, ki so nekje vmes (npr. bolečina).

Izhajajoč iz delitve duševnih stanj na fenomenološka in psihološka, Chalmers razcepi problem duha in telesa na *enostaven* in *težek* del. Enostavni del se nanaša na psihološka stanja. Le-ta (npr. učenje in spomin) so opredeljena kot funkcionalna stanja, zaradi česar se vprašanje »Kako ima lahko nek psihični sistem psihološko lastnost P?« zvede na »Kako lahko fizični sistem izvaja neko specifično vzročno vlogo?«. To pa ni *metafizično* vprašanje, temveč vprašanje, na katerega mora odgovoriti *znanost o fizičnih sistemih* (str. 24). Težki del problema duha in telesa se po drugi strani navezuje na fenomenološka stanja. Ker so le-ta opredeljena s tem, kako jih nek organizem občuti, nam še tako nadrobno poznavanje fizičnega substrata, v katerem so realizirana, ne more razložiti, zakaj neko stanje občutimo tako, kot ga občutimo (str. 24).

V skladu povedanim Chalmers sklepa, da je pojem, imenovan »zavest«, v resnici *spoj* dveh pojmov, ki označujeta različna vidika duševnosti. Pojem, ki se nanaša na množico fenomenoloških vidikov, imenuje *zavest*, pojem, ki se nanaša na množico psiholoških vidikov, pa *pozornost*. Zavest (v tehničnem pomenu) je torej stanje, za katerega je značilna neka specifična takšnost, medtem ko je pozornost »stanje, v katerem imamo dostop do nekaterih informacij in lahko te informacije uporabimo pri nadzoru našega vedênja« (str. 28). Čeprav izraza običajno uporabljamo kot sopomenki, Chalmers poudarja, da sta zelo različna: pozornost je funkcionalni pojem, ki ga lahko razložimo v fizičnem besedišču, zavest pa ne. Čeprav različna, pa to ne pomeni, da sta tudi nepovezana: videli smo, da je eno izmed dejstev o našem svetu to, da se zavest in pozornost pojavljata skupaj (*prav tam*).

Zavesti torej za razliko od pozornosti po Chalmersu ne moremo zvesti na nevrofiziologijo. Nobena fizična razlaga ne more razložiti zavestnega izkustva. Zavest je vsekakor *odvisna* od možganov – duševna stanja ne morejo obstajati brez fizičnega substrata –, vendar ta odvisnost *ni logična*, temveč *naravna*. Na podlagi dejstev o fizičnem svetu namreč ne moremo priti do logično nujnega sklepa, da zavest res obstaja; to, da so naši možgani tudi zavestni, je (logično) naključno dejstvo o našem naravnem svetu (str. 93 – 94). Trditev, da duševno ni logično odvisno od fizičnega, Chalmers podkrepi z več argumenti. Mi si bomo v nadaljevanju ogledali argumenta iz zamisljivosti.

Chalmers meni, da je najočitnejši (čeprav ne edini) način, da preučimo, ali so duševna stanja logično res neodvisna od fizičnih stanj, ta, da si ogledamo možnost obstoja *fenomenoloških zombijev*. Fenomenološki zombiji so bitja, ki so fizično istovetna z ljudmi, a jim manjka izkustvene zavesti: čeprav jih »navzven« (fiziološko-anatomsko) ne moremo razlikovati od ljudi, pa so v »notranjosti« brez fenomenoloških stanj (str. 94 – 95).

Chalmers poudarja, da se vprašanje o obstoju zombijev ne nanaša na to, ali tovrstni zombiji v naravnem svetu res obstajajo, temveč na to, ali je takšna možnost pojmovno (logično) dopustna oz. ali si lahko brez protislovij zamislimo, da obstajajo. Zaključi, da so fenomenološki zombiji v tem oziru manj podobni npr. okroglemu trikotniku (pojmovna možnost), kot npr. deset kilometrov visokemu kolesu (naravna možnost). Fenomenološki zombiji so potemtakem logično možni, a je narava našega sveta takšna, da jih v njem ne najdemo. In ker so fenomenološki zombiji logično možni, lahko zaključimo, da dejstva o duševnosti ne sledijo iz fiziološko-anatomskih dejstev (str. 96 – 97).

Drugi argument iz zamisljivosti pravi, da si lahko logično neprotislovno zamislimo svet, v katerem so vsa dejstva v fizičnem svetu identična dejstvom v našem svetu, zavestna stanja pa so *obrnjena*. Predstavljajmo si, da obstaja bitje, ki je fizično identično meni, a takrat, kadar jaz zaznavam neko stvar *x* kot rdečo, moj dvojnik zaznava taisto stvar kot modro (in obratno). Čeprav se strinjava, da je *x* »rdeč«, pa je kvalitativno izkustvo mojega dvojnika obratno mojemu izkustvu. Seveda je obrnjeni spekter – podobno kot obstoj fenomenoloških zombijev – možen le *logično*, ne pa tudi *naravno*, saj bi fizično identična posameznika v našem svetu imela ob gledanju istega predmeta *x* isto kvalitativno izkustvo. Toda nas ne zanima naravna možnost, temveč ali je logično možno, da obstajata dva osebka, ki sta fizično identična, a imata obrnjeni spekter zavestnih izkustev; in zdi se, da je ideja obrnjenega spektra neprotislovna (str. 100).

Chalmers svoje pomisleke strne v skupni osnovni argument proti materializmu:

1. V našem svetu obstajajo zavestna izkustva.

2. Obstaja logično možen svet, ki je fizično identičen našemu, v katerem pozitivna dejstva o zavesti iz našega sveta ne veljajo.

3. Dejstva o zavesti so potemtakem dodatna dejstva o našem svetu, ki presegajo fizična dejstva.

4. Torej: materializem je napačen (str. 123).

Če je obstoj fizično identičnega sveta fenomenoloških zombijev logično možen (in videli smo, da je), iz tega sledi, da je prisotnost zavesti *dodatno* dejstvo o našem svetu, ki ne sledi iz fizičnih dejstev.

Neuspešnost materializma nas privede do *dualizma*, ki pravi, da obstajajo tako fizične kot nefizične lastnosti sveta (str. 124). To, da zavest ni logično odvisna od fizičnih lastnosti, priča o tem, da je njen značaj v osnovi nezvedljiv na fizične lastnosti. Toda pri dualizmu, ki ga zagovarja Chalmers, ne gre za različico substancialnega dualizma, temveč za *različico dualizma lastnosti*: ko ima nek posameznik zavestno izkustvo, sodelujejo pri tem lastnosti, ki jih ne moremo izpeljati iz posameznikovih fizičnih lastnosti, in ne neka nesnovna duhovna substanca. Zavest je *lastnost*, ki presega fizične lastnosti sveta: obstaja določena množica lastnosti (fenomenološke lastnosti), ki so ontološko neodvisne od fizičnih lastnosti (str. 125).

Čeprav duševne lastnosti niso logično odvisne od fizičnih lastnosti, pa so od njih vsekakor *naravno* odvisne. To pomeni, da obstajajo določeni *naravni zakoni*, ki povezujejo zavest z njenim fizičnim substratom. Končna ontološka shema mora poleg temeljnih *fizikalnih* lastnosti (prostor-čas, masa-energija itd.) vključevati tudi temeljne *duševne* lastnosti (zavestna izkustva). Tako kot za temeljne fizikalne lastnosti veljajo temeljni fizikalni zakoni, ki določajo, kako so te lastnosti medsebojno povezane, veljajo tudi za temeljne duševne lastnosti temeljni psihofizični zakoni, ki določajo, kako so fenomenološke lastnosti povezane s fizičnimi lastnostmi. Ti zakoni pa se ne vmešavajo v fizične zakone, temveč le razlagajo, kako iz fizičnih procesov vznikne izkustvo (str. 126 – 127).

Naloga *naturalističnega dualizma* (kakor Chalmers poimenuje stališče, ki ga zagovarja) je ugotoviti te naravne psihofizične zakone. Chalmers ponudi nekaj predlogov. Prvi je *načelo o sovpadanju fenomenologije in psihologije*, ki pravi, da v nekem duševnem pojavu ne more biti prisoten psihološki značaj, ne da bi bil prisoten tudi njegov fenomenološki značaj (in obratno). Drugi tak predlog je *načelo organizacijske invariance*, ki pravi, da imajo funkcionalni izomorfi kvalitativno identična izkustva. *Funkcionalni izomorfi* so fizični sistemi, ki imajo skupno funkcionalno organizacijo (četudi realizirano v različnih substratih, npr. biološkem substratu – ljudje – in silikonskem substratu – inteligentni računalniki). To pomeni, da bi imeli bitji, ki v dveh različnih fizičnih substratih uprimerjata isto funkcionalno zgradbo, identična zavestna izkustva (str. 248 – 249).

Kaj pa lahko povemo o vzročni učinkovitosti duševnih pojavov? Ker zavestna izkustva niso zvedljiva na fizične lastnosti, fizični svet pa je vzročno zaprt, lahko sklepamo, da zavestna izkustva ne igrajo nobene neodvisne vzročne vloge. Vsak dogodek ima ustrezen fizični vzrok, tako da duševni pojavi ne posegajo v fizično vzročno verigo: so le vzročno nemočni *zgolj-pojavi* oz. *epifenomeni*.

5. ZAKLJUČEK

Kvalitativni epifenomenalizem se začne tam, kjer se klasični funkcionalizem konča: priskrbi vsebinsko dopolnilo, ki je v klasičnem funkcionalizmu umanjkal, in kot to, kar naj bi duševne pojave delalo različne od fizičnih, navede njihov *fenomenološki* značaj. Ker je slednji vezan na prvoosebno izkustvo (»kako-je-biti«), ga ni mogoče razložiti s tretjeosebnim (fizičnim) besediščem: med zavestnim izkustvom in fizičnimi procesi v možganih zeva razlagalna vrzel.

Duševnost se deli na dve množici: *pozornost*, ki zajema vse psihološke pojave, in *zavest*, ki zajema vse fenomenološke pojave. Naravo pojavov v prvi množici izčrpa funkcionalna organizacija in jih zato lahko razložimo v fizičnem besedišču; narava pojavov v drugi množici pa poseduje določen fenomenološki presežek, ki se fizični razlagi izmika. Kljub njuni logični neodvisnosti pa sta množici naravno soodvisni, kar pomeni, da v naravnem svetu določeno funkcionalno organizacijo vselej spremljajo ista izkustva. Ker so duševne lastnosti zavoljo svojega fenomenološkega značaja nezvedljive na fizične lastnosti, bo morala končna teorija poleg temeljnih fizičnih elementov in zakonitosti postulirati tudi temeljne duševne elemente in zakonitosti. Ti elementi in lastnosti pa nimajo nobenega vzročnega vpliva na fizične dogodke.

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[i] Pri pričujočem članku gre za prirejeni izsek iz mojega diplomskega dela, v katerem nadrobno obravnavam dualistične sisteme v filozofiji duha.

[ii] Za podrobnejšo razlago glej Vörös, 2008, podpoglavje 4.3.

ENABLING ENABLING SPACES FOR KNOWLEDGE CREATION AND INNOVATION

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ABSTRACT

This paper presents two concepts of knowledge creation and innovation: (i) the process of *emergent innovation* which represents a heuristic for generating profound change and/or organically grown radical innovations; (ii) the concept of *enabling spaces* providing the holding places and supporting environments for these processes. The strength of the approach lies in the combination and integration of both concepts. Additionally we discuss the (im)possibilities of designing, creating and hosting – thereby enabling – such *enabling spaces* within the emerging field of *cognitive design*.

1 INNOVATION AS PROCESS OF KNOWLEDGE CREATION

Knowledge is considered as the primary resource of the 21st century. Therefore understanding knowing and knowledge resp. the "production processes" and wellsprings of knowledge are of vital importance. Closely connected with the aspect of "production" is the question of knowledge creation – generating radically new knowledge and profound innovation. These topics have become leading issues on the economical and political agenda not only in Europe and North America, but all over the world.

This paper proposes to understand innovation as a holistic and sustainable process of knowledge creation. Thereby two concepts are presented: (i) the process of *emergent innovation* [1] which allows "organically grown" radical innovation, and (ii) the concept of *enabling spaces* [2] providing the place and context for such processes to happen. Strong emphasis is put on the combination and integration of both concepts [3]. Connections to Cognitive Science and Design are sought and possibilities for further research concerning the discussed concepts in the realm of *cognitive design* are presented.

2 EMERGENT INNOVATION

The process of *emergent innovation* aims at generating radically, yet organically fitting new knowledge. It is based on the assumption, that innovations develop organically and "from within" – fitting into an emerging future – and still can be fundamentally new. This approach is based (amongst others) on C.O. Scharmer´s "Theory-U" [4] – which is able to connect and integrate wisdom from diverse cultural backgrounds with findings from leading edge (natural-) science and thereby forming a powerful heuristic for innovation.

In the following we present briefly the most important phases of this process-heuristic. Each phase has a specific character and incorporates certain "modes of knowing", which are mediated and supported by *enabling spaces* (see section 3):

A | Selecting the Team

Applying a special interview technique (in-depth interviews) an innovation team is formed, which is capable of bringing forth and realizing radical innovations.

B | Entering the Enabling Space

In this phase a common (social) space is created by establishing a high level of trust, removing prejudices and forming a common understanding of the process of emergent innovation.

C | Sensing the Field - Learning to see and becoming aware

Emergent innovation is not solely based on creativity (-techniques), but focuses on a profound understanding of and intense interaction with the subject –matter and its context. One prerequisite for that is the ability to see/perceive reality in its wholeness. This is a cognitive ability, which needs time and space for practicing and includes a selection of techniques of observation and perception.

D | Reflecting and redirecting through topic centered dialogue

In this phase individual and collective patterns of perception and thought are questioned and broken up by explicating hidden assumptions in a dialogical setting [15] and sharing them within the innovation team. These practices aim at getting to know the individual origins of thought, challenging them and thereby redirecting [16] perceptions and the focus of attention. From the perspective of shared assumptions a first common topic or theme is selected, which then forms the semantic container for the innovation project (an "emergent thematic field"). These processes happen both on a personal and group level.

E | Experiencing potentialities and Presencing – Deep knowing and profound understanding

As preparation for this phase a comprehensive body of knowledge related to the selected thematic field is collected from a variety of areas and sources (e.g. learning journeys, interviews, etc.). Deep knowing and profound understanding based on this exploration is the prerequisite for the process of *Presencing*.

In that phase the participants let go of everything in order to enter the (in the first run empty) space of potentialities as unbiased as possible. In this space the challenge is to connect and come into resonance with the core of oneself, the thematic field, and the organization (i.e. its purpose and the theme in a larger context).

This happens most likely if the participants allow themselves sufficient space for silence and inner leisure. The atmosphere is relaxed and at the same time everybody is fully concentrated in order to reach the openness for dealing with substantial questions and topics; this supports the process of perceiving and exploring the space of potentialities. From this process deep insights about the future emerge which present themselves with high certainty and a high level of inner and outer coherence.

This special level of certainty evolves from the inside out and is based on the openness for and from listening to "the future as it emerges". The knowledge coming up in such a process has the quality of fundamentally new insights and at the same time creates innovations which seem to have grown organically from and are fitting well into the already existing.

F | Crystallizing - Emergent design

The knowledge gained in the process of presencing has a high level of fragility and, thus, has to be cultivated. In this phase the insights of all the participants are shared and combined to common scenarios. This is achieved by dialogical techniques, mood-boards, story-boards and practices from design-thinking. Through this process an emergent design evolves and crystallizes.

G | Prototyping – Fast cycle learning through immediate realization

The emergent designs are condensed and form the basis for concrete building plans and prototypes. Such models and functional scenarios allow fast learning through rapid feedback-loops and openness for mistakes. The aim of this phase consists of developing them to a level of maturity that allows the existing processes and structures of the organization to assimilate them.

H | Embodying – Putting things into practice in an organizational setting

In the final stage the tested prototypes and models are integrated in the daily business and routines of the organization.

3 ENABLING SPACES

The process of emergent innovation is embedded in so called *enabling spaces*, which provide the boundary conditions for the processes of knowledge creation. We are aware of the possible meaning of a boundary as a limit and constraint. Nevertheless we rather consider them as supporting – *enabling* – frames that allow observations through new distinctions and thereby providing new insights.

The chosen metaphor contains a multidimensional understanding of space and hints - with the two aspects of enabling as verb and adjective - at the interplay between actively shaping such environments and the impact through place and setting on the processes of knowledge creation.

3.1 Space

Space embraces a multitude of meanings ranging from the situatedness at a certain place or in an environment to the characteristics of all kinds of ambients and surroundings. In that respect we do not only think of physical or architectural aspects of space, but also about social, mental, epistemological or technical dimensions [2]. It is important for our understanding that even though these distinctions mark levels and borders we consider them as connecting rather than separating.

If we follow the work of Ikujiro Nonaka and colleagues concerning "knowledge creation" we can link our understanding of space with the Japanese concept of "ba[sho]" [5,6]. Nonaka dwells here on the in Japanese culture and language deeply rooted pattern of "being together at/in a place in relation to one another and something". Building on the philosophical work of the

founder of the Kyoto school Kitaro Nishida [7], he distinguishes physical, virtual, social/mental (shared context, trust) and intentional (shared meaning) qualities of place/space ("ba").
The present discussions concerning the "topological turn" in the humanities and social sciences [8,9,10] point towards an increasing interest in the whole topic of "space". These contributions add additional levels of understanding to the above mentioned considerations.

3.2 Enabling as Activity

Due to the special properties of the resource "knowledge" and the processes related to its emergence and creation, the practices and attitudes towards them are of vital importance [2]. Abandoning of "heroic" views suggesting that managing such fragile processes would be possible by deterministic "making", is essential for us. These illusions are given up in favor of approaches of *initiating*, *steering* and *facilitating* with an attitude of "*enabling*" them [11]. Providing helpful surroundings, removing barriers and an openness for surprising insights along the way allow and facilitate finding *emergent innovations* resp. increase the likelihood for their occurrence.

Cybernetics – especially "second order cybernetics" – has mapped out the (im-)possibilities of steering complex, interdependent systems in the above mentioned way. In that context the role of the observer as being part of the observed system and the implications for our understanding of cognition and epistemology is vital [12].

Further important aspects of "enabling practices" can be found in the realm of design and the connected attitudes, methodologies and heuristics. Ranulph Glanville has developed interesting accounts of the interrelations between (second order-)cybernetics and design recently, which are of importance for our considerations as well [13].

3.3 Enabling as Characteristics of Space

Continuing the argument, the question arises how "enabling" characteristics and properties of space manifest themselves and in which forms they can be perceived, designed and changed.

Concerning the methods applied, these cases are based on established practices from systemic consultancy, innovation management and recent developments of an "art of hosting" (with roots in large group methods, Open Space and World Café) in combination with own approaches. Inspiration is gained from architecture and theater as well.

The processes being discussed here unfold in each new project with different people in different temporal and spacial contexts. Therefore, even though we can consider the typical process steps as being relatively stable (plus there are well established settings for each phase), one has to search for a customized and coherent solution for each new situation. Descriptions of the applied elements could therefore be derived most appropriately in analogy to (architectural) patterns in the understanding of Christopher Alexander´s "Pattern Language" [14] resp. in the form of stage directions, storyboards or the like. Here as well parallels can be drawn to practices and processes in design.

4 POSSIBILITIES OF COGNITIVE DESIGN

So far we were looking for supportive environments (enabling spaces) for processes of knowledge creation (emergent innovation) and thereby connecting time/process and space/place. The whole endeavor is itself framed by the quest for a deeper understanding of knowing on a personal and collective level and for cross-disciplinary approaches for coping with change and generating new knowledge.

On the one hand cognitive science itself can be understood as an inter-/transdisciplinary endeavor for understanding mind(s) and knowing in interaction; on the other hand, research strategies, methodologies and frameworks that allow and support conversation and cooperation across disciplines are still in a stage of infancy—they are far from being well established and functioning. Therefore getting beyond a theory-practice dichotomy by considering the issue as an interplay of both leading to reflected and prudent action, seems to us very important.

As discussed above, experiences from design offer interesting insights and approaches to the issues under consideration. A promising strand of the discourses is for us the suggestion to develop *cognitive design* by joining contributions from cognitive science and theories of knowing with design practices and information technologies to form an integrative field of work in research and application for enabling efficient and innovative ways of generating and communicating knowledge through socio-technical media-environments [17].

Considering design practices as "conversations with the self (and others)" - as proposed by Ranulph Glanville following Gordon Pask [19,20] - allows to view research in design as a search for a "design approach in design" which through the central act of design (looking and drawing) allows us to see something new, not previously intended [13]. This very much resembles with what is meant with the presencing-phase in the emergent innovation process heuristic.

For the scientific field a revival and further development of practice based studies and action research approaches – if applied with the readiness of truly reflecting also one´s own activities as a researcher – should open new vantage point for theory building to enhance the quality of action [18].

5 CONCLUSIONS

This paper discussed the interplay between processes, frameworks, and conditions for *knowledge creation* by presenting the concepts of *emergent innovation* and *enabling spaces*. Approaches for *enabling* fruitful interaction processes and their embeddedness for creating new knowledge in the sense of radical innovations were discussed. These considerations are based on an understanding of cognition as embodied, situated and process in relation(s). Learning from design practices and forming new thematic interconnections for theory building and prudent action in the field of *Cognitive Design* have turned out to be a fruitful approach in that context.

Building on initial experiences with testing these concepts through the application of the rich set of methods from a wide range of disciplines, we are interested in deepening our understanding of the metaphors presented and sharpening our competencies and instruments further on. The whole endeavor is understood as an iterative design and action research process, which allows us to apply and test our ideas in concrete action and thereby contribute to further developing both, theory and practice.

In this respect the integration and interconnection of the thought and communication processes in innovation projects with an overarching conception of the involved spacial structures seems to us most promising. The necessary research and knowledge creation is still in its infancy and calls for a radical inter-/transdisciplinary approach in order to match the occurring complexity.

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