Benelux A.I. Newsletter

Spring 2015 Edition (No. 1)

BNVKI
AIABN

Editorial

It is a great pleasure for me to introduce to you the new layout of the BNVKI newsletter. Four major changes are made that I highlight briefly. First of all, the BNVKI board decided to change the name of the newsletter to "Benelux A.I. Newsletter". We feel it sounds catchier and reflects the content better than "BNVKI Newsletter". Secondly, from now on the newsletter appears quarterly, at the beginning of each season. Thirdly, the BNVKI board has decided to introduce a new and recurring item, namely an interview with a well-known A.I. researcher born in, or currently working in, the Benelux. I am happy to announce the first interviewee, Leon van der Torre. Leon is Professor at the Department of Computer Science and Communication at the University of Luxembourg (PhD in Computer Science in 1997, Erasmus University Rotterdam). The interview has been conducted by Zohreh Baniasadi and Philippe Ludivig, master students at the University of Luxembourg. Fourth and finally, because we were able to cut on recurrent costs, the BNVKI membership fees have been lowered. We hope that this will allow more AI researchers and practitioners to become a member of the BNVKI. You can find the new fees in this newsletter.

I personally hope that these changes will blow a fresh wind through our community, and bring both the newsletter and the BNAIC conference back to the level it was several years ago. Feel free to contact us at board@bnvki.nl to let us know what you think of it. I wish you all a sunny start of spring!

Marc van Zee, Editor BNVKI.

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Interview with... Leon van der Torre

by Zohreh Baniasadi and Philippe Ludivig

What is your academic background and how did you get drawn to the field that you are dealing with now?
I studied computer science in Rotterdam at the faculty of Economics. Besides computer science, I studied philosophy in my own time. After that, I was accepted for a PhD position on Electronic commerce, which felt like a natural choice because I had a background in Economics. I first studied deontic logic and its combination with non-monotonic logic. Later, I looked at other logics in AI as well.

What did you do after your PhD?
I went to Max Planck Institute for Computer Science and I started to work with Dr. Emil Weydert. It was a bit different from my PhD topic, because I mostly did qualitative decision theory. After that, I went to Toulouse and I did another postdoc on the same topic. I did a postdoc on agent system in Amsterdam afterwards because I was becoming more interested in logic, AI and multi-agent systems. Next, I started working at the CWI (Centrum Wiskunde & Informatica) in Amsterdam. There I worked on Enterprise Architecture for three years, which is more connected to my background in Economics because of the applications in modeling of businesses. Finally, I moved to Luxembourg as a full professor.

Why did you decide to move to Luxembourg?
At that time I was applying for two different positions, one as a lecturer in Liverpool and the other one as a full professor in Luxembourg. I was accepted for both positions, but because the position in Luxembourg was better I selected it. Also, my wife used to work in Luxembourg and we had two small children. The recently founded university of Luxembourg had very good opportunities for setting up a new group in logic in AI.

You are very active in deontic logic, what are your contributions to this field? From your point of view, what are useful research approaches that have been missed?
I was working on classical deontic logic in my PhD thesis– Dyadic Deontic Logic: applying nonmonotonic logic to deontic logic. I had an idea related to a fundamental problem in deontic logic, so I went to David Makinson. We started to develop something completely different from classical deontic logic and the result was the invention of Input/Output logic (I/O logic). It is not well known everywhere yet. Therefore, we position it in the *Handbook of Deontic logic and Normative Systems*. I believe the main open issue is the unification of the old way of thinking and new way of thinking. In the last Deon conference we tried to build the bridge between logical computational approaches and natural language processing approaches.

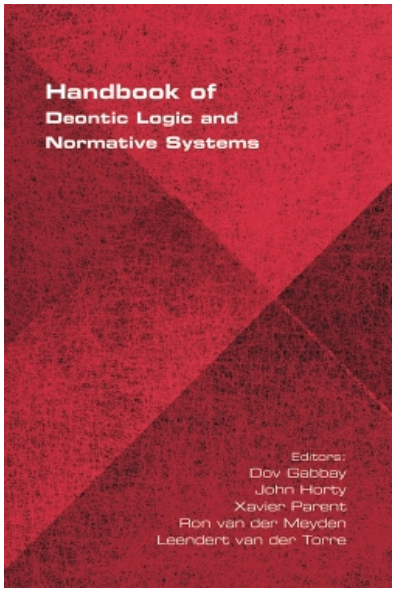
> “There is miscommunication between computer scientists and philosophers about paradoxes. For a computer scientist, paradoxes are simply examples to be modeled. However, for a philosopher paradoxes are much more fundamental.”
>
> *Leon van der Torre*

It is generally known that non-monotonic logic is closer to commonsense reasoning than monotonic logic. When

non-monotonic logic came up in the 1980s, some philosophers immediately realized that this logic could very well serve as a basis for various systems of deontic logic. Can you tell us what the benefits of non-monotonic logic are in the modeling of deontic logic?
Consider this example that I used in my thesis: People are not allowed to kill, but if they have to kill maybe there is a reason for that. Therefore, the act of killing could be a violation or exception. If there is a violation, the guilty person should be imprisoned, but there might be some exceptions proving that he is not guilty. Basically, non-monotonic logic works with exceptions and deontic logic works with violations or abnormality. In some sense, they are very close to each other. However, it is important to realize the difference between a violation and an exception. Nonmonotonic logic is used to find this exceptions in deontic logic. There is a paper *"Five faces of minimality"* by David Makinson in 1993 which focuses on violations and exceptions.

Some philosophers still believe that we shouldn't abandon the use of standard deontic logic (DSDL). They believe that classical logic is still as powerful as non-monotonic logic. What are your ideas on this topic?
In deontic logic there is a field of deontic modality, and in classical logic (for instance Kratzer's system) there is a branch called conditional logic. As this conditional logic is the base for deontic modality non-monotonic logic we cannot abandon using it. Actually, they are very similar to each other.

Mostly, the new system of deontic logic models and evaluates paradoxes of classical logic. Do you think the importance of paradoxes is exaggerated?
When I started to write my thesis in middle of the nineties of the last century, everyone was against using examples, especially paradoxes because they thought that it is not a good idea to start from the methodological point of view. Actually, I defend the use of examples in my thesis. In non-monotonic logic there was a tendency from concrete examples to general properties. So from the beginning, people were driven by examples. Following this, people started proposing general postulates from these examples, which are properties that a logic should satisfy them (for instance, the AGM postulates of belief revision). In deontic logic, a similar approach was followed.



I think there is miscommunication between computer scientists and philosophers about paradoxes. For a computer scientist, paradoxes are simply examples to be modeled. However, for a philosopher paradoxes are much more fundamental. As a computer scientist, I think it is important to use paradoxes because they illustrate limitations of a logic. However, I also think one should not focus on solving paradoxes too much. For instance, Chisholm's paradox (contrary-to-duty) was already solved in the 70s, so it is not productive to use these paradoxes as an open problem because the more recent solutions are not innovative.

Deontic logic is not only of theoretical interest, it is also used for moral and legal reasoning. What do you think are the most practical applications of deontic logic?
Nowadays, there are many applications of deontic logic such as decision systems, databases, security and electronic commerce. The first successful application of deontic logic was in multi-agent systems for

the coordination of agents because norms are very important in coordination of agents. Now, the study of legal reasoning is becoming popular in deontic logic and I would say regulatory compliance is the next successful application for deontic logic. There is large budget on this topic in Europe now.

You recently contributed to the book "handbook of Deontic Logic and Normative Systems". What were your contribution to this book?
My main contribution was the organization of the book. I believe it is a good representation of our community. In deontic logic, there are many people developing different systems, and it is not always clear what is the relation between them. The handbook tries to make these links explicit through several chapters of new developed systems and the relation between them. It was a long process to write the handbook. We started in 2008 during the DEON conference in Luxembourg, and it is finally published in 2013. Currently, a second volume of the handbook is being written.

New BNVKI Membership Fees

Due to a drastic cut of administrative costs the BNVKI inscription fees have gone down. In the table below you can find the new fees, compared to those of last year.

	2014	2015
Regular members	€ 40,-	€ 20,-
PhD students	€ 25,-	€ 10,-
Master students	€ 20,-	€ 10,-

Table 1: BNVKI Registration Fees

Becoming a BNVKI member makes you automatically an ECCAI member and allows you register at a reduced registration rate for certain major events, such as ECAI and ACAI. By increasing the number of BNVKI members, our AI community can also nominate more colleagues to become ECCAI fellows, as the maximum number of fellows we are allowed to have is proportional to the number of members. Finally, it might be good to know that ECCAI has decided to sponsor international events through invited speakers and these invited speakers need to be an ECCAI member over the past years.

If you want to know where our members are currently located, check out http://wilma.vub.ac.be/ dvandeun/mapje.html, if your affiliation is not represented, or you would like to see a larger dot, become a member and convince you colleagues to join as well.

BNAIC 2015

The 27th Benelux conference on Artificial Intelligence (BNAIC 2015) will take place on 5-6 November in Hasselt (Belgium). BNAIC 2015 will be held at the city campus of Hasselt University, in the unique setting of the former prison of Hasselt. BNAIC 2015 will include invited speakers, research presentations, posters and demonstrations. Authors are invited to submit papers on all aspects of artificial intelligence.

One of the keynote speakers is Dr. Elpiniki I. Papageorgiou. She is assistant Professor at the Department of Computer Engineering of the Technological Education Institute (TEI) of Central Greece, Lamia, Greece. She has been working for over thirteen years as researcher in several research projects related with the development of novel computational intelligence methodologies for decision support systems, intelligent algorithms for decision making, data analysis and mining and expert systems.

Please visit bnaic2015.org for more information.

BNAIC 2014 Reports

Session: Knowledge Representation

by Aske Plaat

The Knowledge Representation session consisted of three presentations. The topics were completely different, ranging from clinical trials, via requirements engineering and argumentation-based techniques, to Linked Open Data. This session was one of the last sessions of the first day.

BNAIC 2014 took place on 6 and 7 November 2014 in Concertgebouw De Vereeniging in Nijmegen, the Netherlands.

The first presentation was titled "Feasibility estimation for clinical trials", authored by Zhisheng Huang, Frnak van Harmelen, Annette ten Teije, and André Dekker. Zhisheng was presenting. The presentation was motivated by the observation that at least 90% of trials are extended by at least 6 weeks because investigators fail to enroll patients on schedule. Therefore, at design-time it is important to have good insight in how the choice of eligibility criteria affects the recruitment rate. In the presentation an elegant mathematical model was presented to achieve this goal. Results with real and synthetic patient data were presented. To increase the reproducibility of the results, the datasets have been made available onlline.

The second presentation was titled "Capturing Evidence and Rationales with Requirements Engineering and Argumentation-Based Techniques" by Marc van Zee and Sepideh Ghanavati. Marc van Zee was presenting. In the presentation a problem from Requirements Engineering was discussed. It was noted that in the goal modeling language URN (the User Requirements Notation) it is not possible to trace back the elements of a goal model to discussions between stakeholders and the evidence that this was based. The authors propose an extension to URN to capture these discussions, using a hybrid approach based on evidential reasoning, a technique that was used previously in describing criminal cases.

The third presentation was titled "LOD Laundromat: A Uniform Way of Publishing Other People's Dirty Data" by Wouter Beek, Laurens Rietveld, Hamid Bazoobandi, Jan Wielemaker and Stefan Schlobach. Wouter Beek gave the presentation, using a mix of prepared slides and a live demonstration of the working system. LOD means Linked Open Data. The goals of the paper is to make proper data publishing easier, since it is noted that many published datasets do not contain clean data, causing the Linked Open Data Cloud to contain a high level of dirty data. The LOD Laundromat removes the direty data without human intervention. It uses an automated system of standards-compliant parsing to cleanup data. The Laundromat provides real-time visualizations of the crawled data.

Although all three presentations differed in topic, each presentation was interesting and engendered numerous questions from the audience.

Session: AI for Games and Education

by Jaap van den Herik

The AI for Games and Education session consisted of three presentations. The games were completely

different, ranging from a topic out of the world of Games in combination with Combinatorial Game Theory, via Aggressive De-escalation, to Poly-Y. This was one of the three starting sessions of the 26th BNAIC and it took place immediately after the keynote lecture by Simon Colton.

The first presentation was titled "Combining Combinatorial Game Theory with an Alpha-Beta Solver for Domineering", authored by Michael Barton and Jos Uiterwijk. Jos did the presentation. The main topic was the combination of two research fields. From the perspective of Combinatorial Game Theory (CGT), the Domineering games of different size were investigated on subgame ordening. The authors used five concepts, viz. (1) unknown value, (2) hot (known value), (3) decreasing temperature, (4) infinitive subgames, and (5) number. Moreover, they exploited the standard move ordening with tie breaks. From CGT, the authors adopted the techniques on the exploration of subgames. From the Games World they took the $\alpha - \beta$ solver, negascout and the database concept. Emphasis was on pruning. The results were adequate, but much work has still to be performed. Plans and recommendations for future research were given. The article was a candidate for the Best Paper Award.

The second presentation was titled "Towards Aggression De-escalation Training with Virtual Agents: A Computational Model" by Tibor Bosse and Simon Provoost. Tibor Bosse gave the presentation.

BNAIC 2014: Facts & Figures	
Participants:	130
Of which students:	48
Submissions:	77
A-papers:	24
B-papers:	28
Demo's:	6
D-papers:	9

The motivation of the research was in the observation that in many jobs we see aggressive confrontations. The authors gave some telling figures in this respect, such as in 10% of the cases in which a dispute is at stake, there is escalation, and per year 50 drivers in the public transport in Amsterdam are facing aggressive behaviour. The authors distinguished two types of defense in relation to such behaviour: (1) reactive defense relying on empathic statements, and (2) proactive behaviour, i.e., being dominant (i.e., draw a line) and be not empathic. From these two types it is clear that decision making is most important in this research. The authors introduced a virtual instruction. Their model is based on the dynamics of the processes related to interpersonal aggression. In fact, there are two submoedels, viz. the aggressor model and the de-escalator model. The authors informed us on a number of simulation runs under different parameter settings. Both models were promising but are waiting to be integrated in one system and then should be validated.

The third presentation was titled "Monte-Carlo Tree Search for Poly-Y" by Lesley Wevers and Steven te Brinke. Lesley Wevers gave the presentation. Poly-Y is a generalization of the game Y and that is a generalization of Hex. In short it is a connecting game. Poly-Y is played on a board with an odd number of sides greater or equal to three. The goal of the game is to capture the majority of the corners. A corner is captured by constructing a Y structure. The authors gave many examples in the their article. For reasons of equality there is a swap rule just as in Hex. The authors describe their application of MCTS to Poly-Y and refer to the literature for extensive descriptions. Subsequently they discuss the Monte-Carlo Playouts for Poly-Y with respect to their effectiveness. Then the pay attention to the opening analysis. This is an interesting topic, particularly in relation to the swap rule. For many openings they established win rates. As a consequence they tuned their strategy on their opening findings. "If the opponent opens with a move that has less than 50% win chance for us at the deepest level that we analyzed, we apply the swap rule." Their experimental results were interesting. Finally, in the section future work they recommend some techniques used in the game Y by Saffidine and Cazenave. We look forward to see poly-Y participating in the next Computer Olympiad.

The 2014 SKBS Prize

by Jaap van den Herik

The Foundation for Knowledge Based Systems (SKBS) continued their policy of awarding the SKBS prize to the best demonstration of the Demo-session of the BNAIC 2014. The 2014 referee committee consisted of Jaap van den Herik (chair), Simon Colton, Tom Heskes, Virginia Dignum, Patrick de Causemaecker, and Josca Snippe. The referee committee had to consider five submissions which were eligible for the SKBS prize. In the table below we list them by topic (in the order of their publication in the Conference Program BNAIC 2014).

1. Using Facial Expressions for Personalised Gaming.
Paris Mavromoustakos Blom, Sander Bakkes, and Diederik Roijers.

2. Teaching Mario. Demonstrating the Effectiveness of Human Guidance when q-Learning.
Roland Meertens.

3. Enhancing Operational Work in Maritime Safety-and-Security Tasks.
Steffen Michels, Marina Velikova, Bas Huijbrechts, Peter Novak, Jesper Hoeksma, Roeland Scheepens, Jan Laarhuis, and André Bonhof.

4. An Implementation for Distances between Labellings in Abstract Argumentation.
Mikolaj Podlaszewski and Yining Wu.

5. Interpreting EEG Signals using Artificial Intelligence.
Felipe Gomez Marualnda, Ann Nowé, Yann-Michael De Hauwere, and Peter Vrancx.

Submission for the SKBS 2014 prize

Since 1999 we have seen many different appearances of the Demo-session. The common characteristic is the emphasis on being "an industrial exhibition", although we have seen some "academic exhibitions" too. Up to 2006 the prize money was provided by SKBS only. The Foundation for Knowledge Based Systems originates from the late 1980s as a foundation within SPIN (Stimulerings Projectteam In Nederland). The Foundation SNN (Stichting Neurale Netwerken) is another well-known member of the former SPIN. SNN supported SKBS financially with augmenting the SKBS prize in 2007. In 2008, the industrial partner Strukton announced its willingness to participate in the prize funding. The extra contribution was gratefully accepted. They continued this policy in 2009, 2010, and 2011. Then they stopped. Since 2011 SNN sponsors the BNAIC by € 500,- for the best paper Award.

In 2014, five submissions were exhibited in the demonstration room for the SKBS prize, next to posters and overview demos of this 26th BNAIC. All five SKBS demos were interesting, but in fact of different type. It was really a pleasure to walk along the different demos and to discuss them with the stand holders. The quality and maturity of presentation, particularly the quality of ideas, ranged from brilliant ideas (two demos) worth to be elaborated upon to full pledged applications (three demos) that will find their place in practice. Adding one more original idea to such an application would make it an immediate contender for the first place. All participants showed enormous enthusiasm for their demo and were willing to tell the whole story: from idea to product.

All in all, the referee committee had a difficult task. The procedure went in shifts: from five we reduced

the number of candidates to three (see above), then to two and finally to one.

The members of the referee committee were invited to score on (a) the AI content, (b) the originality of the submission, (c) scientific orientation, (d) the actual applicability in society and scalability, and (e) the visualisation.

There was a balanced discussion with well chosen arguments which finally led to the following winners:

SKBS Prize Winner 2014

Enhancing Operational Work in Maritime Safety-and-Security Tasks.

Steffen Michels, Marina Velikova, Bas Huijbrechts, Peter Novak, Jesper Hoeksma, Roeland Scheepens, Jan Laarhuis, and André Bonhof.

In the table below we provide an overview of the winners of the SKBS prize so far. Congratulations to the Nijmegen team for the organization of the 26th BNAIC and to the Radboud University team for winning the 2014 SKBS prize.

1999 Maastricht M. van Wezel, J. Sprenger, R. van Stee, and H. La Poutré *Neural Vision 2.0 – Exploratory Data Analysis with Neural Networks*
2000 Kaatsheuvel (shared prize) E. Zopfi *HKTG. Schram LubeSelect*
2001 Amsterdam Alexander Ypma, Rob Kleiman, Jan Valk, and Bob Duin *MINISOM – A System for Machine Health Monitoring with Neural Networks*
2002 Leuven F. Brazier, D. Mobach, and B. Overeinder *AgentScape Demonstration*
2003 Nijmegen Bert Kappen, Wim Wiegerinck, Ender Akay, Marcel Nijman, Jan Neijt, and André van Beek *Promedas: A Diagnostic Decision Support System*
2004 Groningen Wouter Teepe *The Secret Prover: Proving Possession of Arbitrary Files While not Giving Them Away*
2005 Brussels Gerald de Jong *Fluidiom: The Evolution of Locomotion*
2006 Namur Marion Verduijn, Niels Peek, Peter Rosseel, Evert de Jonge, and Bas de Mol *Procarsur: A System for Prognostic Reasoning in Cardiac Surgery*
2007 Utrecht Tim Harbers, Rob van der Veen, Marten den Uyl *Sentient Demonstration BNAIC 07: Vicavision*

2008 Enschede (shared prize)
Joris Maervoet, Patrick De Causmaecker, and Greet Van den Berghe
A Generic Rule Miner for Geographic Data

Dennis Reidsma and Anton Nijholt
Temporal Interaction between an Artificial Orchestra Conductor and Human Musicians

2009 Eindhoven
Tom van Bergen, Maarten Brugmans, Bart Dohmen and Niels Molenaar
Cobes: The clean, safe and hospitable metro

2010 Luxembourg
Willem Burgers, Wim Wiegerinck, and Bert Kappen
Disaster Victim Identification System

2011 Ghent
Wim Vancroonenburg, Jannes Verstichel, Greet Vanden Berghe, and Wouter Souffriau
Efficient aircraft loading: a mixed integer programming approach for the aircraft weight and balance problem

2012 Maastricht
Michel Klein, Nataliya Mogles, and Arlette van Wissen
Demonstration of eMate – Stimulating Behaviour Change via Mobile Phone

2013 Delft
Sjriek Alers, Daniel Claes, Joscha Fossel, Daniel Hennes, and Karl Tuyls.
Applied Robotics: Precision Placement in RoboCup@Work

2014 Nijmegen
Steffen Michels, Marina Velikova, Bas Huijbrechts, Peter Novak, Jesper Hoeksma, Roeland Scheepens, Jan Laarhuis, and André Bonhof.
Enhancing Operational Work in Maritime Safety-and-Security Tasks

PhD Abstracts

Argumentation in Flux

by Tjitze Rienstra

Defense Committee

Chairman : Prof. Dr. Lluis Godo, Institut d'Investigacio en Intelligencia Artificial, Bellaterra, Spain
Vice-chairman : Prof. Dr. Pietro Baroni, Universita degli Studi di Brescia, Italy
Co-Supervisor : Prof. Dr. Leon van der Torre, Université du Luxembourg
Co-Supervisor: Prof. Dr. Souhila Kaci, Université de Montpellier, France
Member: Prof. Dr. Beishui Liao, Zhejiang University, China
Member: Dr. Richard Booth, Université du Luxembourg

Abstract Dung's theory of abstract argumentation is a widely used formalism in the field of artificial intelligence. It is used to model various types of reasoning, by representing conflicting or defeasible information using an argumentation framework, i.e., a set of arguments and an attack relation. Different so called semantics have been proposed in the literature to determine, given an argumentation framework, the justifiable points of view on the acceptability of the arguments. The research in this thesis is motivated by the idea that argumentation is not a static process, and that a better understanding of the fundamentals and applications of the theory of abstract argumentation requires a dynamic perspective. We address this issue from three points of view.

First, we identify and investigate two types of change in argumentation. We call them intervention and observation, due to their similarity to the similarly named types of change in the theory of causal Bayesian networks. While intervention amounts to change due to actions (i.e., bringing new arguments/attacks into play), observation amounts to revision due to new information from the environment. We model these two types of change as two types of inference relations. This allows us to contrast and characterize the behaviour of the two types of change, under a number of different semantics, in terms of properties satisfied by the respective inference relations.

Second, we investigate the relation between abduction in logic programming and change in argumentation. We show that, on the abstract level, changes to an argumentation framework may act as hypotheses to explain an observation. The relation with abduction in logic programming lies in the fact that this abstract model can be instantiated on the basis of an abductive logic program, just like an abstract argumentation framework can be instantiated on the basis of a logic program. We furthermore present dialogical proof theories for the main reasoning problem, i.e., finding hypotheses that explain an observation.

Third, we look at change in preference-based argumentation. Preferences have been introduced in argumentation to encode, for example, relative strength of arguments. An underexposed aspect in these models is change of preferences. We present a dynamic model of preferences in argumentation, based on what we call property-based argumentation frameworks. It is based on Dietrich and List's model of property-based preference and provides an account of how and why preferences in argumentation may change. The idea is that preferences over arguments are derived from preferences over properties of arguments and change as the result of moving to different motivational states. We also provide a dialogical proof theory that establishes whether there exists some motivational state in which an argument is accepted.

What to Bid and When to Stop

by Tim Baarslag

Supervisors
Promotor 1: Prof. dr. C.M. Jonker (EWI)
Copromotor: Dr. K.V. Hindriks (UD-EWI)

Abstract Negotiation is an important activity in human society, and is studied by various disciplines, ranging from economics and game theory, to electronic commerce, social psychology, and artificial intelligence. Traditionally, negotiation is a necessary, but also time-consuming and expensive activity. Therefore, in the last decades there has been a large interest in the automation of negotiation, for example in the setting of e-commerce. This interest is fueled by the promise of automated agents eventually being able to negotiate on behalf of human negotiators. Every year, automated negotiation agents are improving in various ways, and there is now a large body of negotiation strategies available, all with their unique strengths and weaknesses. For example, some agents are able to predict the opponent's preferences very well, while others focus more on having a sophisticated bidding strategy. The problem however, is that there is little incremental improvement in agent design, as the agents are tested in varying negotiation settings, using a diverse set of performance measures. This makes it very difficult to meaningfully compare the agents, let alone their underlying techniques. As a result, we lack a reliable way to pinpoint the most effective components in a negotiating agent. There are two major advantages of distinguishing between the different components of a negotiating agent's strategy: first, it allows the study of the behavior and performance of the components in isolation. For example, it becomes possible to compare the preference learning component of all agents, and to identify the best among them. Second, we can proceed to mix and match different components to create new negotiation strategies., e.g.: replacing the preference learning technique of an agent and then examining whether this makes a difference. Such a procedure enables us to combine the individual components to systematically explore the space of possible negotiation strategies.

New network models for the analysis of disease interaction

by Martijn Lappenschaar

Promotor: Prof. dr. P.J.F. Lucas
Copromotor: Dr. A.J. Hommersom

Manuscriptcommission:
Prof. dr. T. Heskes – Radboud University
Prof. dr. S. Andreassen – Aalborg University
Prof. dr. M.G.M. Olde Rikkert – Radboud University Medical Center

Abstract The epidemiology of multiple chronic diseases present at the same time is referred to as comorbidity or multimorbidity. With the ageing of people multimorbidity becomes the rule rather than the exception, especially for the elderly. The human body is a complex adaptive system and very often we only see a few symptoms as a tip of the iceberg. Current statistical methodologies are not entirely suitable to analyse this phenomena as they often consider only one (primary) disease. In this thesis we

have explored the usefulness of probabilistic network models in the field of multimorbidity. First we asked ourselves the question how interactions between diseases, frequently present with multimorbidity, can be best described. These interactions are often stochastic by nature and it turns out that many of the interactions can be expressed very well by using probabilistic networks, e.g., Bayesian networks. An important achievement of our research is that learning the structure of a network from data can significantly contribute to unravelling the intricate interactions that are hidden in clinical data. Another problem we faced in this research is the fact that much of the clinical data comes from multiple sources, e.g., from multiple general practices that use different kinds of electronic health care systems. This introduces a certain bias, and to be able to deal with such data we introduced a new concept called multilevel Bayesian networks. These networks can deal with any big dataset that is hierarchically structured. We applied them by investigating the simultaneous progression of chronic cardiovascular conditions, correcting for both patient and practice-related variables. Because of the network structure the progression is easier to understand. For example, it turned out that in the presence of hypertension, the observed cumulative incidence rates of combinations of cardiovascular disorders, i.e., multimorbidity, differ significantly from the expected rates. Another aspect is that in many real-life systems, interactions often participate in feedback loops. Here we adopted a qualitative viewpoint to model and understand such feedback loops. Although qualitative reasoning has its limitations, we showed that without knowing exact probabilities, we are still able to draw qualitative conclusions of the dynamics that exist in a system. The ideas in this thesis are certainly generalizable to other areas of scientific research. As an example we briefly discussed a simplified model of the Arctic summer sea-ice decline and its regional effects on the polar bear populations.

Aspects of Record Linkage

by Marijn Schraagen

Promotors: prof.dr. J.N. Kok (UL) and prof.dr. C.A. Mandemakers (UL)
Co-promotor: dr. ir. G. Bloothooft (UL)

Abstract This thesis is an exploration of the subject of historical record linkage. The general goal of historical record linkage is to discover relations between historical entities in a database, for any specific definition of relation, entity and database. Although this task originates from historical research, multiple disciplines are involved. Increasing volumes of data necessitate the use of automated or semi-automated linkage procedures, which is in the domain of computer science. Linkage methodologies depend heavily on the nature of the data itself, often requiring analysis based on onomastics (i.e., the study of person names) or general linguistics. To understand the dynamics of natural language one could be tempted to look at the source of language, i.e., humans, either on the individual cognitive level or as group behaviour. This further increases the multidisciplinarity of the subject by including cognitive psychology. Every discipline addresses a subset of problem aspects, all of which can contribute either to practical solutions for linkage problems or to further insights into the subject matter.

Algorithms for Analyzing and Mining Real-World Graphs

by Frank Takes

Promotor: prof.dr. J.N. Kok (UL)
Co-promotor: dr. W.A. Kosters (UL)

Abstract This thesis focuses on algorithms for analyzing large graphs (also referred to as networks). As opposed to synthetic graphs that are usually the result of applying some mathematical model, real-world graphs are based on data generated by some system, organisation or environment. Examples include (online) social networks, webgraphs, information networks, biological networks and scientific citation networks. Although the graphs studied in this thesis differ in terms of what kind of information the objects and relationships represent, it turns out that the structure of each these networks is surprisingly similar. Characteristic properties include a low density, a power-law degree distribution, low average node-to-node distances and usually one giant component containing the majority of the nodes.

A graph is one of the most fundamental data structures used in computer science, and a wide range of algorithms is available to compute all kinds of properties and measures of graphs. However, the graphs studied in this thesis are typically very large: the number of nodes is easily a few million, and a common number of edges is anywhere between a few million and a billion, which makes it problematic to use various traditional graph algorithms due to their (quadratic or worse) time complexity. For computer scientists, there is an obvious challenge to design efficient algorithms that allow these large graphs to be processed and analyzed in a practical setting. As opposed to using brute-force computation power or parallel systems, in this thesis the characteristic non-random structure of real-world graphs is exploited in order to efficiently compute or approximate various properties and measures of these real-world graphs.

For example, the node-to-node distance, which is traditionally computed using Dijkstra's shortest path algorithm (or Breadth First Search in an unweighted graph), can efficiently be approximated with high accuracy using a small set of carefully chosen landmarks for which the distances are precomputed. Another example is computing the exact diameter (longest shortest path length) of a graph, which would normally require a run of an All Pairs Shortest Path algorithm to find the largest distance over all node pairs. This work introduces an efficient exact algorithm based on lower and upper bounds that only assesses a particular subset nodes in order to obtain tight bounds on the value of the diameter, allowing it to be computed with only a handful of Breadth First Searches, whereas normally each node would have to examined. Using a similar technique, exact algorithms for computing the radius, center and periphery of a graph are suggested. The thesis furthermore includes a case study of a large (former) dutch online social network in the context of network centrality measures, as well as an analysis of patterns found in paths generated by humans traversing the network of linked Wikipedia pages.

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