



ESF EUROCORES Programme

Modelling Intelligent Interaction (LogICCC)

Logic in the Humanities, Social and
Computational Sciences

A Retrospective

European Science Foundation (ESF)

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EUROCORES (European Collaborative Research)

The European Collaborative Research (EUROCORES) Scheme enables researchers in different European countries to develop collaboration and scientific synergy in areas where international scale and scope are required for top class science in a global context.

The scheme provides a flexible framework for national basic research funding and performing organisations to join forces in supporting forefront European research in and across all scientific areas.

Until the end of 2008, scientific coordination and networking was funded through the EC FP6 Programme, under contract no. ERASCT- 2003-980409. As of 2009, the national organisations support all aspects including scientific coordination, networking and research funding.

Editors

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www.esf.org/logic

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1.

Introduction



The ESF EUROCORES Programme LogICCC ('Logic in the Humanities, Social and Computational Sciences') has reached the end of its exciting three-year run. The facts and figures in this retrospective tell an impressive story of what was achieved on the way, in terms of new results and events. That story really speaks for itself but, as one of the 'founding fathers', I am happy for this chance to add a few words. Creating the LogICCC programme was a highly rewarding Europe-wide adventure in forging a coalition of congenial researchers of high quality across our continent, all sharing the same vision of new avenues for logic toward a fundamental study of intelligent interaction. This perspective places logic in its rightful intellectual position, at an academic crossroads of the university between the sciences, humanities and social sciences.

Many meetings, letters and dinners later, that vision also convinced many national funding agencies to make the strategic investment that made the actual LogICCC projects which you see in this retrospective possible. These projects reflect major strands in intelligent interaction, from language use and dialogue to 'social software' for public choice or elections. They run from the mathematical foundations of the ubiquitous notion of dependency to innovative computational methods for creating social systems, and the reasoning styles that they analyse range from causal inference to approximative reasoning and exploiting vagueness. In their entirety, these projects have created the contours of a new logic of interaction. In addition, the legacy of this programme is the existence of a European network of outward-looking young (and not so young) researchers, as

well as a platform for launching future strategic initiatives.

It has been said that Europe is more a state of mind than a restricted geographical entity. The LogICCC programme has organised some noteworthy outreach events toward colleagues and students in other continents, including 'LogICCC Meets China' and 'LogICCC Meets India'. The idea of logic and intelligent interaction clearly resonated in several follow-up initiatives.

There are still many scientific challenges ahead for understanding the full richness of the logic of interaction, and we may be seeing new interfaces emerge between the fields represented in this programme, such as a 'theory of play' in between logic and game theory, as well as outreach to the cognitive sciences. But personally I would hope that we are also talking about eventual effects on society, and the rationality and reasonableness (not necessarily the same features...) of public discourse, argumentation and decision making. I am convinced that logic, properly understood, should have a role to play here, and more than that: a role to the good.

Does all this mean that a strategic follow-up to LogICCC should aim for some eventual grand scientific merge of all fields involved, perhaps even throwing society into the mix? I do not think so. I rather think that the success of this programme had to do with something much more delicate and dynamic: fostering interaction while preserving diversity between disciplines. And when all is said and done, that is a dynamic balance much like what the European Union itself is trying to achieve

at cultural and social levels. It is therefore entirely fitting that the European Science Foundation has been the prime mover and facilitator of this programme, since it combines a light touch with high-quality impact. Our scientific community owes a lot to ‘Strasbourg’, and it is a pleasure to acknowledge that debt on a festive occasion like this.



Professor Johan van Benthem

Institute for Logic, Language & Computation (ILLC), University of Amsterdam, The Netherlands

One of the proponents of the original LogICCC research programme

The proposal for a EUROCORES Programme on Logical Modelling in Interaction, Communication, Cognition and Computation (LogICCC) was submitted to the ESF in 2006 by the following scientists:

Professor Samson Abramsky
Computing Laboratory, Division of Mathematical, Physical and Life Sciences, Oxford University, United Kingdom

Professor Luigia Aiello
Dipartimento di Informatica e Sistemistica, Università di Roma ‘La Sapienza’, Italy

Professor Nicholas Asher
Institut de Recherche en Informatique de Toulouse, Université Paul Sabatier, France

Professor Johan van Benthem
Institute for Logic, Language and Computation, University of Amsterdam, the Netherlands

Professor Dov Gabbay
Group of Logic, Language and Computation, Department of Computer Science, King’s College London, United Kingdom

Professor Peter Gärdenfors
Department of Cognitive Science, Lund University, Sweden

Professor Erich Grädel
Mathematische Grundlagen der Informatik, RWTH Aachen University, Germany

Professor Jesus Larrazabal
Institute for Logic, Cognition, Language and Information (ILCLI), Universidad del Pais Vasco, Spain

Professor Jaroslav Peregrin
Institute of Philosophy, Academy of Sciences, Czech Republic

Professor Hans Rott
Institut für Philosophie, Universität Regensburg, Germany

Professor Gabriel Sandu
IHPST, Université Paris I, France

Professor Dag Westerståhl
Department of Philosophy, Linguistics and Theory of Science, Gothenburg University, Sweden

2.

Programme Description



Recent decades have seen major changes in the field of logic. Moving far beyond the traditional emphasis on philosophical argument, formal grammar or mathematical proof, modern logic has become a much richer interdisciplinary which transcends the usual borderlines between academic ‘cultures’.

The goal of the LogICCC programme was to stimulate and coordinate research projects aiming towards:

- Finding a common view of the key structures and phenomena in intelligent interaction between humans, as embedded in their physical environment;
- Creating unifying logical frameworks that function across all disciplines concerned with information flow and rational goal-directed behaviour;
- Understanding - and eventually improving - existing social mechanisms and behaviour, including their links with new computational advances.

The LogICCC programme worked towards the above goals under four headings – whence the **ICCC**:

- Interaction
- Communication
- Computation
- Cognition

Interaction

Human interaction and social procedures has been an active field of research for many years in the social sciences, including issues of conflict resolution, comparative justice or optimal organisation. Researchers in quite different fields have noticed that the same issues of aggregation of individual judgments, actions or preferences which make a collective judgment, action or preference appear all over, from modern multi-agent computer systems to understanding language and reasoning. Notions from game theory like strategy and equilibrium have already proven useful for a common understanding of these phenomena and have led to a new research cluster bringing together game-theorists, computer scientists and social scientists. At the launch of the EUROCORES Programme LogICCC, the time seemed ripe for adding a logical fine-structure dimension to these. LogICCC worked towards producing a unified logical model of interaction which spanned these disciplines.

Communication

One particular area where interaction is crucial to intelligent behaviour is natural language and communication. LogICCC aimed at stimulating research which was focused towards a better understanding of the actual use of natural language and the ensuing activities of interpretation, information transfer and conversation planning between speakers and listeners, writers and readers. Emphasis was put on the logical modelling of the processes of communication, and the learning processes underneath it, as well as the way they determine how syntactic and semantic conventions arise, and how more fine-grained forms of information (and misinformation!) emerge in a social, interactive setting.

LogICCC linked the various disciplines which hold crucial ingredients of the total model that is needed.

Computation

A significant trend in modern computer science has been the emergence of ‘computation with a human slant’: modern computational models involve many interacting agents and the relevant issues of efficient computation are looking more and more like issues of rational human behaviour. This interactive aspect extends all the way from the modern internet to new paradigms like quantum computing, where the interaction between physical systems and agents measuring them is essential. We are now seeing the emergence of logic-inspired models of computation doing justice to this richer setting, and putting them side by side with human-oriented models has great promise. Some researchers even believe that efficient computation is very much like successful conversation. LogICCC included projects which developed this ‘informatics’ as a new fundamental science of information flow and interaction, and helped link it to other disciplines.

Cognition

Originally aiming at identifying ‘correct’ inferences, logical models nowadays account for computational resource bounds, brain architecture and other empirical constraints coming from cognitive science. LogICCC aimed at bringing together researchers interested in this psychological turn in logic, and relating it to parallel developments elsewhere. One crucial issue here is links between a high-level description of cognitive agents (logical reasoning, propositional attitudes, preferences, belief revision) with low-level empirical studies on brain architecture, sub-symbolic processes, etc. This linkage is leading to more efficient systems for reasoning and decision making which reflect the actual inference, learning, representation and performance of humans. To study this whole chain we need insights ranging from cognitive neuroscience all the way to linguistics and philosophy.

A full analysis of these issues requires a common language and a framework which makes major structures visible across the humanities, social, computational and cognitive sciences and integrates them into comprehensive systems. Logic has played this role in the past for the foundation of the sciences, computation and the semantics of natural languages. The LogICCC programme was based on the firm conviction that present-day logic will continue to play this role in the much broader setting described here. Whether this conviction has been

proven right, and to what extent the LogICCC projects have contributed to its fulfilment, is something you are about to find out in the present brochure.

About this retrospective

This retrospective offers an overview of all aspects of the EUROCORES Programme LogICCC. You will find details of all of the eight Collaborative Research Projects (CRPs) including their constituent Project Leaders, Principal Investigators, Project Members and Associated Partners, not to mention the various national funding agencies which financially supported the projects. Each of the CRPs also describes the scientific highlights of their projects, including some of the most important outcomes and results of their work. In addition to this, the retrospective contains some personal reflections on the programme from some Project Members. These testimonials offer a window into the heart of the various projects and, when combined with the other information, add a distinctive fingerprint to LogICCC.

The members of LogICCC were extremely active in organising inter-CRP activities. As the Review Panel concluded in their mid-term evaluation:

“The investigators are making excellent use of the opportunities provided by the LogICCC programme: networking, training, cross-disciplinary collaboration, pooling of various types of expertise and integration of different methodologies make this an excellent example of what a EUROCORES programme can achieve.”

The retrospective provides brief descriptions of these activities, allowing us a good glimpse of the considerable amount of work that went into making LogICCC such a success.

In all, this retrospective is intended to help disseminate and, indeed, celebrate the significant achievements of the LogICCC programme. Whether you are part of LogICCC or not, we hope that you find the following pages both interesting and informative.

3.

Facts and Figures



Following agreement with 18 funding organisations in Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Israel, the Netherlands, Portugal, Romania, Spain, Sweden and Turkey, the European Science Foundation launched the LogICCC Call for Outline Proposals in March 2007.

At the time of the deadline, 11 May 2007, the Call had attracted 34 outline proposals, with 157 individual projects and 46 projects with associate status. On the basis of the criteria published in the Call, the Review Panel (for their composition, see Section 6) selected 16 proposals to be invited to submit a full proposal. Out of these, a total of 8 proposals have been funded, with 29 individual projects and 19 associated partners from across 17 different countries. The launch conference in Prague, from 5-7 October 2008, marked the formal start of the programme. The programme runs for three years and formally comes to an end at the final conference, in September 2011.

The following 13 national funding organisations supported the 29 individual projects in the EUROCORES Programme LogICCC: *Academy of Finland* (AKA), *Academy of Sciences of the Czech Republic* (GAČR), *Austrian Science Fund* (FWF), *Danish Agency for Science, Technology and Innovation* (FIST), *Deutsche Forschungsgemeinschaft* (DFG), *Israel Science Foundation* (ISF), *Fund for Scientific Research* (FNRS), *The Netherlands Organisation for Scientific Research* (NWO), *Foundation for Science and Technology* (FCT), *Interministerial Commission of Science and Technology* (CICYT), *Swedish Research Council* (VR), *Croatian Science Foundation* (HRZZ), *The Scientific and Technological Research Council of Turkey* (TÜBITAK).

The total research budget for the LogICCC programme exceeded 6 M€. The following graphic analyses the proportion of the research budget allocated by the national funding organisations to the LogICCC projects in the context of the general research budget (see Figure 1).

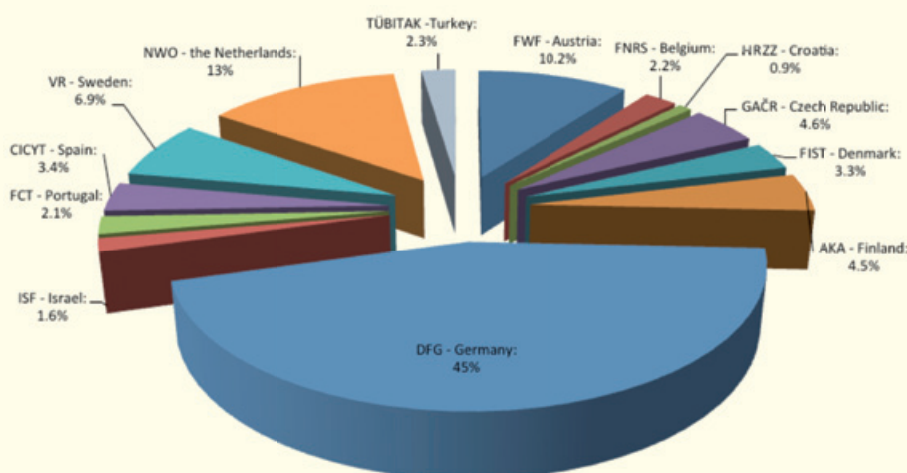


Figure 1:
The percentile distribution of funding for LogICCC's general research budget per national funding agency

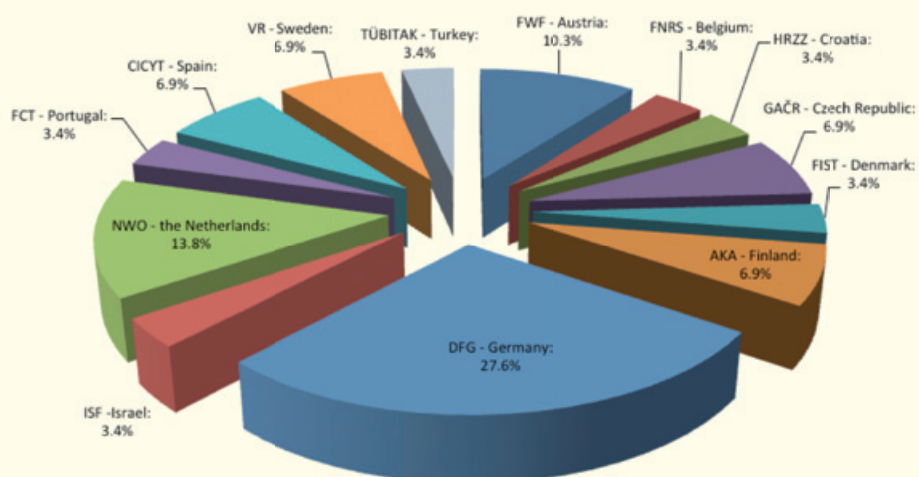


Figure 2:
The percentile distribution of funding for LogICCC's cross-CRP budget per national funding agency

In addition to the research budget, the supporting national funding organisations also covered the costs for the cross-CRP activities. These activities – be it networking, training or dissemination activities – are intended to enhance the cooperation between the various LogICCC Collaborative Research Projects (CRPs) and to sustain the coherence of the programme. They also aim to deepen the impact of the research and to strengthen the field. More on these cross-CRP activities can be found in Section 5. For the cross-CRP activities, a budget of 287 k€ was available. Figure 2 analyses the proportion of networking budget allocated by the 13 supporting national funding organisations.

4.

Overview and Highlights of the Collaborative Research Projects



The EUROCORES Programme LogICCC is constituted by eight CRPs: large, international Collaborative Research Projects with partners in at least three different European countries. This chapter presents an overview of the eight CRPs and highlights some of their most important contributions to the LogICCC programme.

4.1 Computational Foundations of Social Choice (CFSC)

CFSC addresses some of the key issues in computational social choice, an interdisciplinary field of study at the interface of social choice theory and computer science. It aims at deepening our understanding of algorithmic and complexity-theoretic issues in social choice, at developing logic-based languages for modelling and reasoning about choice problems and preference structures, and at applying established techniques from AI, such as preference elicitation and learning, to problems of collective decision making.

Funding Organisations:

- Deutsche Forschungsgemeinschaft (DFG), Germany
- Israel Science Foundation (ISF), Israel
- Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO), the Netherlands
- Türkiye Bilimsel ve Teknolojik Arastırma Kurumu (TÜBİTAK), Turkey

Project Leader:

- Professor Felix Brandt, Technische Universität München, Germany

Principal Investigators:

- Professor Ulle Endriss, University of Amsterdam, the Netherlands
- Professor Jeffrey Rosenschein, The Hebrew University of Jerusalem, Israel
- Professor Jörg Rothe, Heinrich-Heine-Universität Düsseldorf, Germany
- Professor Remzi Sanver, Bilgi University, Istanbul, Turkey

Associated Partners:

- Professor Vincent Conitzer, Duke University, Durham, United States
- Professor Edith Elkind, Nanyang Technological University, Singapore
- Professor Edith Hemaspaandra, Rochester Institute of Technology, United States
- Professor Lane Hemaspaandra, University of Rochester, United States



Professor Brandt presents the CFSC CRP at the Launch Conference
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- Professor Jérôme Lang, Université Paris 9 Dauphine, Paris, France
- Professor Jean Francois Laslier, École Polytechnique, CNRS, Paris, France
- Professor Nicolas Maudet, Université Paris 9 Dauphine, Paris, France

Project Members funded under CRP budget:

- Mr Markus Brill, PhD student, funded as part of Professor Brandt's team
- Dr Haris Aziz, postdoctoral researcher, funded as part of Professor Brandt's team
- Ms Pelin Pasin, PhD student, funded as part of Professor Sanver's team
- Mr Bora Evci, Master's Degree student, funded as part of Professor Sanver's team
- Mr Murat Ozturk, Master's Degree student, funded as part of Professor Sanver's team
- Ms Dorothea Baumeister, PhD student, funded as part of Professor Rothe's team
- Ms Claudia Lindner, PhD student, funded as part of Professor Rothe's team
- Dr Gabor Erdelyi, postdoctoral researcher, funded as part of Professor Rothe's team
- Ms Lena Piras, PhD student, funded as part of Professor Rothe's team
- Mr Aviv Zohar, PhD student, funded as part of Professor Rosenheim's team
- Mr Reshef Meir, PhD student, funded as part of Professor Rosenheim's team
- Mr Michael Zuckerman, PhD student, funded as part of Professor Rosenheim's team
- Dr Daniele Porello, postdoctoral researcher, funded as part of Professor Endriss's team

Project Members with funding from outside CRP budget:

- Mr Felix Fischer, PhD student, a member of Professor Brandt's team
- Dr Paul Harrenstein, postdoctoral researcher, a member of Professor Brandt's team
- Mr Hans Georg Seedig, PhD student, a member of Professor Brandt's team
- Mr Mingyu Guo, PhD student, a member of Professor Conitzer's team
- Mr Lirong Xia, PhD student, a member of Professor Conitzer's team
- Professor Ipek Ozkal-Sanver, collaborative partner of Professor Sanver's team
- Professor Goksel Asan, collaborative partner of Professor Sanver's team
- Mr Magnus Roos, PhD student, a member of Professor Rothe's team
- Mr Thanh Nguyen Trung, PhD student, a member of Professor Rothe's team
- Dr Frank Gurski, postdoctoral researcher, a member of Professor Rothe's team
- Ms Anja Rey, Master's Degree student, a member of Professor Rothe's team

Scientific Highlights:

This collaborative research project addressed key issues in computational social choice, an interdisciplinary field of study at the interface of social choice theory and computer science. Computational social choice is concerned with the application of computational techniques to the study of social choice mechanisms, such as voting rules and fair division protocols, and with the integration of social choice paradigms into computing. The project combined the expertise of some of the most active researchers in the field, who have worked on different aspects of computational social choice in the past, and who have come to this area from very different backgrounds: theoretical computer science, artificial intelligence, logic, economics and political science.

The Amsterdam group studied applications of logic in a number of areas in social choice theory. One strand of work concerns the first computational study of the framework of judgment aggregation, which deals with the aggregation of propositions expressed in a logical language. We have established the computational complexity of problems such as computing the collective judgment, of manipulating a judgment aggregation procedure, and of checking whether consistency of the outcome can be guaranteed for a given set of propositions. A second



Some members of the CFSC team at the Dagstuhl seminar on 'Computational Foundations of Social Choice' (March 2010)
 From left to right: Professor Ulle Endriss, Professor Nicholas Maudet, Professor Edith Hemaspaandra, Professor Edith Elkind, Professor Lane Hemaspaandra, Professor Felix Brandt, Professor Remzi Sanver, Professor Jörg Rothe, Professor Jean-Francois Laslier (bottom right). Missing from the photo: Professor Vincent Conitzer, Professor Jerome Lang and Professor Jeff Rosenschein.
 Photo courtesy of Felix Brandt

line of work concerns the modelling of preferences using logic-based languages. In cooperation with the group at LAMSADE, we have investigated the properties of the framework of weighted goals for preference representation in great detail. We have also extended this framework using the tools of linear logic to allow for a better modelling of domains exhibiting multiplicity of items. This has applications in fair division and combinatorial auctions.

The group in Jerusalem investigated the problem of coalitional manipulation in elections; we put forward efficient algorithms for the problem in Borda, maximin and plurality with runoff voting, and analysed their windows of error. Specifically, given an instance in which an algorithm fails, we bounded the additional power the manipulators need in order to succeed. In other work, we investigated the possibility of stabilising a coalitional game by using external payments (the minimal necessary such payments is called ‘the cost of stability’). We proved general bounds on the cost of stability in several classes of games and provided a detailed algorithmic study of the cost of stability in weighted voting games. We also extended our model and results to games with coalition structures.

The Düsseldorf group studied the computational complexity of control, manipulation and bribery in a variety of models. Among the main achievements are the identification of natural voting rules (namely, Bucklin, fallback voting and sincere-strategy preference-based approval voting) whose winners can be identified in polynomial time, but that have the broadest computational control resistance currently known to hold. In addition, the complexity issues regarding control, bribery and microbribery have been completely settled for the entire family of Llull/Copeland voting rules. For single-peaked electorates in a variety of voting rules, we showed that complexity shields for manipulation and control may evaporate, stay in place or can even be erected, depending on the given scenario. Other topics studied in Düsseldorf include cake-cutting algorithms, probabilistic lobbying and the complexity of some variants of the possible winner problem.

The group in Munich investigated the axiomatics and computational aspects of concepts and voting rules that are based on pairwise majority comparisons. We proposed a systematic methodology for defining such concepts using the notions of qualified subsets, von Neumann-Morgenstern stable sets and Schwartz retentive sets, and studied their relationship to rationalisability and strategy-proofness. On the computational side, we obtained preprocessing techniques via modular decomposi-

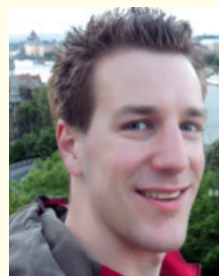
tion, intractability results, efficient algorithms and heuristics in this context. Particularly noteworthy is an NP-hardness proof of computing the tournament equilibrium sets as well as some progress towards solving an important conjecture associated with this concept.

During the course of this project, Professors Jean-Francois Laslier and Remzi Sanver finalised the edition of the *Handbook on Approval Voting* (published by Springer) with several chapters written by one or more project members. A special workshop, attended by researchers inside and outside the project, was organised in Palaiseau (France) on the occasion of the book’s release.

Members of the project consortium also organised a Dagstuhl seminar on ‘Computational Foundations of Social Choice’ (March 2010), two international workshops on Computational Social Choice (September 2008 and September 2010) and an IJCAI workshop on Social Choice and Artificial Intelligence (July 2011), and edited three special issues of international journals on computational social choice.

Personal Reflection:

Mr Markus Brill



“I started my PhD in computer science in October 2008, at the same time the LogICCC programme was launched. This I had the privilege to work in a stimulating international environment right from the beginning.

The programme enabled me to attend several conferences and to meet various people working in my area and related fields. To name just two examples: I greatly benefited from the collaboration with Professors Edith and Lane Hemaspaandra, who visited our group in Munich for several weeks in the summer of 2009. And this summer I’m going to visit the economics group of Professor Jean-François Laslier in Paris, who I met for the first time at the LogICCC launch conference in Prague. Last but not least, the interactions with other projects opened up new perspectives. For instance, I have fond memories of an entertaining talk about medieval dialogues at the MIDiSoVa workshop in Amsterdam.”

Selected List of CRP Publications:

- 1) Baumeister, D., Brandt, F., Fischer, F., Hoffmann, J. and Rothe, J. (2010) The complexity of computing minimal unidirectional covering sets. In: *Proceedings of the Seventh International Conference on Algorithms and Complexity (CIAC), Lecture Notes in Computer Science (LNCS)* 6078, 299–310. Springer-Verlag.
- 2) Faliszewski, P., Hemaspaandra, E., Hemaspaandra, L. and Rothe, J. (2011) The Shield that Never Was: Societies with Single-Peaked Preferences are More Open to Manipulation and Control. *Information and Computation* 209(2), 89–107. (Preliminary version presented at TARK 2009.)
- 3) Laslier, J.-F. and Sanver, M.R. (Eds) (2010) *Handbook on Approval Voting*. Springer-Verlag, Heidelberg, 481 pp. (Contains a chapter on ‘Computational Aspects of Approval Voting’ by D. Baumeister, G. Erdelyi, E. Hemaspaandra, L. Hemaspaandra and J. Rothe and a chapter on ‘Approval as an Intrinsic Part of Preference’ by M.R. Sanver.)
- 4) Uckelman, J., Chevaleyre, Y., Endriss, U. and Lang, J. (2009) Representing Utility Functions via Weighted Goals. *Mathematical Logic Quarterly* 55(4), 341–361.
- 5) Xia, L., Zuckerman, M., Procaccia, A.D., Conitzer, V. and Rosenschein, J.S. (2009) Complexity of Unweighted Coalitional Manipulation Under Some Common Voting Rules. In: *Proceedings of the Twenty-First International Joint Conference on Artificial Intelligence (IJCAI 2009)*, pp 348–353.

Further information:

<http://www.tcs.ifi.lmu.de/~brandtf/cfsc.html>

4.2 Dialogical Foundations of Semantics (DiFoS)

Incorporating interaction and dialogue into logical semantics promises to overcome certain shortcomings of more traditional static approaches. The DiFoS project aims to assess the foundational value of dialogue semantics and examine its potential to lay the foundations for logical reasoning in mathematics, computer science and linguistics. It compares dialogical and game-theoretical semantics with inferentialist approaches, and also investigates the historical roots of dialogues in logic, especially within medieval theories of *obligationes*.

Funding Organisations:

- Deutsche Forschungsgemeinschaft (DFG), Germany
- Fundação para a Ciência e a Tecnologia (FCT), Portugal
- Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO), the Netherlands

Project Leader:

- Professor Peter Schroeder-Heister, University of Tübingen, Germany

Principal Investigators:

- Professor Reinhard Kahle, Universidade Nova de Lisboa, Caparica, Portugal
- Professor Benedikt Löwe, University of Amsterdam, the Netherlands

Project Members funded under CRP budget:

- Dr Sara L. Uckelman, postdoctoral researcher, funded as part of Professor Löwe’s team
- Dr Luca Tranchini, postdoctoral researcher, funded as part of Professor Schroeder-Heister’s team
- Dr Bartosz Wieckowski, postdoctoral researcher, funded as part of Professor Schroeder-Heister’s team
- Dr Jesse Alama, postdoctoral researcher, funded as part of Professor Kahle’s team
- Mr René Gazzari, Diploma student, funded as part of Professor Kahle’s team

Project Members with funding from outside CRP budget:

- Dr Catarina Dutilh Novaes, research collaboration with Professor Löwe’s team
- Mr Thomas Piecha, PhD student, a member of Professor Schroeder-Heister’s team
- Dr Gregory Wheeler, postdoctoral researcher, a member of Professor Kahle’s team

Scientific Highlights:

One of the distinguishing features of the DiFoS project is the combination of technical, philosophical and historical work. The work focused on two main research lines that have been interactively developed in parallel: on the one hand, the relation of traditional – especially medieval – dialectical practices and modern dialogical conceptions of semantics; on the other, the comparison of the modern dialogical approach with other related ones, particularly on the proof-theoretic side.

A main subject of the Amsterdam node was the relationship between the medieval tradition of *obligationes* and modern dialogical logic. Here Dr Uckelman provided a framework for the comparison of these traditions in order to answer the question: *obligationes* and modern dialogical logic are distinct and unrelated formal approaches to logic, despite the game-theoretic flavour that they both share.

The comparison between the Western historical tradition of dialogue-based logical analysis and modern dialogical logic naturally led to a question that was not originally foreseen in the project proposal, but turned out to be extremely fruitful: how many of the techniques used for the comparison of *obligationes* and modern dialogical logic can be used to analyse historical dialogical traditions of other cultures. The project ‘Dynamic and Dialogical Approaches to Historical Logic (DDAHL)’ was developed in the Amsterdam node of the CRP and provided a red thread in the research activity, applying the techniques in particular to the Indian dialogical tradition. The cross-CRP event ‘Dialogues and Games’ in Lille (February 2010) was one of the first events in a series of meetings dealing with these issues. The formal reconstruction techniques used in DiFoS can also be used in fields other than historical traditions of logic. Professor Löwe has successfully applied them in the formalisation of narratives.

On the proof-theoretic side, which was essentially the topic of the Lisbon and Tübingen nodes, the main objective of the CRP was the relationship between proof-theoretic and dialogical/game-theoretic approaches to semantics.

a) The structural relations between dialogues and sequent calculus have been studied in terms of a format which presents dialogues and winning strategies in sequent-style. This format helps to adapt methods from proof theory and also to import ideas from dialogues into proof theory. The proof-theoretic treatment of definitional reflection,

which is a universal approach to deal with inferential definitions of logical and non-logical constants, has been carried over to the dialogical framework. A completeness result for the intuitionistic sequent calculus with complex initial sequents in relation to the corresponding dialogical system for intuitionistic logic has been established, and the dialogical system has been extended by a certain argumentation form for definitional reasoning. The special case of semantical paradoxes, which feature prominently in philosophical theory, was analysed as a test case for the dialogical approach in comparison with the proof-theoretic treatment. The dialogical approach to semantics is grounded on the idea of a basic symmetry represented by the opposite roles played by the two agents engaged in a dialogue. The possibility of displaying such a duality also in the proof-theoretic approach has been thoroughly investigated. Although it is possible to ‘dualise’ the basic proof-theoretic notions by introducing refutations alongside with proofs, it is doubtful that a full analogy with the dialogical setting can be achieved.

b) In relation to this point, the conception of implications as rules, which lies at the heart of computational approaches to implication, was investigated in the dialogical setting. An alternative framework was developed, which diverges from the standard symmetric treatment of implication. A precise comparison of proof-theoretic and dialogical semantics of implications as rules showed that the asymmetry in deductive reasoning, which is the distinguishing feature of the proof-theoretic approach, cannot be given up completely when switching to the dialogue-theoretic approach, which is inherently more symmetric.

c) The comparison of different semantic frameworks has been extended to comprise also the more traditional truth-theoretic approach. The idea of two layers in the structure of a semantic theory (tentatively referred to as ‘categorical’ and ‘hypothetical’ or ‘functional’) naturally applies to the dialogical setting. Here, an analogous distinction takes place between the level of play (i.e., of a single dialogue) and of strategy (i.e., of all possible dialogues with respect to a certain proposition). The choice of which of the two layers is to be assigned priority seems to be critical for the architecture of a semantic theory. The work carried out provides a general pattern of analysis that could be fruitfully applied to other frameworks as well.

These three intertwined issues were presented and discussed at the cross-CRP workshop on ‘Proof and Dialogues’ in February 2011 in Tübingen, which was the first conference ever explicitly devoted to

the relation between dialogical and proof-theoretic semantics. Compared to what was envisaged in the original application, the results of the Tübingen and Lisbon groups exhibit a more fine-grained and sophisticated picture of the two approaches. Although certain conceptual distinctions are indeed available in both frameworks, the dialogical framework can more successfully cope with phenomena involving some kind of symmetry, such as negation, whereas the proof-theoretic approach reveals all its power in describing asymmetric features of reasoning, such as implication-like operators.

Personal Reflection:

Dr Sara L. Uckelman



“Working in the DiFoS project provided me with an excellent opportunity to combine my philosophical and historical interests in medieval logic with my technical and mathematical research in dialogue logic and formal dialogue systems. In addition to being able to share my work with a wide audience, I have also benefited from collaborations working in a variety of traditions, including multiple visits to Lisbon to work with a colleague at the Center for Artificial Intelligence, as well as a cross-CRP trip to Vienna to work with more computer scientists. DiFoS has also been a spring-board for projects I would otherwise probably not have gotten involved in, including the development of the research network Dynamic and Dialogical Approaches to Historical Logic (DDAHL), whose members have, since fall 2009, been involved in a number of workshops related to medieval Indian logic and philosophy.”

Selected List of CRP Publications:

- 1) Alama, J., Knoks, A. and Uckelman, S.L. Dialogue games for classical logic (short paper), to appear in the proceedings of *TABLEAUX 2011*.
- 2) Alama, J. and Uckelman, S.L. What is dialogical about dialogical logic?, submitted.
- 3) Piecha, T. and Schroeder-Heister, P. Implications as rules in dialogical semantics, to appear in *The Logica Yearbook 2011*.
- 4) Schroeder-Heister, P. (2011) Proof-theoretic semantics. *The Stanford Encyclopedia of Philosophy*.

- 5) Uckelman, S.L. (2011) Obligations as formal dialogue systems. In: T. Ågotnes (Ed.) *STAIRS 2010: Proceedings of the Fifth Starting AI Researchers' Symposium*, IOS Press, pp 341-353.

Further information:

<http://www-ls.informatik.uni-tuebingen.de/difos/>

4.3 Games for Analysis and Synthesis of Interactive Computational Systems (GASICS)

This project studies game theoretic formalisations of interactive complex computational systems and algorithms for their analysis and synthesis. Our goal is to overcome the limitations of the existing notions of games played on graphs introduced by computer scientists, most of them being of the kind ‘two players-zero sum’. We aim to extend them to ‘multiple players-non zero sum’ games, and show the applicability of the new theory to the analysis and synthesis of interactive computational systems.

Funding Organisations:

- Deutsche Forschungsgemeinschaft (DFG), Germany
- Forsknings – og Innovationsstyrelsen (FIST), Denmark
- Fonds de la Recherche Scientifique (FNRS), Belgium

Project Leader:

- Professor Jean-François Raskin, Université Libre de Bruxelles, Belgium

Principal Investigators:

- Professor Wolfgang Thomas, RWTH Aachen University, Germany
- Professor Kim Larsen, Aalborg University, Denmark

Associated Partners:

- Professor Marcin Jurdzinski, University of Warwick, United Kingdom
- Professor Jean Eric Pin / Professor Olivier Serre, Université Paris Diderot-Paris 7, France
- Dr Nicolas Markey, LSV, École Normale Supérieure, Cachan, France

Project Members funded under CRP budget:

- Dr Emmanuel Filiot, postdoctoral researcher, funded as part of Professor Raskin’s team
- Dr Olivier Gauin, postdoctoral researcher, funded as part of Professor Raskin’s team

- Mr Martin Zimmermann, PhD student, funded as part of Professor Thomas's team
- Mr Jörg Olschewski, PhD student, funded as part of Professor Thomas's team
- Mr Roman Rabinovich, PhD student, funded as part of Professor Thomas's team
- Ms Line Juhl, PhD student, funded as part of Professor Larsen's team
- Mr Mikkel Pedersen, PhD student, funded as part of Professor Larsen's team
- Professor Alexandre David, funded as part of Professor Larsen's team

Project Members with funding from outside CRP budget:

- Professor Ranko Lazic, collaborative partner of Professor Jurdzinski's team
- Mr Michal Rutkowski, PhD student, a member of Professor Jurdzinski's team
- Mr John Fearnley, PhD student, a member of Professor Jurdzinski's team
- Professor Véronique Bruyère, collaborative partner of Professor Raskin's team
- Professor Thomas Brihaye, collaborative partner of Professor Raskin's team
- Ms Julie De Pril, PhD student, a member of Professor Raskin's team
- Mr Marc Ducobu, PhD student, a member of Professor Raskin's team
- Dr Laurent Doyen, postdoctoral researcher, a member of Professor Raskin's team
- Mr Frédéric Servais, PhD student, a member of Professor Raskin's team
- Mr Nicolas Maquet, PhD student, a member of Professor Raskin's team
- Dr Christof Löding, collaborative partner of Professor Thomas's team
- Mr Wladimir Fridman, PhD student, a member of Professor Thomas's team
- Mr Frank Radmacher, PhD student, a member of Professor Thomas's team
- Michael Holtmann, PhD student, a member of Professor Thomas's team

Scientific Highlights:

To illustrate the scientific contributions obtained in the GASICS project, we give several examples of concrete progress in the four main topics structuring the project:

Multi-player non-zero sum games:

The notion of Nash equilibrium has been studied for multi-player non-zero sum games played on graphs, both for Boolean objectives and for quantitative objectives. The existence of Nash equilibria has been proven in the two cases and computational complexity questions have been settled. Variants like secure equilibria or subgame perfect equilibria have also been studied.

Quantitative games:

Quantitative games played on weighted graphs are important mathematical models for synthesis of optimal or Pareto optimal controllers. In the project, progress has been made on this important topic. For example, we have improved existing algorithms for solving mean-payoff games. We have also extended mean-payoff and energy games from the one-dimensional case to the multi-dimensional case.

Games with imperfect information:

When modelling reactive systems made of several components, we need to explicitly take into account that each component has a partial view of the system in which it operates. This partial view leads to imperfect information, e.g., in a multi-process system a process does not have access to the private variables of other processes. Games of imperfect information are usually more expensive from a computational complexity point of view. We have developed a new symbolic data-structure to efficiently handle state spaces underlying the analysis of games with imperfect information. This new data-structure, based on the notion of 'antichain', has several other applications in the field of automata theory.

Implementation and heuristics:

To evaluate the possibility of tool-based automatic synthesis of reactive systems using game theory, we have started the implementation of tools for synthesis. In particular, we have implemented a tool for solving timed games. This tool is a variant of the tool set UppAal which has been developed in Aalborg (PI2). The UppAal-Tiga allows for the modelling of a timed game using a product of timed automata and it is able to decide if the controller has a winning strategy in the timed game. If it is the case, the tool allows the user to extract a winning strategy that can then be turned into a programme.

Personal Reflection:

Dr Emmanuel Filiot



“After a PhD centred on formal models for XML documents and databases (Lille, 2008), I joined the GASICS project as a postdoctoral researcher in 2009 (Université Libre de Bruxelles). Although there were some connections between my PhD topics and the GASICS project (tree automata for example), I was not familiar with all the concepts of computational game theory. The GASICS project and its bi-annual project meetings were a wonderful opportunity for me to learn fast and to integrate into a new community. Being part of GASICS was a great opportunity to get feedback on my recent work, before going to formal publications, by some of the best international experts in the domain.”

Selected List of CRP Publications:

- 1) Bouyer, P., Fahrenberg, U., Larsen, K.G., Markey, N. and Srba, J. (2008) Infinite Runs in Weighted Timed Automata with Energy Constraints. In: Cassez, F. and Jard, C. (Eds) *6th International Conference on Formal Modelling and Analysis of Timed Systems (FORMATS 2008)*, Saint-Malo, France, LNCS 5215, 33-47. Springer-Verlag.
- 2) Bouyer, P., Markey, N., Olschewski, J. and Ummels, M. (2011) Measuring Permissiveness in Parity Games: Mean-Payoff Parity Games Revisited. LSV Research Report.
- 3) Brihaye, T., Da Costa, A., Laroussinie, F. and Markey, N. (2009) ATL with Strategy Contexts and Bounded Memory. *LFCS'09. LNCS* 5407, 92-106.
- 4) Doyen, L., Geeraerts, G., Raskin, J.-F. and Reichert, J. (2009) Realizability of Real-Time Logics. In: *Proceedings of FORMATS: Formal Modelling and Analysis of Timed Systems. LNCS* 5813, 133-148.
- 5) Doyen, L. and Raskin, J.-F. (2011) Games with Imperfect Information: Theory and Algorithms. *Lectures in Game Theory for Computer Scientists*. Cambridge University Press, pp 185-212.

Further information:

<http://www.ulb.ac.be/di/gasics>**4.4 The Logic of Causal and Probabilistic Reasoning in Uncertain Environments (LcpR)**

This project combines expertise from probability logic and nonmonotonic reasoning, probability and coherence, causality, conditional independence, models, human reasoning and empirical research on mental probability logic, counterfactuals and cognitive development. It focuses on:

- (i) foundational topics like rationality and evolution;
- (ii) algorithms and implementation of local knowledge representation in non-graphical models (alternatives to Bayesian networks);
- (iii) actual human reasoning in children and adults.

Funding Organisations:

- Deutsche Forschungsgemeinschaft (DFG), Germany
- Fonds zur Förderung der wissenschaftlichen Forschung (FWF), Austria
- Grantová agentura České republiky (GAČR), Czech Republic

Project Leader:

- Professor Gernot Kleiter, University of Salzburg, Austria

Principal Investigators:

- Professor Radim Jiroušek, Academy of Sciences of the Czech Republic, Prague, Czech Republic
- Professor Josef Perner, University of Salzburg, Austria
- Professor Gerhard Schurz, University of Düsseldorf, Germany

Associated Partners:

- Dr Sarah Beck, University of Birmingham, United Kingdom
- Professor Angelo Gilio, University of Rome ‘La Sapienza’, Italy
- Professor Maximilian Kistler, Institut Jean Nicod, Paris, France

Project Members funded under CRP budget:

- Dr Jirka Vomlel, senior researcher, funded as part of Professor Jiroušek’s team
- Mr Václav Kratochvíl, PhD student, funded as part of Professor Jiroušek’s team
- Mr Václav Lín, PhD student, funded as part of Professor Jiroušek’s team
- Dr Andrew Fugard, postdoctoral researcher, funded as part of Professor Kleiter’s team

- Mr Christian Wallmann, PhD student, funded as part of Professor Kleiter's team
- Dr Eva Rafetseder, postdoctoral researcher, funded as part of Professor Perner's team
- Ms Louisa Hacking, project member, funded as part of Professor Perner's team
- Ms Christine Hofer, project member, funded as part of Professor Perner's team
- Mr Matthias Unterhuber, PhD student, funded as part of Professor Schurz's team
- Dr Paul Thorn, postdoctoral researcher, funded as part of Professor Schurz's team

Project Members with funding from outside CRP budget:

- Dr Patrick Burns, postdoctoral researcher, a member of Dr Beck's team
- Dr Giuseppe Sanfilippo, collaborative partner of Professor Gilio's team
- Dr Niki Pfeifer, collaborative partner of Professor Kleiter's team

Scientific Highlights:

The team of Professor Gerhard Schurz developed a computer simulation comparing different logico-probabilistic reasoning systems. Four prominent systems were investigated, the systems O, P, Z and QC (quasi classical). These systems differ in the number of inferences they license ($O \subset P \subset Z \subset QC$). Systems that license more inferences enjoy the possible reward of deriving more true informative conclusions, but with this possible reward comes the risk of drawing more false conclusions. Each of the four systems was extended by appeal to theorems that allow one to compute almost-tight lower-probability bounds for the conclusion of an inference, given lower-probability-bounds for its premises. The results suggest that system Z offers the best balance.

Professor Max Kistler investigated causality and causal reasoning within a *causation as transmission* approach. Professor Kistler argued against the intervention account of causality and against modelling causal structures by Bayesian networks. In physics we find many examples of *simultaneous lawful dependence*. These laws involve quantities that are related to one another in equations. Equations, however, may be solved for any of the variables they contain. Consider, for example, a magnetic stirrer rotating in a magnetic field with a certain angular momentum and a certain magnetic momentum (keeping other variables fixed). The causal law relat-

ing the variables is expressed in an equation which may be solved for the angular momentum or the magnetic momentum with equal rights.

By adopting a coherence-based approach to probabilistic default reasoning, Professor Angelo Gilio studied the quasi conjunction (a basic notion for defining consistent conditional knowledge bases) and the Goodman and Nguyen inclusion relation for conditional events. Given any family of conditional events F , they proved that:

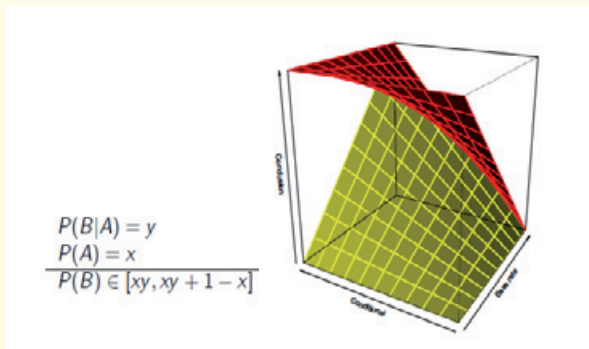
- F p -entails the quasi conjunction $C(S)$ for every subset S of F ;
- p -entailment from F is equivalent to p -entailment from $C(S)$, for some nonempty subset S of F .

Professor Gilio characterised p -entailment by some alternative theorems. Finally, given any pair $(F, E|H)$, they deepened the connections between p -entailment and inclusion relation by introducing the class K of subsets S of F such that $C(S)$ implies $E|H$. We show that K is additive and that its greatest element can be determined by a suitable algorithm.

As an alternative to the well-known Bayesian networks, Professor Radim Jiroušek has shown that conditional independence models can also be represented with the help of a *composition operator* defined for *marginal distributions*. He generalised this composition operator to Shafer-Dempster belief functions and to possibility functions. A number of new properties of conditional independence within these approaches emerged during this work.

Dealing with causality it is important to have the possibility to study causal associations and causal chains. The models have to be able to cope with the concepts like counterfactual reasoning. Until recently, mathematical models were usually founded on the basis of probabilistic graphical models, mainly Bayesian networks and influence diagrams. The new approach does not employ graphs to describe structural properties of the distributions. Instead, the process of how the distributions can be assembled (composed) from its parts (marginals) is described. Studying algebraic properties of the operator of composition, it was found that this approach is also advantageous for describing causal relationships. These models can easily describe how causality is processed within the model.

In the group of Professor Gernot Kleiter principles of probability logic were used to model human inference. The human *understanding of conditionals* and human inference in a probabilistic setting were investigated experimentally. About two-thirds of the participants understand conditionals as condi-



A three-dimensional die with upper and lower probability bounds
Reproduced with permission of Gernot Kleiter

tional events and one-third as conjunctions. When a sequence of 50 or 70 conditionals was presented, many participants shifted from conjunction to a conditional event interpretation. A test for working memory capacity was included in one experiment. Only a low correlation (.30) between the interpretation (conjunction vs conditional event) and one of the memory test variables was found.

If one wants to get an understanding of the nature of a cognitive capability it is a good strategy to study its origin and development. The groups of Professor Josef Perner and Dr Sarah Beck investigated the origins of counterfactual reasoning in children. Both groups developed prototypical scenarios in which children first could play out a 'story' and afterward be asked "What if... would not have been the case?". The distinction between a hypothetical version and a genuinely counterfactual version of problem is critical.

In Professor Perner's project various age groups were investigated, children between three years and fourteen years old, adolescents and adults. Only 42% in the 5.0 to 6.5 years group give the correct answers to the genuinely counterfactual version, but 92% to the hypothetical version. The results support the conclusion that children are capable of hypothetical reasoning before six, but to counterfactual reasoning only after ten. There are remarkable parallel developmental lines of counterfactual reasoning and the development of children's theory of mind.

One aim of Dr Beck and her group was to find out when children are capable of counterfactual reasoning. She explored how counterfactual reasoning can be distinguished from other types of reasoning. When a counterfactual scenario is being elaborated cognitively any open assumptions must be filled by facts from the real world scenario as far as logically possible. Counterfactual reasoning has to follow the nearest possible world constraint (Lewis). Prior studies yielding individual differences data suggested that counterfactual thinking may

be related to overcoming prepotent responses. In two experiments she manipulated how three- to five-year-olds responded to counterfactual conditional and syllogism tasks. Children's performance improved on both conditional and syllogism tasks when they responded with an arrow, rather than pointing with their fingers. Three- to four-year-olds benefited from both an arrow manipulation and, separately, the introduction of a delay before responding. We suggest that both manipulations help children to overcome an impulsive prepotent response to counterfactual questions, arising from a default assumption that information about the past is true.

Personal Reflection:

Dr Jirka Vomlel



"I came to Salzburg for the first time as a PhD student visiting Professor Gernot Kleiter. Since then I have come to love this city not only because of the historical buildings at the foot of green hills that look beautiful, the Marzen beer

in the Augustiner monastery that tastes great, but mainly because the people I met at the University of Salzburg are very friendly and open-minded – I have had many interesting conversations with them. When our Prague group was invited to take part in the LcpR project we were happy to join. The project meetings in Salzburg were in the spirit I remember – interesting talks and discussions not only at the university, but also during the evenings with a glass of beer in hand, at a lift or even in a hut in a skiing resort, as was witnessed during the workshop 'ProbNet 10' in February 2010."

Selected List of CRP Publications:

- 1) Beck, S.R., Riggs, K.J. and Burns, P.L. (2011) Multiple developments in counterfactual thinking. In: Hoerl, McCormack and Beck (Eds) *Understanding Counterfactuals/Understanding Causality*. OUP, Oxford, UK.
- 2) Fugard, A.J.B., Pfeifer, N., Mayerhofer, B. and Kleiter, G. D. (2011) How people interpret conditionals: Shifts towards the conditional event. *J. Experimental Psychology: Learning, Memory, and Cognition* 37(3), 635-648.

- 3) Gilio, A. and Sanfilippo, G. (2011) Quasi Conjunction and Inclusion Relation in Probabilistic Default Reasoning. In: W. Liu (Ed.): *ECSQARU 2011, LNAI 6717*, 497–508. Springer-Verlag, Berlin Heidelberg.
- 4) Kistler, M. (2009) Mechanisms and Downward Causation. *Philosophical Psychology* 22, (5), 595–609.
- 5) Jiroušek, R. Foundations of Compositional Model Theory. To appear in *Int. J. General Systems*.
- 6) Rafetseder, E., Christi-Vargas, R. and Perner, J. (2010) Counterfactual Reasoning: Developing a sense of “nearest possible world”. *Child Development* 81(1), 362—375.
- 7) Schurz, G. and Thorn, P. Logico-probabilistic reasoning systems: Logical investigation and simulation based analysis. Submitted to review of Symbolic Logic, pre-published in: *TPP PREPRINTS*, University of Düsseldorf, Annual 2011 No.1.

Further information:
www.sbg.ac.at/lcpr

4.5 Logic for Interaction (LINT)

LINT is a collaborative research project aimed at developing mathematical foundations for interaction. Intelligent interaction involves agents in complex scenarios like conversation, teamwork or games. Contours of a broad mathematical description are starting to emerge today, based on several individual research developments that now need to be brought together. LINT gathers logicians, computer scientists and philosophers from six European countries in an effort to lay the grounds for a unified account of the logic of interaction.

Funding Organisations:

- Suomen Akatemia / Finlands Akademi (AKA), Finland
- Deutsche Forschungsgemeinschaft (DFG), Germany
- Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO), the Netherlands
- Vetenskapsrådet (VR), Sweden

Project Leader:

- Professor Dag Westerståhl, University of Gothenburg, Sweden

Principal Investigators:

- Professor Jouko Väänänen, University of Amsterdam, the Netherlands
- Professor Erich Grädel, RWTH Aachen University, Germany
- Professor Lauri Hella, University of Tampere, Finland

Associated Partners:

- Professor Samson Abramsky, Oxford University, United Kingdom
- Professor Gabriel Sandu, Université Paris I, CNRS / ENS, Paris, France

Project Members funded under CRP budget:

- Mr Bernd Puchala, PhD student, funded as part of Professor Grädel’s team
- Mr Roman Rabinovich, PhD student, funded as part of Professor Grädel’s team
- Dr Juha Kontinen, postdoctoral researcher, funded as part of Professor Hella’s team
- Dr Allen Mann, postdoctoral researcher, funded as part of Professor Hella’s team
- Mr Pietro Galliani, PhD student, funded as part of Professor Väänänen’s team
- Dr Denis Bonnay, postdoctoral researcher, funded as part of Professor Westerståhl’s team
- Dr Fredrik Engström, postdoctoral researcher, funded as part of Professor Westerståhl’s team

Project Members with funding from outside CRP budget:

- Dr Nikos Tzevelekos, postdoctoral researcher, a member of Professor Abramsky’s team
- Mr Roman Priebe, PhD student, a member of Professor Abramsky’s team
- Dr Dietmar Berwanger, collaborative research associate in Professor Grädel’s team
- Dr Lukasz Kaiser, postdoctoral researcher, a member of Professor Grädel’s team
- Mr Antti Kuusisto, PhD student, a member of Professor Hella’s team
- Mr Jonni Virtama, PhD student, a member of Professor Hella’s team
- Dr Allen Mann, postdoctoral researcher, a member of Professor Sandu’s team
- Professor Johan van Benthem, collaborative research partner in Professor Väänänen’s team
- Ms Fan Yang, PhD student, a member of Professor Väänänen’s team

Scientific Highlights:

The LINT CRP has achieved a qualitative improvement in the understanding of the logic of the concept of dependence, such as the dependence of a move of a player on previous moves, and of independence, such as the independence of a move of a player on a move he or she has not seen. At the beginning of the project these concepts were understood in terms of so-called dependence logic and so-called independence friendly logic. During the project a wealth of related concepts emerged, some of them interestingly probabilistic. It is remarkable that, as it turned out, many of these concepts have previously also arisen in database theory with slightly different emphasis, but the connection had eluded observation.

It now seems that there is a general theory of dependence and independence, based on ideas within logic, computer science and mathematics, that underlies many seemingly unrelated topics in a multitude of areas of science, including physical, behavioural, social and biological sciences. This development, based on analyses and results within the LINT CRP, seems very promising and will be further pursued in future research projects.

An important observation of the LINT CRP at the beginning of the project was the realisation that there is an undiscovered connection between dependence logic and intuitionistic logic. It turned out that a proper use of intuitionistic logic leads to a deeper understanding of dependence logic and reveals an unexpected connection to second-order logic. Reverberations of this observation were felt throughout the project and the full impact of it has probably not yet been perceived.

Game Theoretic Semantics is one of the underlying themes in LINT. It is based on the concept of the existence of a winning strategy. Therefore it was self-evident that there is a connection to existential second-order logic. During the LINT CRP this connection was put under a microscope and completely analysed. As a result a fairly complete picture emerged and one can now pinpoint exactly what the second-order equivalent of most logics that have arisen around the concept of dependence is. This is important for conceptual reasons but it has also led to hierarchy theorems that delineate the complexity of dependence and independence logics. In another direction new resources known as Nominal Game Semantics were developed, leading to concise mathematical models, which capture realistic fragments of dynamic programming languages such as ML.

In their full power the logical systems considered in the LINT CRP have high complexity. This led the project to consider more manageable fragments such as modal logics and 2-variable logics. In both cases a rather complete picture emerged. The results on decidability and complexity delineated nicely the difference between dependence and independence: the satisfaction problem for 2-variable dependence logic turned out to be EXPTIME complete but the same for 2-variable independence friendly logic turned out to be undecidable.

Compositionality has been a recurring theme in the area of the LINT CRP. During the project major steps forward were taken by demonstrating that translations between certain of the relevant logics were non-compositional. On the other hand, it was established that even the probabilistic game-theoretic semantics permits a compositional rendering.

The LINT CRP also proposed a new approach to the problem of logical constants. According to this approach the logical constants are the output of a new operation of ‘constant extraction’, dual to logical consequence as a function from sets of symbols to consequence relations. By its generality, the method is relevant to a variety of logical frameworks studied within the LogICCC programme. In a nutshell, the idea is to combine Bolzano’s insight that any choice of constants determines a semantic consequence relation with a method for going in the converse direction: to extract, from any given consequence relation, its constants. The method might thus be called consequence mining.

Another breakthrough within the LINT CRP was the emergence of a framework for capturing the dynamics of information in games on graphs. Since the 1980s, it was known that the elementary questions about non-terminating games with imperfect information are undecidable. A technique was developed for tracking the knowledge acquired by the members of a coalition during a play, leading to a comprehensive decidability criterion and a determination construction. A method was established for extracting the perfect-information structure of a game with imperfect information, based on a new concept of strategic independence. Applications to the imperfect information games behind independence logic and independence friendly logic remain a topic for future research.

Personal Reflection:

Mr Pietro Galliani



"The LINT project is the best thing that could have happened to my PhD. It gave me the opportunity to interact and cooperate with some of the foremost experts in my chosen field and in many related ones, in an interdisciplinary research environment in which ideas are freely exchanged. The theme of the project – the development of mathematical foundations for interaction – proved itself open-ended enough to be adapted to individual research interests, but strict enough to foster a focused and very animated research community. And what to say about the many workshops and conferences that LINT, and LogICCC in general, gave me the opportunity to attend, and to present my research in, and on one occasion even to help organise? What I learned from these experiences will be of great value for my future career, and I thank the ESF, the LogICCC programme, and all the members of the LINT project for having offered me this unique experience."

Selected List of CRP Publications:

- 1) Galliani, P. and Mann, A.L. Lottery semantics: a compositional semantics for probabilistic first-order logic with imperfect information. *Studia Logica* (accepted).
- 2) Grädel, E. and Väänänen, J. Dependence and independence, *Studia Logica* (accepted).
- 3) Kontinen, J. and Väänänen, J. (2009) On definability in dependence logic. *Journal of Logic, Language and Information*, 18(3), 317-332.
- 4) Mann, A.L., Sandu, G. and Sevenster, M. (2011) *Independence-Friendly Logic: A Game-Theoretic Approach*. London Mathematical Society Lecture Note Series, Cambridge University Press.
- 5) Puchala, B. and Rabinovich, R. (2010) Parity games with partial information played on graphs of bounded complexity. In: *Proceedings of the 35th International Symposium on Mathematical Foundations of Computer Science 2010, MFCS'10, LNCS 6281, 604-614*.

Further information:
<http://www.illc.uva.nl/lint/>

4.6 Logical Models of Reasoning with Vague Information (LoMoReVi)

Vagueness is a ubiquitous phenomenon pervading almost all forms of human interaction. This project focuses on logical aspects of processing vague information and aims at formal models that may serve as bridges between deductive fuzzy logics and various theories of vagueness. It also examines relations to other forms of imperfect information and connections to data extraction.

Funding Organisations:

- Fonds zur Förderung der wissenschaftlichen Forschung (FWF), Austria
- Grantová agentura České republiky (GAČR), Czech Republic
- Comisión Interministerial de Ciencia y Tecnología (CICYT), Spain

Project Leader:

- Professor Christian Fermüller, Vienna University of Technology, Austria

Principal Investigators:

- Professor Lluís Godo Lacasa, Spanish Scientific Research Council (CSIC), Bellaterra, Spain
- Professor Petr Hajek, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Project Members funded under CRP budget:

- Mr Christoph Roschger, PhD student, funded as part of Professor Fermüller's team
- Mr Friedrich Slivovsky, PhD student, funded as part of Professor Fermüller's team
- Dr Markus Moschner, postdoctoral researcher, funded as part of Professor Fermüller's team
- Dr Felix Bou, postdoctoral researcher, funded as part of Professor Godo Lacasa's team
- Dr Angel Garcia-Cerdana, postdoctoral researcher, funded as part of Professor Godo Lacasa's team
- Mr Lukáš Bajer, PhD student, funded as part of Professor Hajek's team
- Dr Libor Běhouněk, postdoctoral researcher, funded as part of Professor Hajek's team
- Dr Marta Bílková, postdoctoral researcher, funded as part of Professor Hajek's team
- Mr Karel Chvalovský, PhD student, funded as part of Professor Hajek's team
- Dr Petr Cintula, researcher, funded as part of Professor Hajek's team
- Dr Milan Daniel, researcher, funded as part of Professor Hajek's team

- Dr Zuzana Haniková, postdoctoral researcher, funded as part of Professor Hajek's team
- Dr Martin Holeňa, researcher, funded as part of Professor Hajek's team
- Dr Rostislav Horčík, researcher, funded as part of Professor Hajek's team
- Dr Ivan Kramosil, researcher, funded as part of Professor Hajek's team
- Mr Jaroslav Moravec, PhD student, funded as part of Professor Hajek's team
- Dr Ondrej Majer, co-project investigator, funded as part of Professor Hajek's team
- Dr Michal Peliš, postdoctoral researcher, funded as part of Professor Hajek's team
- Ms Dagmar Harmancová, administrative assistant, funded as part of Professor Hajek's team
- Ms Petra Ivaničová, administrative assistant, funded as part of Professor Hajek's team

Project Members with funding from outside CRP budget:

- Professor Teresa Alsinet, collaborative research partner in Professor Godo Lacasa's team
- Mr Marco Cerami, PhD student, a member of Professor Godo Lacasa's team
- Professor Pilar Dellunde, collaborative research partner in Professor Godo Lacasa's team
- Professor Francesc Esteve, collaborative research partner in Professor Godo Lacasa's team
- Dr Tommaso Flaminio, postdoctoral researcher, a member of Professor Godo Lacasa's team
- Dr Enrico Marchioni, postdoctoral researcher, a member of Professor Godo Lacasa's team
- Dr Carles Noguera, postdoctoral researcher, a member of Professor Godo Lacasa's team
- Mr Pere Pardo, PhD student, a member of Professor Godo Lacasa's team
- Ms Eva Pospíšilová, ICS ASCR secretary, administrative support for Professor Hajek's team

Scientific Highlights:

The CRP has significantly contributed to the maturity of Mathematical Fuzzy Logic (MFL) as a research field combining traditional topics of mathematical logic, focused on a wide range of many-valued logics, with further perspectives on formal models of reasoning under uncertainty, as well as methods and themes from computer science, like automated deduction and complexity theoretic aspects. This progress is not just witnessed by a continuing stream of papers on algebraic, model- and proof-theoretic aspects of various logics, but - more important to the aims of LogICCC and LoMoReVI - by an intensified focus on the relation between MFL and theories of vagueness (e.g., supervaluation, contextualism, plurivaluationism, epistemicism). Moreover, a number of our results connect MFL with related research paradigms, like probability and possibility theory, truthlikeness and similarity based reasoning.

As a specific highlight that also reflects the indicated development we mention the *Handbook of Mathematical Fuzzy Logic*, edited by the LoMoReVI members Dr Petr Cintula, Professor Petr Hajek and Dr Carles Noguera: 6 of its 11 chapters are (co) authored by members of LoMoReVI.

We list a few further scientific achievements in somewhat telegraphic style:

- Generalisation of Giles's dialogue game with betting scheme for Lukasiewicz logic to further t-norm based fuzzy logics. A related, more recent result demonstrates how to extract truth functions of a many-valued logic from a generalised form of the game. Conversely, it is shown that a wide range of many-valued logics, including all finitely-valued logics, can be characterised by such a game.
- Clarification of the relation between hypersequent based proof systems and winning strategies in Giles's game. It has been shown that the logical rules of a particular analytic hypersequent system for Lukasiewicz logic can be interpreted as instructions for the systematic construction of strategies for one of the players in the game, where due to ignorance about the evaluation of final game states (unknown risk values) different choices have to be registered disjunctively in states.
- Evaluation games for the characterisation of logics that arise from Shapiro's contextualist model of vagueness. This provides a basis for combining (at least) three aspects of models of reasoning with vague propositions: context dependence,

alternative semantics of connectives and quantifiers, interaction of speakers.

- Exhaustive study of minimal modal expansions over finitely-valued fuzzy logics and axiomatisations over several classes of modal frames.
- Definition of different fuzzy modal logics to formalise reasoning about the uncertainty (probabilistic, possibilistic) of fuzzy events.
- Formalisation of logical consequence operators in the frame of similarity-based reasoning.
- Advances in the study of fuzzy description logics: decidability results and finite model property.
- New results on arithmetical complexity and model theory for first order fuzzy logics.

Given the wide range of results it is hard to single out a particular result as most significant or valuable. However, the five joint publications listed at the end of this section represent a fair sample of what has been achieved in the project.

Personal Reflections:

Mr Pere Pardo:



“Working within the LoMoReVI project has been a great experience in terms of learning and collaboration. Meeting other LoMoReVI researchers with the same background, but slightly different interests and approaches, has stimulated my own research and improved certain aspects of it. It also provided useful pointers to present and future joint work. In addition, meeting people from other research areas (linguistics, applied mathematics, psychology) has also been a valuable source of information to evaluate each other’s work (common interests, possible application domains) and towards future collaborative work with groups in related areas. Finally, the LoMoReVI project has also given me the opportunity to join events abroad and discuss research with students and senior researchers from countries with which joint work was hardly possible otherwise. At all these levels, scientific meetings were well-organised, and gave rise to friendly and cooperative environments for the discussion of senior as well as junior participants’ work.”

Mr Christoph Roschger:



“The LoMoReVI project offered me the perfect opportunity for pursuing my PhD project. In particular, the networking of CRPs facilitated interdisciplinary work in the intersection of logic, linguistics and philosophy, which nicely fits my work on dialogue game based models of reasoning under vagueness. Meetings co-organised by our group (DIPLEAP, ProDI workshops and the initial LoMoReVI conference) as well as the possibility to join other inter-CRP events were very valuable in getting feedback from experts working in other disciplines, such as linguistics and psychology, that tackle from a different perspective the same phenomena and problems as we do in LoMoReVI. Thus I am lucky that my PhD project could take place in such a lively international and interdisciplinary setting.”

Selected List of CRP Publications:

- 1) Cintula, P., Fermüller, C., Godo, L. and Hájek, P. (Eds) *Understanding Vagueness - Logical, Philosophical, and Linguistic Perspectives*. To be published by College Publications, London in 2011. (Contains contributions by members of three IPs, some of them jointly written by authors from different IPs)
- 2) Cintula, P. and Noguera, C. (2010) Implicational (Semilinear) Logics I: A New Hierarchy. *Archive for Mathematical Logic* 49(4), 417-446.
- 3) Cintula, P., Hájek, P. and Noguera, C. (Eds.) *Handbook of Mathematical Fuzzy Logic*. To be published by College Publications, London in 2011.
- 4) Esteva, F., Godo, L., Rodriguez, R. and Vetterlein, T. Logics for approximate and strong entailment. To appear in *Fuzzy Sets and Systems*. Short version: Esteva, F., Godo, L., Rodriguez, R.O. and Vetterlein, T. (2010) On the logics of similarity- based approximate and strong entailment. In: *Proceedings of the 15th Spanish Congress on Fuzzy Logic and Technology* (Huelva 2010), pp 187 – 192.
- 5) Hájek, P., Montagna, F. and Noguera, C. Arithmetical Hierarchy. Chapter in 3) above.

Further information:

<http://www.logic.at/lomorevi/>

4.7 SOCIAL SOFTWARE for elections, the allocation of tenders and coalition/alliance formation (SSEAC)

All familiar election systems are known to have very bad properties and to yield counterintuitive results. The same holds for the allocation of tenders, resulting in many cases in court. In this project we want to study the topics mentioned above in the new framework recently introduced by Balinski and Laraki, avoiding the paradoxes. Making use of relational reasoning we will develop appropriate software.

Funding Organisations :

- Suomen Akatemia / Finlands Akademi (AKA), Finland
- Deutsche Forschungsgemeinschaft (DFG), Germany
- Comisión Interministerial de Ciencia y Tecnología (CICYT), Spain

Project Leader:

- Professor José Luis García-Lapresta, University of Valladolid, Spain

Principal Investigators:

- Professor Rudolf Berghammer, Christian-Albrechts-Universität Kiel, Germany
- Professor Hannu Juhani Nurmi, University of Turku, Finland

Associated Partners:

- Professor Harrie C.M. de Swart, University of Tilburg, the Netherlands
- Dr Agnieszka Rusinowska, Université Paris 1 Panthéon-Sorbonne, France



The SSEAC Principal Investigators and Associated Partners. From left to right: Professor Rudolf Berghammer, Professor Hannu Nurmi, Professor Harrie de Swart, Dr Agnieszka Rusinowska and Dr Jose-Luis García-Lapresta.

Photo courtesy of Jose-Luis García-Lapresta

Project Members funded under CRP budget:

- Ms Eurne Falcó, PhD student, funded as part of Professor García-Lapresta's team
- Dr Miguel Martínez-Panero, senior researcher, funded as part of Professor García-Lapresta's team
- Mr David Pérez-Román, PhD student, funded as part of Professor García-Lapresta's team
- Mr Stefan Bolus, PhD student, funded as part of Professor Berghammer's team
- Mr Kari Saukkonen, PhD student, funded as part of Professor Nurmi's team
- Mr Juha Helin, PhD student, funded as part of Professor Nurmi's team

Project Members with funding from outside CRP budget:

- Mr Manzoor Zahid, PhD student, a member of Professor de Swart's team

Scientific Highlights:

This collaborative research project contributed to the scientific goal of the LogICCC programme by improving existing social mechanisms and behaviour, including their links with new computational advances, based on logical formalisms, in particular algebraic logic.

This CRP was multidisciplinary (using logic, mathematics, economics, computer science and political science), contributed to broader insight and theory building in the field of elections, allocation of tenders and coalition/alliance formation, and made innovative use of logical formalisations in its application areas.

Apart from theory building and logical modelling, the research has important practical applications, which are essential for a sound future for Europe: a fair election system, a fair allocation of tenders, a fair procedure for coalition and alliance formation. The European added value of the collaboration is evidenced by the fact that each group has specific competences, which are combined in the CRP, resulting in procedures and software products that could never have been developed by just one group alone. That the allocation of tenders gives rise to similar problems as the aggregation of preferences is not generally known, and causes many cases in court. Hence a solution to this problem is of great practical value.

SSEAC organised four workshops: 'Social Software and Computational Social Choice', in Lyon (France), April 1-2, 2009; 'New approaches to Voting

and Social Choice’, in Tilburg (the Netherlands), May 25-26, 2009; ‘Voting and Allocation Systems’, in Turku (Finland), June 8-9, 2010; and a final workshop which will take place in Kiel (Germany), May 3-4, 2012.

IP1: The extension of Majority Judgment based on distances has been decomposed in two stages. The first one assigns a collective assessment to each profile of individual assessments. This procedure has been conducted by means of appropriate aggregation functions by considering suitable metrics that guarantee interesting properties. The second stage consists of a tie-breaking process, also based on distances. The complete procedure assigns a weak order on the set of alternatives to each profile of individual assessments. It satisfies suitable properties within the social choice framework. The devised decision making method has been applied to the allocation of tenders within a multi-criteria setting in such a way that some of the drawbacks denounced by Chen have been eliminated.

IP2: Based on a lot of investigations and experiments made with the BDD-based tool RelView, a new method has been developed to represent simple games as BDDs and to solve a lot of problems on simple games by working directly on the BDD-representations and not indirectly via relational operations only as RelVIEW does. Compared with RelVIEW this led to much faster game-theoretic algorithms. Concerning efficiency in general, in most cases the runtimes of our algorithms linearly depend on the sizes of the BDDs. Due to this property, the new approach proved to be at least of the same value as known approaches, like the use of generation functions. In many practical experiments it even proved to be superior.

IP3: We studied fundamental problems of opinion modelling with implications for committee composition and social choice, connections and implications of the Ostrogorski paradox for spatial voting models, and continuity and measurability of Arrovian social welfare functions.

AP1: We have developed a procedure, partly based on Balinski and Laraki’s ideas and partly based on the ideas of Range Voting and Borda, called the Borda majority count, which – based on evaluations of the voters of the different parties – yields a seat distribution of parties in parliament. We are studying the properties of this procedure.

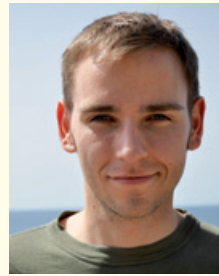
We have applied several procedures – plurality vote, Borda count, approval voting and the Borda majority count – to a set of about 7,000 data, obtained from the LISS (Longitudinal Internet Studies for the Social sciences) panel and com-

pared the different results for the parliament in the Netherlands.

AP2: Social networks play a central role in our activities, in social phenomena, in economic and political life. They are particularly important in studying all kinds of influence phenomena, and are very useful for analysing the diffusion of information and the formation of opinions and beliefs. As we have provided an exhaustive analysis of social network structures and studied the impact they may have on human behaviour, we believe that our investigations are of significant importance.

Personal Reflection:

Mr Stefan Bolus



“After my diploma thesis in computer science in 2009 my advisor asked me to join one of his projects in the field of social sciences. For me this was a great opportunity because of the interesting topic and the advantages of a project with a network of experts spread over the European Union. The close collaboration with top level researchers motivates your own efforts and enables a scholarly exchange beyond the borders of your own area of studies. Workshops of the projects invite to exchange ideas, give feedback and suggestions for further studies and promote personal contacts inside the project. So for me, it has always been a great pleasure to work inside this project and it still is.”

Selected List of CRP Publications:

- 1) Berghammer, R., Bolus, S., Rusinowska, A. and de Swart, H. (2011) A Relation-Algebraic Approach to Simple Games. *European Journal of Operational Research* 210, 68-80.
- 2) de Swart, H., Berghammer, R. and Rusinowska, A. (2009) Computational Social Choice Using Relation Algebra and RelView. In: R. Berghammer et al. (Eds), *Proceedings RelMiCS / AKA 2009, LNCS* 5827, 13-28.
- 3) Falcó, E. and García-Lapresta, J.L. (2011) A distance-based extension of the Majority Judgement voting system. *Acta Universitatis Matthiae Belii, series Mathematics* 8, 17-27.
- 4) Nurmi, H. and Saari, D. (2010) Connections and Implications of the Ostrogorski Paradox for Spatial Voting Models. In: A. Van Deemen and

A. Rusinowska (Eds) *Collective Decision Making: Views from Social Choice and Game Theory*. Springer-Verlag, Berlin-Heidelberg-New York.

5) Rusinowska, A., Berghammer, R., de Swart, H. and Grabisch, M. (2011) Social Networks: Prestige, Centrality and Influence. In: *Proceedings RAMiCS 2011, LNCS 6663*, 21 – 38.

Further information:

<http://www2.eco.uva.es/presad/SSEAC/>

4.8 Vagueness, Approximation and Granularity (VAAG)

Vagueness is a pervasive property of human language and cognition. While vagueness has often been regarded as undesirable, the VAAG project is based on a growing recognition that vagueness is actually in many respects useful. The VAAG project targets a broad, interdisciplinary reassessment of vagueness with contributions to general cognitive science, linguistic semantics, experimental psychology, formal pragmatics and computer science.

Funding Organisations:

- Deutsche Forschungsgemeinschaft (DFG), Germany
- Hrvatska zaklada za znanost (HRZZ), Croatia
- Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO), the Netherlands
- Vetenskapsrådet (VR), Sweden

Project Leaders:

- Professor Manfred Krifka, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany
- Dr Ulrich Sauerland, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany

Principal Investigators:

- Professor Peter Gärdenfors, Lund University, Sweden
- Professor Velimir Isgum, University Clinical Hospital Centre Rebro, Croatia
- Dr Robert van Rooij, University of Amsterdam, the Netherlands
- Professor Frank Veltman, University of Amsterdam, the Netherlands

Associated Partners:

- Dr Michael Rovatsos, University of Edinburgh, United Kingdom
- Professor Ewan Klein, University of Edinburgh, United Kingdom

Project Members funded under CRP budget:

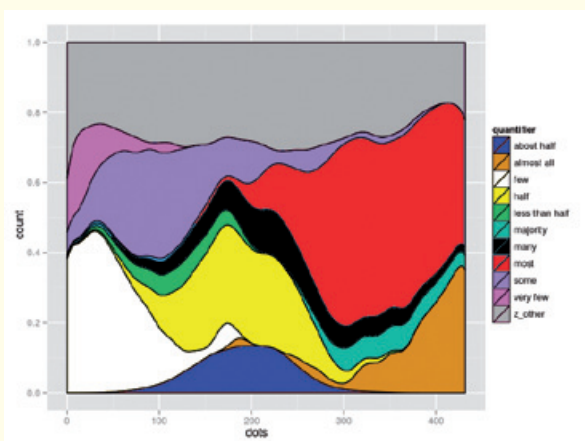
- Dr Stephanie Solt, postdoctoral researcher, funded as part of Professor Krifka and Dr Sauerland's team
- Ms Nicole Gotzner, PhD student, funded as part of Professor Krifka and Dr Sauerland's team
- Professor Sverker Sikström, senior researcher, funded as part of Professor Gärdenfors's team
- Mr Rasmus Bååth, PhD student, funded as part of Professor Gärdenfors's team
- Ms Eva Sjöstrand, project assistant, funded as part of Professor Gärdenfors's team
- Ms Ines Crespo, PhD student, funded as part of Dr van Rooij and Professor Veltman's team

Project Members with funding from outside CRP budget:

- Dr Clemens Mayr, postdoctoral researcher, a member of Professor Krifka and Dr Sauerland's team
- Dr Marijan Palmovic, research associate of Professor Isgum's team
- Ms Magdalena Krbot, PhD student, a member of Professor Isgum's team
- Ms Ana Branka Sefer, PhD student, a member of Professor Isgum's team
- Ms Gordana Hrzica, PhD student, a member of Professor Isgum's team
- Dr Galit Sassoon, postdoctoral researcher, a member of Dr van Rooij and Professor Veltman's team
- Mr Harald Bastiaanse, PhD student, a member of Dr van Rooij and Professor Veltman's team

Scientific Highlights:

Vagueness has often been seen as the antithesis of logic, and work in several fields that use logic has begun to address vagueness only recently using the tools of modern logic. The VAAG project has made tremendous progress addressing vagueness and related phenomena from the perspectives of the five subfields involved - logic-based cognitive science, model-theoretic semantics of natural language, formal pragmatics, general psychology and computer science - and to integrate these perspec-



The distribution of quantifiers in English
Courtesy of Ulrich Sauerland

tives. Three highlights of our results concern the questions why natural language is vague, how are vague concepts represented and how vagueness can be empirically measured.

Why is language vague? One of the most influential findings of recent research on vagueness is Professor Krifka's observation that language often prefers to be vague: e.g., it's more natural to talk of a two hour meeting rather than '2'13''12.5''' meeting even if the latter is known to be accurate. Professor Gärdenfors has argued furthermore that language must be vague because of its finiteness. To explain the preference for vagueness, Dr van Rooij and colleagues have developed a model within signalling game models. The model predicts that vagueness is a natural property of meaning that evolves when boundedly rational agents repeatedly engage in cooperative signalling.

How are vague concepts represented? The vagueness of concepts can often be traced to effects of their core meaning. But there are exceptions: in a line of research Dr Solt has pursued, quantifiers like 'more than half' and 'most' seem to have the same core meaning, but differ for borderline cases like that of a 51% majority. In work with Dr Sauerland and others, Dr Solt further extended this type of research to the comparison of unmodified numerals like '120' and comparative quantifiers such as 'more than 120'. They argue that the latter trigger a granular related inference ('less than 150') that results in a weaker interpretation of the bare numerals.

How can vagueness be measured empirically? The classical conception of vagueness revolves around the notion of an unclear border: we find it hard to decide whether a 180cm tall man is tall. But finding other measures relating to vagueness is crucial to develop. Dr Palmovic and colleagues have approached vagueness with a number of

neuro-cognitive methods and have found evidence for vagueness in their ERP data. Mr Bååth and colleagues have discussed a number of ways to measure vagueness in production data, specifically for the production of quantifiers. They show that a detection theoretic measure correlates with intuitive judgments of the vagueness of quantifiers.

Personal Reflection:

Dr Stephanie Solt



"For me, participation in the VAAG project has been about making new connections and exploring new directions. A case in point was our workshop 'Vague Quantities and Vague Quantifiers' in Berlin, which brought together

members of three LogICCC projects as well as external experts for an interdisciplinary look at the topic of vagueness in the expression of quantity – a central focus of my research. Through this and other activities I've had a chance to be exposed to approaches and results from the fields of formal logic, mathematics, psychology and psycholinguistics, some of which I've been able to incorporate directly into my own work. And I've met new colleagues who I hope to collaborate with long after the LogICCC programme has come to an end."

Selected List of CRP Publications:

- 1) Nouwen, R., van Rooij, R., Sauerland, U. and Schmitz, H.-C. (Eds) (2011) *Vagueness in communication*. Springer, Heidelberg, Germany. doi:10.1007/978-3-642-18446-8.
- 2) Sauerland, U. Vagueness in Language: The Case Against Fuzzy Logic Revisited. To appear in: P. Cintula, C. Fermüller, L. Godo and P. Hajek (Eds) *Understanding Vagueness - Logical, Philosophical and Linguistic Perspectives*. College Publications, London.
- 3) Solt, S. Vagueness in quantity: Two case studies from a linguistic perspective. To appear in: P. Cintula, C. Fermüller, L. Godo and P. Hajek (Eds) *Understanding Vagueness - Logical, Philosophical and Linguistic Perspectives*. College Publications, London.

Further information:

<http://www.zas.gwz-berlin.de/vaag.html?&L=1>

5. Cross-CRP Networking, Dissemination and Training Activities



Networking and collaboration within every EUROCORES Programme takes place at two levels:

1. between the various Individual Projects within a Collaborative Research Project (CRP);
2. between the funded CRPs within the programme as a whole.

The **intra-CRP** collaboration is motivated by the nature of the CRP's research objectives, i.e., by the scope and the complexity of the questions it deals with. In a CRP, the participating groups have the opportunity to gather the required critical mass to successfully address the objectives and challenges of their project. In their reports, the project leaders have indicated how they have been achieving the required level of integration in question 1.

The **cross-CRP** networking and collaboration – more on which you will find below – is stirred by the aims and the nature of this particular EUROCORES Programme. The LogICCC programme has been developed precisely because of its clear need for enhanced collaboration in this field. The funded CRPs have collectively set up and further streamlined this new collaboration. To this end, the CRPs have engaged their members and, when of clear benefit, colleagues from outside the programme, in joint activities such as seminars, workshops, expert meetings, conferences and training activities - either stand-alone or as part of other larger events.

Through active participation of scientists in the above-mentioned activities, not only have existing collaborations been enhanced but also new and strategic partnership opportunities have been identified. Furthermore, these activities provided opportunities to explore aspects of the LogICCC programme which are not covered by the funded research projects.

The integrative activities between the CRPs aim to strengthen the field by building coherence within this emerging research community and serve as a platform for the work that is done in the programme. Below, you will find a complete overview of these activities.

Dissemination of the research results is primarily done by the principal investigators and the project leaders at the level of the Individual Projects (IPs) and Collaborative Research Projects (CRPs).

Some of the dissemination activities are also supported at the level of the LogICCC programme, especially in the context of increasing the visibility of the programme and the EUROCORES Scheme as a whole. These activities have been included in the overview below.

Further information can be also be found at the programme website www.esf.org/logic, click on 'Events'.

- **LogICCC Launch Conference**

5-7 October 2008, Prague, Czech Republic
The LogICCC Launch Conference brought together all LogICCC project members - together with representatives of related research efforts, members of the Review Panel and members of the Management Committee - to find connections between each other's work and to visualise the road ahead.

The conference provided a good occasion to explore possible networking opportunities at an early stage and to plant the seeds for follow-up activities, across and beyond the LogICCC programme. The conference was followed by the first meeting of the LogICCC Scientific Committee where the work plan for the Networking, Training and Dissemination Activities in 2009 was discussed and agreed upon.



A snapshot from one of the Launch Conference's presentations
© Marie Suchanova

As a direct result of the conference, six proposals for cross-CRP follow-up activities were submitted and awarded for funding, bearing witness to the degree of fruitful interaction created at the conference.

Organisers: ESF office

- **Conference on 'Logical Models of Reasoning with Vague Information'**

14-17 September 2009, Cejkovice,
Czech Republic

This conference centred on issues of vagueness in logical reasoning and the diversity of the scientific challenges the concept poses. It served as an important forum for fostering collaboration between CRPs, in particular between LoMoReVi and VAAG, who made concrete plans for further collaborative activities. As a result of this meeting, a special journal issue of IGPL (*Journal of the Interest Group in Pure and Applied Logic*) was planned. In addition, an agreement with College Publications was secured to publish a corresponding volume in their Studies in Logic series. The meeting also resulted in discussions for a planned volume, to be edited by Dr Petr Cintula, Professor Chris Fermüller, Professor Lluís Godó and Professor Petr Hajek, which will focus on logical as well as linguistic aspects of vagueness.

In general, the conference enabled the participants to exchange field-specific research issues, including essential methodological assumptions and the current state of the art, as well as some preliminary results. This was particularly relevant to junior researchers, those who were still in the process of formulating their interest and ideas with respect to the interdisciplinary challenges posed by reasoning under vagueness.

Organiser: Professor Christian Fermüller,
Vienna University of Technology, Austria
(LoMoReVi)



The conference participants hard at work (above)
before enjoying an evening meal (below) © Petr Cintula



- **WUPES 2009 – LogICCC working day**

19-24 September 2009, Liblice, Czech Republic

Uncertainty processing, i.e., methods for representing, managing and exploiting uncertain knowledge, is one of the main topics within several of the LogICCC CRPs. This is quite natural, since one can hardly imagine that modelling intelligent interaction (especially for humanities and social sciences) could be based on deterministic behaviour. However, not all of the CRPs share a common methodology when it comes to uncertainty processing. Whilst LcpR is based mainly on probability theory, the LoMoReVi project develops approaches based on multivalued logics. For both of these research teams then (as well as for researchers from other CRPs), it is important to find conferences and workshops which embrace varied methodologies, so that project members can learn from each other's methods.

WUPES, or Workshops on Uncertainty Processing, are organised every three years and act as a forum for the discussion of different approaches to uncertain knowledge modelling. These workshops are aimed at fostering creative intellectual activities and the exchange of ideas. LogICCC teams attended this meeting in 2009 whilst extending it by one working day in order to direct discussion as to the future plans of the project members and facilitate further the methodological exchange between LoMoReVi and LcpR. The proceedings of the WUPES meeting were subsequently published

in a special issue of the *International Journal of Approximate Reasoning*.

Organiser: Professor Radim Jiroušek,
Academy of Sciences of the Czech Republic (LcpR)

• **LogICCC meets China**

7 October 2009, Chongqing, China

The LogICCC theme of logic and intelligent interaction is also becoming a trend in the newly emerging logic scene in China. The Institute for Logic and Cognition in Guangzhou has adopted it for a future research line as did other institutes, such as the Institute for Logic and Intelligence in Chongqing, as well as groups of logicians in Beijing. This event was the first major initiative to bring together Chinese and European scholars and students for an intensive work day with the explicit goal of initiating and furthering interaction and cooperation within the broad field of logic.

The scientific content of the event consisted of (a) overview presentations of research issues within the LINT and CFSC CRPs given by senior LogICCC speakers; (b) poster presentations and short oral presentations of research within these CRPs by junior researchers from LogICCC; (c) poster presentations and short oral presentations by junior Chinese researchers. A selection of presentations at the conference was published in a special issue of *Synthese*.

Apart from numerous ideas for research and cooperation that were discussed among individual researchers during the workshop, various larger initiatives were also discussed. These initiatives included exchange visits between Chinese and European logicians and possible Chinese summer schools in logic.

Organiser: Professor Dag Westerståhl,
Gothenburg University, Sweden (LINT)



Some of the participants of the conference deep in thought
From left to right: Dr Daniele Porello, Ms Fan Yang,
Professor Jouko Väänänen and Dr Allen Mann

Photo courtesy of Institute of Logic and Intelligence, Southwest University, Chongqing, China

• **Integrated workshop GASICS-LINT-CFSC**

22-23 October 2009, Aachen, Germany

This workshop was the second plenary meeting of GASICS in 2009 and served two purposes. First, it was devoted to an exchange of results of current work in all research axes and all research teams of GASICS. The scientific topics as represented by the research axes included: (a) adapted notions of games for synthesis of complex interactive computational systems, (b) games played on complex and infinite graphs, (c) games with quantitative objectives, (d) games with complete information and over dynamic structures, (e) heuristics for efficient game solving.

The second purpose of the meeting, which gave it a special flavour and contributed much to its success, was the presentation of work being done in two of the other LogICCC CRPs, namely LINT and CFSC. It had become clear during the LogICCC Launch Conference that several interesting links existed between GASICS, LINT and CFSC that should be explored and developed during the tenure of the projects. The meeting succeeded in exposing project members from each of these CRPs (including a large selection of junior researchers) to the research and methodologies of the other CRPs, resulting in a number of discussions between GASICS, LINT and CFSC concerning research topics of common interest which were identified for further study through bilateral (or even trilateral) cooperation in the time span 2010-2011.

Organiser: Professor Wolfgang Thomas, RWTH Aachen University, Germany (GASICS)

• **Workshop 'Dialogues and Games: Historical Roots and Contemporary Models'**

8-9 February 2010, Lille, France

This workshop focused on the distinctive dialogical and epistemological characteristics that are shared by the medieval traditions of Western Europe and India. For recently it has become apparent that these shared characteristics can be fruitfully modelled in the context of modern developments in logic, which are dynamic and dialogical in flavour. This workshop was centred on the belief that investigating the common properties of these two historical approaches (with the help of recent technical advances in dialogical and game semantics and dialogue games) can advance our understanding of these philosophical and historical traditions.

The purpose of the workshop was to bring together LogICCC researchers from four different CRPs (LINT, CFSC, DiFoS and LoMoReVi), from both the philosophical and technical traditions, so as to provide a spring-board for collaboration



The workshop participants

© Sara L. Uckelman



Some of the workshop participants in action (above). An après-ski discussion between (from left to right) Mr Christoph Roschger, Professor Radim Jiroušek and Dr Sarah Beck (below). © Marco Cerami

and potential cross-discipline applications, allowing people working in both historical traditions, the Western and the Indian, to gain knowledge of current modelling techniques and those on the technical side access to new problems and theories to model.

The date for the workshop was deliberately chosen in mid February so that the groundwork for future collaboration laid by the event could be further supported by the larger cross-CRP conference 'Modelling Interaction, Social Choice, Dialogue and Vagueness', which was to take place in Amsterdam in late March 2010 and where all workshop participants from LogICCC were to participate.

Organiser: Professor Benedikt Löwe, University of Amsterdam, The Netherlands (DiFoS)

- **Workshop 'ProbNet10' (Probabilistic Networks 2010)**

25-28 February 2010, Salzburg, Austria

The ProbNet series of workshops emerged within the AKTION exchange programme between Czech and Austrian researchers to provide a forum for interaction between mathematicians, philosophers and psychologists working in the field of uncertain reasoning.

This particular workshop was developed between LcpR and LoMoReVi, and focused on causal reasoning, counterfactuals and conditionals, with special attention devoted to issues of vagueness and probability. This interaction not only intensified the contacts between the two projects, but also stimulated the exchange of ideas and information between project members. As a result of the meeting it was decided to have another meeting later in the year that would include the DiFoS group.

Organiser: Professor Gernot Kleiter, University of Salzburg, Austria (LcpR)

- **Short-term visit by Dr Niki Pfeifer (LcpR, Salzburg) visiting Professor Benedikt Löwe (DiFoS, Amsterdam)**

11-15 March 2010, Amsterdam, the Netherlands



Professor Löwe (DiFoS CRP) and Dr Pfeifer (LcpR CRP) met during this short-term visit to discuss their respective research interests and possible overlaps, as well as to plan future joint projects. The main aim of the visit was to start a new collaboration between LcpR and DiFoS. The visit was also used for preparing a pre-proposal for submitting a new CRP (Formal Models of Understanding in Communicative Situations) for the EUROCORES Programme 'Understanding and Misunderstanding: Cognition, Communication and Culture' (EuroUnderstanding) so as to continue the inter- and transdisciplinary research that has started within LogICCC.

Organiser: Dr Niki Pfeifer, University of Salzburg, Austria (LcpR)

- **Workshop 'Modelling Interaction, Dialogue, Social Choice and Vagueness'**

26-28 March 2010, Amsterdam, the Netherlands

The computational bases of social choice, theories of vagueness, dialogical semantics and the mathematical foundations of interaction were the topics discussed during this two-day workshop. Organised by four of the LogICCC CRPs, namely CSFC, DiFoS, LINT and VAAG, the event was designed to promote opportunities for cooperation amongst the project members. Given this drive for cooperation, the topics of the talks were carefully chosen so as to ensure the interdisciplinary characters of the projects were well catered for.

The workshop managed to spark a remark-

able amount of discussion and collaboration ideas among the members of different research communities. In particular, there appeared to be a surprising – albeit, of course, far from total – amount of overlap between the theoretical tools used by the researchers who presented their work at the meeting, a positive note indeed for the potential of future interactions.

Organiser: Professor Jouko Väänänen, University of Amsterdam, the Netherlands (LINT)

- **Special session on ‘Obligationes’ at the International Medieval Congress in Leeds**

12-15 July 2010, Leeds, United Kingdom

The International Medieval Congress, held every year at the University of Leeds, is one of the two largest congresses for medievalists in the world, running for four days and attracting over 1,500 participants.

Medieval philosophy, and logic in particular, are often underrepresented. The aspect of the DiFoS project dealing with medieval logic, specifically the medieval theory of *obligationes* and how it relates to dialogues in contemporary logic, was acknowledged by the Review Panel as one of the crucial aspects of this CRP. The Leeds IMC was a perfect venue both to present preliminary results of this subproject to the wider community of medievalists, and to showcase the ESF EUROCORES funding scheme.

Via an advert in the programme booklet and a flyer in the conference package, participants were attracted to the session. In conjunction with the scientific session, participants were able to find out more about the LogICCC programme and the

EUROCORES Scheme in general at a special booth on 12-13 July.

The session was a great success as it formed the first contact between the *obligationes* research in the DiFoS project and Professor Fermüller in LoMoReVi. In the months since the session, this contact resulted in further research by Dr Alama and Dr Uckelman (DiFoS) and also an invitation by Professor Fermüller to Vienna for a short-term research visit in the summer of 2011.

Organiser: Professor Benedikt Löwe, University of Amsterdam, the Netherlands (DiFoS)

- **Workshop on ‘Dependence and Independence in Logic’, as part of the European Summer School on Logic, Language and Information (ESSLLI 2010)**

16-20 August 2010, Copenhagen, Denmark

Dependence and independence are common phenomena wherever one looks: ecological systems, astronomy, human history, stock markets, etc. Yet what is their role in logic and – conversely – what is the logic of these concepts? The possibility of nesting quantifiers, thus expressing patterns of dependence and independence between variables, accounts for much of the expressive power of first order logic. However, first order logic is not capable of expressing all such patterns, and as a consequence various generalisations – such as branching quantifiers or the different variants of independence-friendly logic – have been introduced during the last fifty years. Dependence logic is a recent formalism, which brings to the forefront the very concept of dependence, isolating it from the notion of quantifier and making it one of the primitive elements of the language. It can also be added to other logics, such as modal logic. This has opened up an opportunity to develop logical tools for the study of complex forms of dependence, with applications to computer science, philosophy, linguistics, game theory and mathematics. Recently there has been an increasing interest in this topic, especially among young researchers.

This workshop provided an opportunity for researchers to further explore the very notions of dependence and independence and their role in formal logic, in particular with regard to logics of imperfect information. Selected papers from the workshop were published in the *Studia Logica* special issue on Dependence and Independence in Logic, edited by Professor Juha Kontinen, Professor Jouko Väänänen and Professor Dag Westerståhl.

Organiser: Professor Jouko Väänänen, University of Amsterdam, the Netherlands (LINT)



The advertisement which appeared in the programme booklet, alerting participants to the LogICCC session

- **Third International Workshop on Computational Social Choice (COMSOC-2010)**

13-16 September 2010, Düsseldorf, Germany

Computational social choice is a new discipline emerging at the interface of social choice theory and computer science. It is concerned with the application of computational techniques to the study of social choice mechanisms, and with the integration of social choice paradigms into computing.

The aim of this workshop was to bring together the different communities that have been addressing such issues: computer scientists interested in computational issues in social choice; people working in artificial intelligence and multi-agent systems who are using ideas from social choice to organise societies of artificial software agents; logicians interested in the logic-based specification and analysis of social procedures (social software); and, last but not least, people coming from social choice theory itself. The workshop, which proved to be a great platform for researchers working in different disciplines of computational social choice, included a special LogICCC session as well as a LogICCC tutorial day. This helped strengthen the cross-CRP networking between the attending CRPs CFSC, SSEAC and DiFoS. Conference proceedings are available at <http://ccc.cs.uni-duesseldorf.de/COMSOC-2010/proceedings.shtml>.

Organiser: Professor Jörg Rothe, Heinrich-Heine-Universität Düsseldorf, Germany (CFSC)

- **Set Theory, Model Theory, Dependence Logic and Foundations of Mathematics: Meeting in Honour of Jouko Väänänen's 60th Birthday**

16-18 September 2010, Helsinki, Finland

This conference was in honour of Jouko Väänänen's 60th birthday, celebrating the multidisciplinary contributions he has made to such areas as mathematical logic, generalised quantifiers, linguistics and philosophy. His recent work on dependence logic has launched a new research direction on the borderline between mathematical logic, philosophy-



Professor Rothe © Jörg Rothe



A group shot of the conference participants

Photo courtesy of Sampo Tiensuu

cal logic, computer science and social choice theory. This new topic investigates mathematical, computational and logical properties of various concepts that can vaguely be called dependence-notions. It has not only raised considerable interest among logicians, but dependence logic is the cornerstone of much of the research connected with the LINT project.

This major conference took place over three days and brought together scientists from across the multifaceted subject-area of logic. The multidisciplinary character of the conference was a perfect reflection of Professor Väänänen's own research, as well as the research of the LogICCC programme as a whole. The organisers decided to publish the proceedings of the meeting which will appear at a later date.

Organiser: Professor Lauri Hella, University of Tampere, Finland (LINT)

- **Workshop, 'DIPLEAP: Dialogues, Inference and Proof | Logical and Empirical Perspectives'**

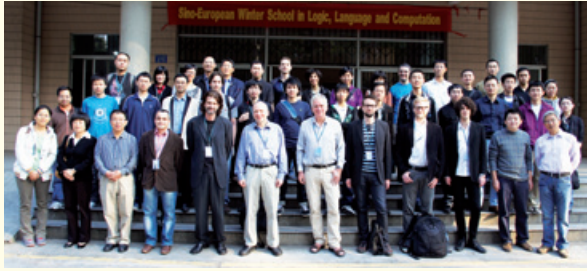
26-28 November 2010, Vienna, Austria

Bringing together participants from four CRPs (DiFoS, LcpR, LoMoReVI and VAAG), as well as a number of leading international experts, this workshop sought to connect the different lines of research that were being pursued by the involved CRPs into a common elucidation of the nature of reasoning, argumentation and proof. In particular, formal logical and empirical aspects of the topic have largely been pursued separately so far. The joint workshop provided the impulse and opportunities to exchange findings and to establish corresponding links between these two worlds.

Joint interest in various streams of research within LogICCC became visible during the workshop. Examples include logical dialogue games that form the centre of research in DiFoS but are also recognised as an important tool in modelling reasoning with vague and uncertain information as envisaged by LoMoReVI. Interestingly, in addition to the more technical, proof- and game-theoretic aspects of the topic, psychological aspects were

also discussed. Similarly, in the field of modelling reasoning under uncertainty, both mathematical problems as well as challenges for psychological models became visible as topics for further research within and beyond the context of LogICCC. The slides corresponding to all four invited talks, as well as all but two of the contributed talks, have been made available at <http://www.logic.at/lomorevi/dipleap/schedule>

Organiser: Professor Christian Fermüller, Vienna University of Technology, Austria (LoMoReVi)



A group shot of the workshop's participants © Pere Pardo

- **Sino-European Workshop in Logic, Language and Computation**

3-18 December 2010, Guangzhou, China

This workshop, which was initiated at (and can be seen as a continuation of) the highly successful 'LogICCC meets China' workshop in 2009, took place during the Sino-European Winter School in Logic, Language and Computation (SELLC 2010). The international group of lecturers of the SELLC-2010 Winter School formed the basis of the speakers of the workshop, in addition to several international expert speakers and members of the LogICCC CRPs. The body of students and researchers who participated in the SELLC-2010 Winter School formed the main part of the audience of the workshop.

As the title might suggest, the subject of the workshop was logic in its broadest sense. It provided a forum for LogICCC researchers to disseminate the latest results of their work to the international audience of the entire SELLC-2010 Winter School. In particular, the workshop provided an opportunity for LogICCC to reach Chinese students and researchers of logic. The event created an important link between the aspiring logic establishment of China and the rather well developed logic establishment of Europe.

Organiser: Professor Jouko Väänänen, University of Amsterdam, the Netherlands (LINT)

- **Workshop 'Vague Quantities and Vague Quantifiers'**

8-9 December 2010, Berlin, Germany

The topic of vagueness has been extensively investigated from the perspective of a diverse range of disciplines. While most work in this area has focused on vague adjectives (e.g. *red*, *thin*, *bald*) and nouns (e.g. *heap*), there is also a growing body of work on vague quantifiers and other vague expressions of quantity.

This workshop brought together the members of a number of LogICCC CRPs actively involved in researching vagueness – VAAG, LcpR, LoMoReVi and LINT – to exchange ideas, methods and research results relating to vague quantity and vague quantifiers. The topic of vague quantities and vague quantifiers has the potential to represent an important testing ground for alternate approaches to vagueness and related phenomena. In approaching this topic in a collaborative manner, the VAAG, LoMoReVi and LINT groups explored connections between their approaches and methods, and in doing so, set towards developing a deeper interdisciplinary perspective on the phenomenon of vagueness as it occurs in the expression of quantity. Participation in the event gave members of VAAG, LoMoReVi, LINT and LcpR the opportunity to look across disciplinary boundaries for ideas and methods, opening up possibilities for further dialogue and cooperation.

Organiser: Dr Ulrich Sauerland, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany (VAAG)

ICLA 2011

- **Cross-CRP Workshop 'LogICCC meets India' – a cross-CRP workshop at the conference ICLA**

7-8 January 2011, Delhi, India

In the spirit of the highly successful event 'LogICCC meets China' held in 2009 and followed up in 2010, the current workshop linked the CRPs of LogICCC to the Indian research community in logic. The Indian logic community is strongly influenced by the basic research questions that drive the LogICCC CRPs: the role of interaction in logic, the role of logic in interaction, and the friction between the vague and the precise. Almost all of the LogICCC CRPs have an immediate research link to the main logic topics in India: for instance, LINT relates closely to the work on interactive logic done in India; LcpR and VAAG to the work on vagueness (including both modern logic, such as the rough set

theory that is done at IIT Kanpur, and traditional Indian logic); both the dialogical and the historical approach of DiFoS link it to various Indian traditions (and, in fact, some research in DiFoS has already dealt with Indian logics).

Representatives from all eight CRPs attended the workshop which was a satellite meeting of the 4th Indian Conference on Logic and its Applications, making it a truly ‘pan-LogICCCal’ event. As part of the event, the organiser arranged an appointment with the Delhi office of the DFG to meet Dr Torsten Fischer. Prior contact had been made with the Indian Department for Science and Technology (DST) and these strands were tied together in the months after the meeting with the DST offering a generous multiyear support for exchange in research and teaching in logic between Europe and India, as long as a consortium of European universities is found to match the Indian funds. This project is coordinated by the organiser of the ‘LogICCC meets India’ event and Professor Ramanujam and is currently in the process of taking shape.

Organiser: Professor Benedikt Löwe, University of Amsterdam, the Netherlands (DiFoS)

- **Workshop ‘Proof and Dialogues’**

25-27 February 2011, Tübingen, Germany

The notion of proof is one of the cornerstones of logic. Proof theory is a discipline whose development contributed in an essential manner to our understanding of what logic is. The interest in logical characterisations of the notion of dialogue in the spirit of Lorenzen’s work has, on the other hand, only recently spread in the international literature after it had been discussed in the 1960s and 1970s. Dialogues were introduced in order to overcome some difficulties that the project of characterising the meaning of logical constants in proof-theoretic terms had to face.

This joint workshop was organised by DiFoS and LoMoReVI as a way of bringing the CRPs together so as to discuss several aspects of the relationship between the notions of ‘proof’ and ‘dialogue’. The workshop aimed at displaying and discussing the theoretical questions raised by a comparison of proofs and dialogues from a logical and philosophical standpoint. New insights were gained from the presentations of several completeness results for variations of (hyper-)sequent calculi with respect to dialogical systems. Plans were made for Professor Pawel Urzyczyn to visit the Tübingen group later in the year, where these issues would be treated further (this meeting took place in May, 2011). Furthermore, the meeting enabled the collaboration

between DiFoS and LoMoReVI on hypersequent systems to be intensified. Thus it acted as a way of further developing the established and reciprocally acknowledged research interests of the two projects involved.

Organiser: Professor Peter Schroeder-Heister, University of Tübingen, Germany (DiFoS)

- **Oxford-LINT Workshop**

2-3 April 2011, Oxford, United Kingdom

This dissemination activity aimed at informing the wider LogICCC community, and the wider Oxford computer science community, about new results achieved in the LINT project by the Tampere-Helsinki team. These results concerned decidability and undecidability independence logic with two variables. The two-variable fragment is important not least because modal logic can be embedded into it.

Bringing the results of the Tampere-Helsinki team to a wider audience helped strengthen the science objectives of the LogICCC programme, by indicating in an important special case the most relevant boundary between what is in principle possible, i.e., decidable, and what is practically impossible, i.e., undecidable.

Organiser: Professor Jouko Väänänen, University of Amsterdam, the Netherlands (LINT)

- **Workshop ‘Conditionals, Counterfactuals and Causes in Uncertain Environments’**

19-22 May 2011, Düsseldorf, Germany

This inter-CRP workshop brought together new and fruitful approaches to the logics, philosophy and psychology of indicative, counterfactual and causal conditionals. It focused on semantic modelling of uncertainty in conditional and counterfactual reasoning. A further intention was also to establish fruitful interrelations between logical, philosophical and psychological theories on these topics.

Organiser: Professor Gerhard Schurz, University of Düsseldorf, Germany (LcpR)

- **Short-term joint exchange visit by Dr Sara Uckelman (DiFoS, Amsterdam) and Dr Jesse Alama (DiFoS, Lisbon) visiting Professor Chris Fermüller (LoMoReVi, Vienna)**

29 May – 10 July 2011, Vienna, Austria

The aim of this short-term visit was for Drs Uckelman and Alama from the DiFoS CRP to work with the LoMoReVI team. In particular, the interaction was with Professor Fermüller, an expert on dialogical logic and its connections to proof theory, and Mr Roschger, who has also worked on a web-implementation of dialogue games.

The focus of the proposed visit was to extend work that Drs Uckelman and Alama have already done on dialogical logic. Specifically, the intention was to: (a) increase their knowledge of the connections between dialogical logic, proof-theoretic semantics and proof theory; (b) extend the website for playing Lorenzen dialogical games that Dr Alama has developed to cover many-valued logics; (c) exploit the developments in logics of vagueness as produced by members of LoMoReVI to investigate super-intuistic logics. Drs Uckelman and Alama took advantage of both the expertise in proof-theoretic aspects of dialogical logic in the members of the LoMoReVI group, as well as bringing their expertise in implementations to bear on vagueness-related problems studied in that CRP. The visit thus had positive added value for members of both DiFoS and LoMoReVI.

Organisers: Dr Sara Uckelman, University of Amsterdam, the Netherlands (DiFoS) and Dr Jesse Alama, New University of Lisbon, Portugal (DiFoS)

- **12th International Conference on Relational and Algebraic Methods in Computer Science – with a special track on computational social choice and social software (RAMiCS 12)**
30 May – 3 June 2011, Rotterdam, the Netherlands

Relational and algebraic methods and software tools like RELVIEW are useful for solving problems in social choice and game theory. For that reason this conference included a special track on social software, organised by the CFSC and SSEAC CRPs from the LogICCC programme. This track on computational social choice and social software was not restricted to one special day, but was visible throughout the whole conference.

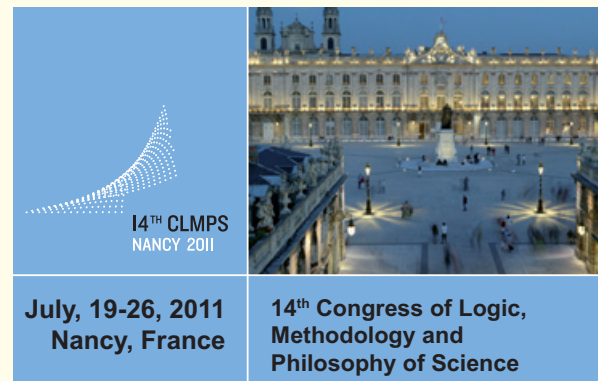
For LogICCC participants it was instructive to see how relational and algebraic methods and



Erasmus Bridge in Rotterdam, the Netherlands, the host city for the conference

software tools like RELVIEW may be useful for computational social choice and social software, while participants from the field of relational and algebraic methods learned how these approaches may be applied to real life problems from social choice and game theory. At the same time, members of the LogICCC community had the opportunity to disseminate their results to a group of interested scientists in the field of relational and algebraic methods in computer science.

Organiser: Professor Harrie de Swart, Erasmus University of Rotterdam, the Netherlands (SSEAC)



The poster for the event © IUHPS/CLMPS

- **Cross-CRP symposium ‘Logical Modelling for Interaction, Communication, Cognition and Computation’ at the Congress for Logic, Methodology and Philosophy of Science (CLMPS XIV)**

19-26 July 2011, Nancy, France

This cross-CRP symposium will focus on logical modelling and its empirical component. In logical modelling, ‘empirical’ or ‘testing’ does not always refer to a laboratory situation. The goal of the meeting is for the participants to paint a broad picture of how logicians encounter various empirical situations, and the resulting methodological issues. Representatives from five of LogICCC’s CRPs will be in attendance, ensuring that the theme of the interface between the formal and the empirical will be covered well.

Beyond the dissemination of LogICCC research, the meeting will also be an excellent opportunity for the LogICCC researchers to interact and exchange experiences. It is expected that most of the speakers will not only come for the LogICCC symposium, but stay for the CLMPS XIV congress, giving ample opportunity for cross-CRP interaction.

Organiser: Professor Benedikt Löwe, University of Amsterdam, the Netherlands (DiFoS)

- **ESSLLI Workshop ‘The Proper Use of Quantification in Ordinary Language’**

7-12 August 2011, Ljubljana, Slovenia

Quantification has been at the heart of logic since the invention of predicate logic by Frege more than 140 years ago. Quantification is an important topic in many of the LogICCC CRPs, especially VAAG, LoMoReVI, DiFoS, GASICS and LINT. Several aspects of quantification have been addressed at LogICCC events already, specifically at ESSLLI 2010 in Copenhagen. This workshop will focus on an aspect not yet addressed in previous LogICCC workshops: generalised quantifier theory in its relation to linguistic pragmatics. This theme is particularly important for LINT and VAAG, but will also have a wider significance for some of the other CRPs.

The workshop will be in the *Logic and Language* thematic line of ESSLLI and will include both graduate students and advanced researchers in linguistics, logic, computer science and philosophy.

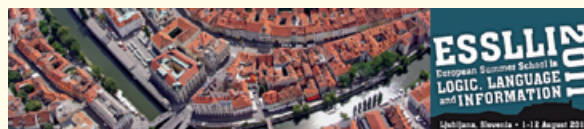
Organiser: Dr Ulrich Sauerland, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany (VAAG)

- **ESSLLI Workshop on Logical Constants**

8-12 August 2011, Ljubljana, Slovenia

All logical systems and languages make a distinction between logical and non-logical symbols. The meaning of the former needs to be specified in detail and in effect defines the logic in question, whereas the meanings of the latter are in a sense arbitrary. This distinction is usually stipulated (though it can be argued that natural languages make a similar distinction), but the issue of the grounds for it, i.e., of what characterises a logical constant, is a central question in logic, cutting across the huge variety of logical systems existing today (although it in fact goes back to the medieval distinction between categorematic and syncategorematic terms). This question is the focus of one of the subprojects of the LINT CRP (located in Gothenburg). It naturally ties in with other parts of LINT and also with other CRPs within LogICCC, in particular those dealing with vagueness and fuzzy logic.

The two main aims of the workshop will be to bring closer together the various approaches to logicity, both within and outside the logic community, and to determine whether and how the methods used for classical systems can be exported to other settings. Regarding the first goal, the workshop will gather advocates of both the semantic and the proof-theoretic perspectives, as well as some linguists interested in the status of functional



The logo for the ESSLLI 2011

expressions. As far as the second goal is concerned, the event will encourage submissions relying on non-classical logics.

Organiser: Professor Dag Westerståhl, University of Gothenburg, Sweden (LINT)

- **ESSLLI Course ‘Imprecision and Approximation’**

8-12 August 2011, Ljubljana, Slovenia

The topics of imprecision and approximation are central to the research goals of the VAAG CRP, and work by VAAG researchers in the context of the project has explored these issues in depth. As such, the European Summer Schools in Logic, Language and Information (ESSLLI) provide an ideal setting to disseminate the results of the VAAG project to the research community as a whole. In addition, the topic of this course is closely related to the theme of the cross-CRP workshop ‘Vague Quantities and Vague Quantifiers’, which was held in Berlin in December 2010 as a joint activity of VAAG, LoMoReVI and LINT. The ESSLLI course will also provide an ideal opportunity to disseminate the multidisciplinary findings from this workshop to a wider audience. The intention is also to offer a workshop that ties in with the class specifically on themes related to vagueness and approximation in quantification.

Organiser: Dr Ulrich Sauerland, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany (VAAG)

- **LogICCC Final Conference**

15-18 September 2011, Berlin, Germany

The networking phase of the EUROCORES Programme LogICCC comes to a close with this final, major event. With many representatives from across the CRPs in attendance, the final conference promises to offer a fitting celebration of all that the programme has achieved over the last three years. The structure of the conference seeks to reflect these achievements, which have been witnessed both within and across the CRPs.

By way of introduction, during the first day of the conference all CRPs will be given the floor to present themselves. Rather than providing an overview of all the work that they have carried out in the past three years (which participants can find

described in the accompanying conference package), the CRP presentations will focus on a particular result or research line that they wish to highlight.

Throughout the running time of the programme, the LogICCC members have been actively engaged in creating synergy among the various LogICCC CRPs. An important outcome of the LogICCC programme as a whole is indeed that the programme has proven to be more than the sum of its parts. To present this added value, the second day of the LogICCC final conference will be structured around four sessions that each address an issue that lies on the interface of various LogICCC CRPs and that have emerged during the running time of the programme as holding particular promise. In each session speakers from at least two different CRPs will present their views. Apart from presenting the outcome of the programme, this structure also allows the conference to point towards new directions of research. The conference will end in the plenary with a session that will be of interest to many CRPs, concerning the general theme of ‘logic and games’.

What seems clear from the array of cross-CRP presentations is that, although this may be billed as a ‘final’ conference, the research links and networks that have been created through LogICCC will continue well into the future, ensuring a long life for all that the programme has done.

Organiser: ESF Office

Publications

In addition to the above networking, training and dissemination activities, funds were also granted to support the following publications:

- ***Vagueness in Communication***, publication in the Lecture Notes in Artificial Intelligence, Springer, 2011

This volume consists of a selection of contributions to the ESSLLI 2009 workshop on ‘Vagueness in Communication’ which took place in Bordeaux, France. All five sessions of the workshop were very well attended and provided significant publicity to the LogICCC programme. Vagueness can be described as one of the central issues of LogICCC with two of the eight projects focussing solely on it and others giving it an investigatory role. This volume collects a state of the art review and new insights on the problem of vagueness. Furthermore, it includes four chapters that are directly drawn from the VAAG research team. VAAG was very fortunate in being able to organise this high-quality workshop early in the tenure of the project. The book was published by Springer Press in 2011.

Organiser: Dr Ulrich Sauerland, Zentrum für Allgemeine Sprachwissenschaft, Berlin, Germany (VAAG)

- ***Reasoning under Vagueness – Logical, Philosophical and Linguistic Perspectives***, edited by Petr Cintula, Christian Fermüller, Lluis Godo and Petr Hajek, College Publications, forthcoming

The volume is scheduled to contain 21 papers, all but one by participants of the conference ‘Logical Models of Reasoning under Vagueness’, that took place in Cejkovice, in September 2009. All contributions focus on the topic of that conference.

It was already announced in the application for support of the conference that corresponding results would be published in an adequate form. It was felt that a volume of a broad range of contributions from various different fields calls for a specific, properly edited volume, rather than a special journal issue which would have an intended readership that is less interdisciplinary as seems adequate here. Moreover, the volume will also provide a fine opportunity to document results from LoMoReVi and VAAG researchers in a manner that is able to attract attention of an audience not just consisting of specialists in one or other of the particular fields. The book is currently in press at College Publications, London.

Organiser: Professor Christian Fermüller, Vienna University of Technology, Austria (LoMoReVi)

6.

Governing Bodies



The quality of the EUROCORES Programme LogICCC was ensured by the following committees:

6.1 Scientific Committee

The Scientific Committee – including representatives of each of the LogICCC Collaborative Research Projects and the EUROCORES Programme Coordinator – was responsible for the networking and dissemination of activities in the programme.

Professor Felix Brandt

University of Munich, Germany
Representing the LogICCC project: CFSC

Professor Harrie de Swart

Tilburg University, the Netherlands
Representing the LogICCC project: SSEAC

Professor Christian Fermüller

Vienna University of Technology, Austria
Representing the LogICCC project: LoMoReVi

Professor Gernot Kleiter

University of Salzburg, Austria
Representing the LogICCC project: LcpR

Professor Manfred Krifka

Zentrum für Allgemeine Sprachwissenschaft, Typologie und Universalienforschung, Berlin, Germany
Representing the LogICCC project: VAAG

Professor Jean-François Raskin

Université Libre de Bruxelles, Belgium
Representing the LogICCC project: GASICS

Professor Peter Schroeder-Heister

Universität Tübingen, Germany
Representing the LogICCC project: DiFoS

Professor Dag Westerståhl

Gothenburg University, Sweden
Representing the LogICCC project: LINT

Dr Eva Hoogland (Secretary)
European Science Foundation

6.2 Review Panel

The independent international Review Panel, formed of leading experts in the field, oversaw the scientific aspects of the programme. The Review Panel played a key role in the selection and review process.

Professor Luigia Carlucci Aiello
(Chair)

Dipartimento di Informatica e Sistemistica
Università di Roma ‘La Sapienza’, Italy

Dr Klaus Abbink

Center for Research in Experimental Economics and Political Decision-Making
University of Amsterdam, the Netherlands

Dr Natasha Alechina (as from September 2007)

School of Computer Science and Information Technology, University of Nottingham, United Kingdom

Professor Franz Baader

Chair for Automata Theory,

Institute of Theoretical Computer Science, TU Dresden, Germany

Professor Patrick Blackburn

TALARIS project
INRIA Lorraine, Villers les Nancy, France

Dr Ilan Fischer

Department of Social Psychology
University of Haifa, Israel

Professor Jean Gabriel Ganascia

Groupe Sciences Cognitives
Université Pierre et Marie Curie (Paris VI), France

Dr Hannes Leitgeb

Department of Mathematics and Department of Philosophy,
University of Bristol, United Kingdom

Professor Herman Ruge Jervell

Research Group of Logic and Natural Languages
University of Oslo, Norway

Professor Jan Štěpán

Department of Philosophy
Palacký University, Olomouc, Czech Republic

Professor Isabel Trancoso

Spoken Language Systems Lab, Electrical and Computer Department, Universidade Técnica de Lisboa, Portugal

6.3 Management Committee

The programme was overseen by the Management Committee, formed by one representative of each of the National Funding Agencies and the EUROCORES Programme Coordinator.

Austria



Der Wissenschaftsfonds.

Dr Maria Weissenböck

(from 2007-2008)

Dr Falk J. Reckling

(from 2008-present)

Fonds zur Förderung der wissenschaftlichen Forschung (FWF) - Austrian Science Fund, Abteilung für Geistes- u. Sozialwissenschaften, Wien, Austria

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