

Scientific Report
The Challenge of Semantics
ESF Exploratory Workshop (EW03-066)

Vienna, from 12. July (afternoon) to 17. July 2004

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1 Executive Summary

The workshop was held in the Prechtl-Auditorium and the Schütte-Lihotzky-Auditorium¹ of the Vienna University of Technology, from July 12th (afternoon) to July 17th 2004.

Below, we provide some general information on the workshop.

1.1 Committee

Scientific Committee

Matthias Baaz (Scientific Convenor) and Agata Ciabattoni (Scientific Co-convenor):

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Local Organizing Committee

Matthias Baaz (Chair), Arnold Beckmann, Agata Ciabattoni, Christian G. Fermüller, Rosalie Iemhoff, George Metcalfe, Norbert Preining, Sebastiaan Terwijn.

1.2 Structure of participants

The workshop was attended by 30 participants from various European and non-European countries, making the workshop a truly international event. Both young and female scientists were well represented. See Section 4.2 for more details.

1.3 Technical Program

The technical program of the workshop consisted of 27 talks (of length varying between 20 and 60 minutes). All talks had been well prepared and were presented at a common high scientific level. At the end of (almost) every talk there were lively discussions and exchange of ideas. The content of these discussions will be also included in the proceedings of the workshop (see Section 1.5).

The schedule of the workshop was devised to leave ample time for individual discussions and to give participants the opportunity to attend some talks of the

¹Both rooms were equipped for the wireless transfer of datas during the lectures.

workshop (ERCIM) on related topics organized by Prof. Hajék on the Tuesday, Wednesday and Thursday afternoons. Since all participants were staying in the same area (most of them at the same hotel), these discussions frequently continued during dinner and even into the late evening.

1.4 Social Program

On the late afternoon of Friday 16th of July, two walks were organized, giving participants the opportunity either to have a guided tour of the impressive architecture at the center of Vienna, or to take in the beautiful scenery of the nearby Vienna Woods. The two groups then reconvened in the evening for the workshop social dinner which took place at the restaurant Eischers Kronenstüberl, located in the wine-growing region of Vienna.

1.5 Proceedings

A special issue of the international journal

Logic Journal of the IGPL (see <http://www3.oup.co.uk/igpl/>)

published by Oxford University Press, will be devoted to selected papers presented at the Workshop. The deadline for the submission of papers will be the end of November 2004, and the process of refereeing and revising submissions is expected to be finished by May 2005. Discussions/comments related to the accepted papers will also be published, subject to review. The editors of this volume will be Matthias Baaz, Agata Ciabattoni, Dov Gabbay and Petr Hajék.

1.6 Web Site

The workshop web site can be located at:

<http://www.logic.at/cos04>

2 Scientific Content of the Workshop

Due mainly to the pioneering work of L. Zadeh, it is widely recognized that fuzzy logic is the basis for reasoning with vagueness. Nowadays, the literature on fuzzy logic is enormous; however, only in recent years has a sound mathematical foundation for this field emerged. As a consequence of this research, it has been shown that reasoning in fuzzy logic may be formalized in certain infinite-valued logics, the most fundamental being Łukasiewicz, Gödel and Product logic. At the propositional level, these logics jointly allow the representation of all continuous t -norm based logics, the latter being the main tool to deal with imprecise information.

However, most practical and scientific applications require *deduction systems* in *first-order* logics. In contrast to the propositional level, it has been shown that most of the above mentioned *t*-norm based logics are not recursively axiomatizable with respect to the natural first-order extension of their propositional semantics. A notable exception is Gödel logic, the logic of ordinal relations of truth-values, but since this logic cannot be applied in circumstances where quantitative information counts, various groups of scientists have started to express doubts about the true nature of the underlying semantics, especially in the case of Łukasiewicz logic, the most important of the logics considered.

3 Assessment of the results, contribution to the future direction of the field, outcome

The main topic of the workshop was the issue of the semantic background of fuzzy logics and logics of vagueness, particularly in the context of first-order reasoning. The workshop brought together eminent scientists from mutually disjoint communities (logic, philosophy, mathematics, computer science and engineering) representing different approaches to dealing with this issue. Below we describe these various lines of investigation, giving a brief synopsis of some related lectures presented at the workshop.

Algebraic and geometric approaches were highlighted by the lectures of F. Esteva, U. Höhle and S. Jenei among others, the problem of first-order extensions appearing in this context as the problem of defining adaequate completions. A Cantorian approach was presented by P. Hajék in his opening lecture, which outlined the set-theoretic foundations of fuzzy mathematics. The lecture of H. Ono provided a direct characterization of the syntax/semantics relation of intermediate first-order logics. A. Avron demonstrated how semantic concepts can be generated from proof theoretic ones and vice versa.

A more methodological viewpoint was prominent in the lectures of R. Zach and C. Fermüller, who provided alternative game theoretic foundations for the semantics of fuzzy logics. The lecture of P. Vojtas demonstrated on the other hand, that semantic concepts can be directly abstracted from applicative issues. The gap between abstract semantics and applications was bridged by the lecture of D. Dubois, who explained, how a thorough semantical analysis may be used to avoid practical problems caused by a confusion of notions.

In the course of the lectures and discussions the following three main problems emerged:

1. A strong preference for the properties of classical logic and classical reasoning on the meta-level obstructs the development of adaequate semantics for fuzzy logics.

2. The classes of logics under consideration are either generated by semantic or by deductive (proof theoretic) concepts. It is often difficult to establish correspondences between the two.
3. A frequent confusion of notions such as fuzziness, vagueness and probability is a serious obstacle to real-world applications of semantical concepts.

The organizers are convinced that the workshop has achieved its goals, providing partial answers to the problems above.

1. Game theoretic semantics and partially specified semantics are an important step in the right direction in providing more robust semantics for first-order logics.
2. A thorough proof theoretic analysis has the potential to connect semantic and syntactic presentations of fuzzy logics.
3. Confusion of notions such as fuzziness, vagueness and probability can be avoided by a thorough semantic analysis of the application under consideration.

Moreover it became obvious during the workshop, that these problems can be fully solved only by the interactions of different disciplines and hence it is one of the major contributions of the workshop towards the future of the field, that it fostered the collaboration of previously disconnected research communities.

The results of the workshop will be disseminated by publishing the lectures in a special issue of the Logic Journal of the IGPL edited by M. Baaz, A. Ciabattoni, D. Gabbay, P. Hajék (see Section 1.5). Also participants of the workshop have agreed to include discussions connected to the lectures which will indeed be continued via e-mail up until publication of the volume.

4 Participants

The list of participants at our workshop is provided below, sorted by country.

4.1 List of Participants

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4.2 Statistical Information

Including the organizers, the workshop had 30 participants from 12 European countries and from Japan, Canada and Israel. The convenors made a special effort to encourage the participation of female and young scientists (≤ 35 years). Indeed, there were 7 female participants (21%) and 12 young scientists (36%).

5 Scientific Program

The final program of the workshop is given below. Note that the afternoon program of some days was intentionally short. This way participants had the opportunity to discuss and attend some talks on related topics organized separately at these times by Prof. Hajék.

²Richard Zach studied at the Institut für Diskrete Mathematik und Geometrie, Technische Universität Wien, Austria

MONDAY 12. July

13.00 – 14.00 Registration and Welcome Reception

14.00 – 14.10 Opening

14.10 – 15.10 Petr Hajék (Prague, Czech Republic): “On set theory in fuzzy logic”

15.10 – 15.40 Norbert Preining (Vienna, Austria): “Semantics of Gödel logics”

15.40 – 16.00 Petr Cintula (Prague, Czech Republic): “Evaluation games in fuzzy logics”

16.00 – 16.30 Discussion and Coffee Break

16.30 – 17.30 Peter Vojtas (Kosice, Slovak Republic): “Relations between deductive and inductive models of imperfect information and knowledge”

17.30 – 18.20 Richard Zach (Calgary, Canada): “Semantics for vagueness vs. logics for vagueness: The case of fuzzy logics”

TUESDAY 13. July

09.00 – 10.00 Arnon Avron (Tel-Aviv, Israel): “Non-deterministic multiple-valued structures – a general semantic framework”

10.00 – 11.00 Ewa Orłowska (Warsaw, Poland): “Semantic framework for lattice-based logics”

11.00 – 11.30 Discussion and Coffee Break

11.30 – 12.30 Beata Konikowska (Warsaw, Poland): “From semantics to deduction with Rasiowa-Sikowski methodology”

12.30 – 13.20 Lluís Godó (Bellaterra, Spain): “Reasoning with partial degrees of truth in t-norm based fuzzy logics”

13.20 Lunch

WEDNESDAY 14. July

09.00 – 10.00 Ulrich Höhle (Wuppertal, Germany): “Local Existence in Monoidal Logics”

10.00 – 10.45 Daniele Mundici (Florence, Italy): “Regularity conditions for nonboolean partitions and projective lattice-ordered groups”

10.45 – 11.15 Discussion and Coffee Break

11.15 – 12.15 Hiroakira Ono (Ishikawa, Japan): “Predicate logics around Gödel logic – completeness problem and expressive power”

12.15 – 12.45 Arnold Beckmann (Vienna, Austria): “On a connection between Gödel logics and linearly ordered Kripke frames”

13.05 Lunch

THURSDAY 15. July

09.00 – 10.00 Didier Dubois (Toulouse, France): “Some remarks on truth-values and degrees of belief”

10.00 – 11.00 Piero Bonatti (Napoli, Italy): “Fuzzy description logics for knowledge representation”

11.00 – 11.30 Discussion and Coffee Break

11.30 – 12.15 Reiner Haehnle (Göteborg, Sweden): “Many-valued logic in formal specification language”

12.15 – 12:45 Libor Behounek (Prague, Czech Republic): “Fuzzy intensional Semantics and Its Applications”

12:45 Lunch

FRIDAY 16. July

09.00 – 10.00 Dov Gabbay (London, England): “Temporal Dynamics of Argumentation Networks”

10.00 – 11.00 Viorica Sofronie-Stokkermans (Saarbrücken, Germany): “Representation theorems for lattice-ordered structures and automated theorem proving in non-classical logics”

11.00 – 11.30 Discussion and Coffee Break

11.30 – 11:50 Petr Cintula, Libor Behounek (Prague, Czech Republic): “From Fuzzy Logic to Fuzzy Mathematics: Methodological Aspects”

11:50 – 12.50 Christian Fermüller (Vienna, Austria): “Revisiting Giles: On Bets, Dialogue Games, Fuzzy logics, and Hypersequents”

12.50 Lunch

14.30 – 15.30 George Metcalfe (Vienna, Austria): “Uninorm based Fuzzy Logics”

15.30 – 16.10 Susana Muñoz Hernández (Madrid, Spain): “Fuzzy Prolog Evolution: Implementation vs Semantics”

16.10 – 17:00 Discussion and Coffee Break

Evening Social dinner.

SATURDAY 17. July

09.00 – 10.00 Albert Visser (Utrecht, Netherlands): “The Janus Faced Nature of Polish Notation”

10.00 – 10.45 Francesc Esteva (Bellaterra, Spain): “Exploring algebraic aspects of t-norm based logics: work in progress”

10.45 – 11.15 Discussion and Coffee Break

11.15 – 12.00 Sandor Jenei (Pécs, Hungary): “On monoidal operations for non-classical logics”

12.00 – 13.00 Irina Perfilieva (Ostrava, Czech Republic): “Functional systems of BL-algebras: characterization and canonical representation”

13.00 Lunch

14.30 – Open end Final Discussion