Non-classical Logics:
from Foundations to Applications

Centro di Ricerca Matematica Ennio de Giorgi,
Scuola Normale Superiore, Pisa

http://homepage.sns.it/hosni/ncl08/

24-26 April 2008

Contents

1 Timetable

	24 April	25 April	26 April
09:00 - 10:00	Registration	Williamson	Caleiro
10:00 - 11:00	Hájek	Flaminio	Wheeler
11:00 - 11:30	Coffee	Coffee	Coffee
11:30 - 12:30	Baaz	Ciabattoni	Leitsch
12:30 - 14:30	Lunch	Lunch	Lunch
14:30 - 15:30	Marra	van der Hoek	Paris
15:30 - 16:30	Aguzzoli	Fermueller	Round table
16:30 - 17:00	Coffee	Coffee	
17:00 - 18:00	Bova		
17:30 - 18:00			Reception

The default venue for the meeting will be the **Conference Room of the Palazzo Puteano**. In case of an unexpectedly large number of participants, the workshop will be moved to the Aula Bianchi of the Palazzo della Carovana starting from 25 April.

Organization

Programme committee Hykel Hosni, Franco Montagna Massimo Mugnai and Daniele Mundici

Local arrangements Ilaria Gabbani, Antonella Gregorace and Hykel Hosni.

2 List of invited speakers

- Stefano Aguzzoli (Dipartimento di Scienze dell'Informazione, Università di Milano)
  aguzzoli[at]dsi.unimi.it

- Matthias Baaz (Vienna, Tech. Universitaet)
  baaz[at]logic.at

- Simone Bova (Dipartimento di Matematica, Università di Siena)
  bova[at]unisi.it

- Carlos Caleiro (Departamento de Matemática, Instituto Superior Técnico, Lisboa)
  ccal[at]math.ist.utl.pt

- Agata Ciabattoni (Vienna, Tech. Universitaet)
  agata[at]logic.at

- Chris Fermueller (Vienna, Tech. Universitaet)
  chrisf[at]logic.at

- Tommaso Flaminio (Dipartimento di Matematica, Università di Siena)
  flaminio[at]unisi.it

- Petr Hájek (Academy of Sciences, Prague)
  hajek[at]cs.cas.cz

- Wiebe van der Hoek (Department of Computer Science, University of Liverpool)
  Wiebe.Van-Der-Hoek[at]liverpool.ac.uk

- Alexander Leitsch (Vienna, Tech. Universitaet)
  leitsch[at]logic.at

- Vincenzo Marra (Dipartimento di Informatica e Comunicazione, Università di Milano)
  marra[at]dico.unimi.it

- Jeff Paris, (School of Mathematics, University of Manchester)
  jeff.paris[at]manchester.ac.uk

- Gregory Wheeler (Centro de Inteligência Artificial, Universidade Nova de Lisboa)
  gregory.r.wheeler[at]gmail.com

- Jon Williamson (Center for Reasoning, University of Kent)
  j.williamson[at]kent.ac.uk

3 Participants

- Pietro Battiston, Università di Pisa, Italia. battiston@mail.dm.unipi.it

- Franco A. Cardillo, Università di Pisa, Italia. cardillo@di.unipi.it

- Giovanni Casini, Università di Pisa, Italia. giovanni.casini@gmail.com

- Petr Cintula, Academy of Science, Prague, Czech Republic. cintula@cs.cas.cz

- Giovanna Corsi, Unversità di Bologna, Italia. giovanna.corsi@unibo.it

- Peter Drabik, Università di Pisa, Italia. drabik@di.unipi.it

- Antonino Drago, Università di Pisa, Italia. drago@unina.it

- Umberto Grandi, Università di Pisa, Italia. grandi@mail.dm.unipi.it

- Ada Lettieri, Università di Napoli Federico II, Italia. lettieri@unina.it

- Claudio Marini, Università di Siena, Italia. marjnj@libero.it

- Ilaria Matteucci, Università di Siena, Italia. ilaria.matteucci@iit.cnr.it

- Carles Noguera, Università di Siena Italia. cnoguera@iiia.csic.es

- Soroush R. Rad, University of Manchester, UK. soroush.r.rad@gmail.com

- Giorgio Venturi , Università di Torino, Italia. gio.venturi@gmail.com

Students supported by a CRM travel grant

- Han T. Ahn, Universitade Nova de Lisboa, Portugal. h.anh@fct.unl.pt

- Bianca Boretti, Università di Milano, Italia. bianca.boretti@unimi.it

- Pietro Codara, Università di Milano, Italia. codara@mat.unimi.it

- Martina Fedel, Università di Siena, Italia. fedel@mail.dm.unipi.it

- Anna R. Ferraiolo, Università di Salerno, Italia. annarita.ferraioli@libero.it

- Juergen Landes, Universy of Manchester, UK. juergenlandes@yahoo.de

- João Moura, Universitade Nova de Lisboa, Portugal. joaomoura@yahoo.com

- Laura Porro, Università di Milano, Italia. lauracecilia.porro@gmail.com

- Luca Quaglia, Universitade Nova de Lisboa, Portugal. l.quaglia@fct.unl.pt

- Carroline D.P.K. Ramli, Universitade Nova de Lisboa, Portugal. cardepus@yahoo.co.uk

- Mikheil Rukhaia, Universitade Nova de Lisboa, Portugal. mrukhaia@yandex.ru

- Richard Simmonds, Universy of Manchester, UK. richard.simmonds@gmail.com

- Daniel Weller, Vienna, Tech. Universitaet, Austria. weller@logic.at

4   Abstracts

Complexity of fuzzy logic - an introduction

Petr Hájek

Main notions of computational complexity (NP-complete problems) and of arithmetical hierarchy of sets of natural numbers will be recalled. Mathematical fuzzy logic will be briefly surveyed as a particular many-valued logic with a comparative notion of truth. Then main results on the computational complexity of fuzzy propositional calculi and arithmetical complexity of fuzzy predicate calculi will be presented.

The S5 analoguous fragment of fuzzy logics

Matthias Baaz

We discuss decidable cases and open problem for the S5-analoguos fragment of first order logics. (The S5 analoguous fragment consists of formulas without overbinding of variables)

De Finetti's coherence criterion and finitely additive measures on algebras of many-valued logics. Part 1 — The general setting

Vincenzo Marra

By way of introduction to the following talk (by Stefano Aguzzoli), we discuss de Finetti's approach to the definition of probability as subjective rational belief. Following a suggestion by, among others, Jeff Paris, we then discuss how to extend de Finetti's criterion to many-valued (truth-functional) logics with truth-values ranging in the real unit interval $[0, 1]$. In particular, we briefly report on recent results (by Daniele Mundici and Jan Kühr) for Łukasiewicz logic and, more generally, logics whose connectives are interpreted by continuous functions. It turns out that the classical results generalize to the latter setting. We then turn to Gödel propositional logic, i.e., intuitionistic logic with the prelinearity axiom $(\alpha \rightarrow \beta) \vee (\beta \rightarrow \alpha)$. Here, in contrast to classical and Łukasiewicz logic, the sematics of implication is given by a discontinuous function. We illustrate by examples how this leads to an interesting new phenomenon. In Gödel logic, the notion of probability arising from de Finetti's coherence criterion is strictly weaker than that arising from averaging the truth-value of formulæ with respect to some measure.

De Finetti's coherence criterion and finitely additive measures on algebras of many-valued logics. Part 2 — The case of Gödel logic

Stefano Aguzzoli

We give axiomatic characterizations of the notions of finitely additive measure and de Finetti's subjective probability in Gödel logic, as introduced in the talk given by Vincenzo Marra. A *Gödel algebra* is the Lindenbaum-Tarski algebra of a theory in Gödel propositional logic. Equivalently, it is a Heyting algebra satisfying the prelinearity law $(x \to y) \vee (y \to x) = 1$. Fix an integer $n \geq 0$, and let G_n denote the free n-generated algebra in the variety of Gödel algebras. We characterize both the finitely additive measures on G_n, and the maps $s \colon G_n \to [0, 1]$ satisfying de Finetti's coherence criterion. Unlike the case of classical and Łukasiewicz logic, the two notions differ. Specifically, each map $s \colon G_n \to [0, 1]$ that is to be a finitely additive measure must satisfy a certain property related to the join-irreducible elements of G_n. The latter property, by contrast, is not enforced by de Finetti's coherence.

Functional Representation of BL-Algebras

Simone Bova

A BL-algebra is a commutative residuated bounded lattice satisfying divisibility and prelinearity. The variety of BL-algebras has a natural logical counterpart in the fuzzy propositional logic known as Hájek's basic logic, which is the logic of all continuous t-norms and their residua. Therefore, an explicit functional representation of the free n-generated BL-algebra amounts to a full description of the n-variate fragment of Hájek's basic logic. Using the free 2-generated BL-algebra as a case study, we present a geometrical approach to the functional representation of the free BL-algebra.

Probabilistic Logic and Probabilistic Networks

Jon Williamson

In this talk I'll describe the progicnet programme, joint work with Rolf Haenni, Jan-Willem Romeijn and Gregory Wheeler.

While in principle probabilistic logics might be applied to solve a range of problems, in practice they are rarely applied at present. This is perhaps because they seem disparate, complicated, and computationally intractable. However, we shall argue in this programmatic paper that several approaches to probabilistic logic fit into a simple unifying framework: logically complex evidence can be used to associate probability intervals or probabilities with sentences.

Specifically, we show first that there is a natural way to present a question posed in probabilistic logic, and that various inferential procedures provide semantics for that question: the standard probabilistic semantics (which takes probability functions as models), probabilistic argumentation (which considers the probability of a hypothesis being entailed by the evidence), evidential probability (which handles reference classes and frequency data), classical statistical inference (in particular the fiducial argument), Bayesian statistical inference (which ascribes probabilities to statistical hypotheses), and objective Bayesian epistemology (which determines appropriate degrees of belief on the basis of available evidence).

Further, we argue, there is the potential to develop computationally feasible methods to mesh with this framework. In particular, we show how credal and Bayesian networks can naturally be applied as a calculus for probabilistic logic. The probabilistic network itself depends upon the chosen semantics, but once the network is constructed, common machinery can be applied to generate answers to the fundamental question introduced above.

Probability of many-valued events: a many-valued logical approach

Tommaso Flaminio

In this talk we show how Mundici's states can be treated in a many-valued logical setting. In particular we firstly survey on modal extensions of Łukasiewicz logic allowing to deal with the probability of many-valued events, and then we introduce the variety of SMV-algebras which is obtained by internalizing states on MV-algebras. More precisely an SMV-algebra is an MV-algebra A added with a unary operator $\sigma : A \to A$ equationally described so to preserve the properties of a state.

For the latter approach we show how, starting from an SMV-algebra A one can define a state (in the sense of Mundici) on the MV-reduct of A, and vice-versa. We also apply SMV-algebras to equationally characterize the coherence of a rational-valued assessment over formulas of Łukasiewicz logic. Finally we propose an algebraic treatment of the Riemann integral and we show that internal states defined on a divisible MV_Δ-algebra can be represented by means of this more general notion of integral.

From axioms to analytic rules in nonclassical logics

Agata Ciabattoni

Gentzen sequent calculi and their extensions have been the central tool in many proof-theoretical investigations and applications of logic in computer science. In this talk I will introduce a systematic procedure to transform large classes of (Hilbert) axioms into equivalent inference rules in sequent and hypersequent calculi. This allows for the automated generation of analytic calculi for a wide range of nonclassical logics including intermediate, substructural and fuzzy logics. Applications of the generated calculi are also presented.

On Modal Logics for Cooperation and Coalition

Wiebe van der Hoek

In this talk I will first introduce Alternating-time Temporal Logic (ATL), a logic to reason about Coalitions. ATL is a natural extension of CTL, but rather than quantifying over branches, ATL quantifies over strategies of coalitions. Marc Pauly's Coalition Logic is a special case of ATL and, consequently, ATL is useful for reasoning about games as well. I will mention extensions of ATL that deal with Information and with Social Norms.

Then, if time allows, I will explain Coalitional Games, and, argue that terminology in the literature is somewhat confusing: Coalition Logic (and hence ATL) is for reasoning about cooperative games, and not for Coalitional Games. I will sketch how a logic for reasoning about Coalitional Games might look like.

Dialogue games as foundations of non-classical logics

Chris Fermüller

One of the oldest, but nowadays rather marginal approach to logic consists in viewing logic as a frame for rational argumentation to be modeled by a strategic dialogue game between an proponent and an opponent of a statement. Already in the 1950s Paul Lorenzen suggested to identify logical validity with the existence of a winning strategy for the proponent in such a game. While Lorenzen intended to provide a foundation for constructive reasoning in this manner, it is nowadays clear that many different nonclassical logics can be characterized by appropriate variations of Lorenzen's original dialogue game. In this talk we will explain and illustrate, in particular, also Robin Giles's dialogue game for Lukasiewicz logic and parallel Lorenzen style dialogues for the characterization of various intermediate logics

A bird's eye view on the joys and troubles of combined logics

Carlos Caleiro

Working with logics of a combined nature is becoming the rule, rather than the exception, as a tool for reasoning about complex phenomena, not just in mathematics but also in application fields ranging from computer science to linguistics. The systematic study of combined logics and mechanisms for combining logics has attracted the interest of many logicians in the last years. In this talk, we propose to revisit some of the cornerstones of the area, including the theory of fibring logics and associated transference results, but also more recent developments directed towards solving the so-called "collapsing problem" and leading to novel, perhaps unexpected, logics.

Rethinking Psychologism in Logic

Gregory Wheeler

What does it mean to say that logic is formal? There are two main candidates, one that concerns a technical ability to discriminate between different types of individuals, and another that concerns constitutive norms for reasoning as such. This essay embraces the former, **permutation-invariance** conception of logic and rejects the latter, Fregean conception of logic. Logic on my view hasn't anymore a direct connection to reasoning than analytical geometry does to moving planets. Still, there are **indirect** relationships. This talk addresses how logical norms arise within a purely mathematical conception of logic and presents a methodology for applied logic through remarks on a variety of issues concerning non-monotonic logic and non-monotonic inference.

CERES: Analysis of the fifth Proof of the Infinity of Primes

Alexander Leitsch

In this talk we present an application of the system CERES (cut-elimination by resolution) to proof mining. The investigated object is a well-known mathematical proof, the 5th proof of the infinity of primes in the book "Proofs from the Book" (from Aigner and Ziegler). This proof is based on a topological argument, where the topology is defined by arithmetic progressions. The characteristic clause set CL of this proof (which is actually formalized as a proof schema) produced by CERES can be refuted by resolution and paramodulation; one of the possible refutations of CL contains Euclid's construction of infinite sequences of primes. This shows that cut-elimination on the fifth proof, which removes all topological arguments from the proof, results in a well-known elementary proof. However, there are other refutations of CL representing arguments different from Euclid's one.

New Wave Inductive Logic

Jeff Paris

Abstract: Inductive Logic is commonly thought of as the creation of Rudolf Carnap and his followers in the 1940's though in fact a very similar path had been trodden some 20 years earlier by W.E. Johnson. The basic question underlying the subject is how pure logic, normally expressed as the observance certain arguably rational principles, should determine the subjective probabilities one assigns to uncertain events. In other words, if one is 'rational' how much freedom does one have in assigning beliefs as probabilities, to what extent is this subjective choice actually objective?

Whilst initially very promising Carnap's programme stalled in the late 1940's with the emergence of Nelson Goodman's GRUE Paradox and for the last four decades of the century this approach within formal logic to understanding induction fell almost entirely out of favour, to the extent of being dubbed 'Old fashioned Inductive Logic'.Recently however the subject has seen a renaissance with many new ideas being introduced, in part due to the topic's clear overlap with the wider and highly active branch of AI known as uncertain reasoning.

In my talk I will endeavour to explain the motivation and underlying assumptions within the subject, why GRUE is no longer relevant and some of the recent discoveries.

5 Getting to the workshop

The Centro De Giorgi can be reached from Pisa Airport http://www.pisa-airport.com (also known as Pisa-Florence Airport Galileo Galilei) and from the train station (Pisa Centrale) using city buses.

From the train station take the LAM VERDE (green) bus. It will head towards the Arno River and cross the river at the Solferino bridge. It then goes to the right along the river. Get off at the second stop after the bridge and locate Via Curtatone e Montanara, across the street and a few meters ahead. Take this street north, away from the river. It will change its name to via San Frediano, but leads directly to the Piazza dei Cavalieri where the Centro De Giorgi is located. The Centro is about 300 meters away from the river.

From the airport, take the LAM ROSSA (red) bus and switch to the LAM VERDE at the train station, continuing as above.

You can also take a taxi; the trip from the airport to the Centro costs about EUR 10.