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Editorial

It is with great pleasure that I return as guest editor of *The Reasoner*; my thanks to Jon Williamson and Federica Russo for the invitation. Dr. Keith Devlin kindly agreed to be this month's interviewee. Dr. Keith Devlin is a Senior Researcher at CSLI and its Executive Director, a Consulting Professor in the Department of Mathematics, and a co-founder of the Stanford Media X research network and of the university's H-STAR institute. He is a World Economic Forum Fellow and a Fellow of the American Association for the Advancement of Science.

Keith Devlin was a member of the Department of Mathematics at the University of Lancaster UK when I first met him, although I'm sure he doesn't remember me—a graduate student in a different department. Although I never took his courses, I knew students who did and his reputation as a communicator was considerable even in those early days, with high praise for his first book: *Sets, Functions and Logic*. Keith is a prolific author and his most recent book is *The Unfinished Game: Pascal, Fermat, and the Seventeenth Century Letter that Made the World Modern*, published by Basic Book in late 2008. Recipient of the Pythagoras Prize, the Peano Prize, the Carl Sagan Award, and the Joint Policy Board for Mathematics Communications Award, Keith is also 'the Math Guy' on National Public Radio in the United States. He also finds time for public lectures and television appearances! As a communicator of mathematics and reasoning to a wide audience, his work is truly in the spirit of *The Reasoner*.

As you will see from the interview, Keith's dedication to mathematics started at an early age leading to a career in pure mathematics. As a pure mathematician his philosophy was Platonist but no longer so; he now claims that 'mathematics is a human, social construct.'

Although Keith sees little value in teaching logic to students of statistics, he underlines the importance of teaching philosophy to students of probability. In most departments of statistics, neither logic nor philosophy is taught; an unfortunate situation. In studying the philosophy of probability to any depth, the student surely needs to understand logic; maybe this lack of initial training is the reason why so few students of statistics and probability also study the philosophical foundations of their subject.

I am delighted to introduce Professor Keith Devlin.

Dawn E. Holmes
Statistics and Applied Probability, University of California Santa Barbara

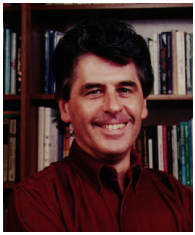
§2

FEATURES

Interview with Keith Devlin

Dawn E. Holmes: When was your interest in mathematics first aroused? How did you first get into logic as an area of research?

Keith Devlin: In 1957, the year before I transitioned from elementary school to high school, the Russians launched Sputnik, the world's first space vehicle. That so excited me, I decided right there and then I wanted to go into "science". I didn't really know what that involved. Growing up in a working class neighborhood in Hull, in the north of England, I had no role models in science, nor indeed in any profession. So "science" was little more than a word that I believed was the key to an exciting life in what everyone knew was going to be the Space Age. So when I went to high school in 1958, from the get-go I put a huge effort into mastering anything to do with science. That included mathematics. At the start I was okay at it but by no means the best in my class. But as the years progressed and I kept working at it, I eventually got to be Top Gun in math, with my career goal by then having narrowed to physics. Then, when I was about sixteen, I began to realize that I was more turned on by the mathematics than the physics it was intended to support. So by the time I went to university, I knew that I wanted to study mathematics. I've done so ever since.



DH: You are a prolific author, with 24 books to your name as well as over 70 research papers. Can you tell us, briefly, something about your research interests?

KD: The book count is now up to 28 published, with three more in the works! My first books were research monographs and then graduate texts in mathematical logic, specifically set theory, one of the hottest research areas in mathematics in the late 1960s when I went to graduate school. I worked in set theory until the early 1980s, but then lost interest as the subject grew more and more specialized and baroque, as most branches of mathematics do when the basics have been fully worked out. After a brief flirtation with AI, I became interested in mathematical linguistics, which led on to an additional interest in what is now called mathematical cognition, but back then did not have a name. I also became interested in using different media to expose, to explain, and sometimes to teach, mathematics to diverse audiences, including media in popular culture.

DH: Your book *Logic and Information* has become a standard text in situation theory. How has research in situation theory changed since this was first published?

KD: When I wrote that book in the late 1980s, there was still a belief, highly conditioned by Tarski's work on formal truth (model theory), Chomsky's work on syntax, and by advances in AI, that it would be possible to develop a fairly rigorous mathematical theory of natural language semantics and human rationality. Physics was the ideal we strove for. *Logic and Information* was written to be, and in the book I claimed it to be, the first of a two-volume work, the second of which would be a fully worked out, formal mathematical treatment of the material developed in a more intuitive way in that first volume. But as I worked on that planned (but never completed) second

volume, I came to realize that natural language communication and human rationality are not rule-based, and that the best that could be hoped for is an *approximate* mathematical description, and that the really interesting scientific questions would be at the boundaries, where the mathematics breaks down. I was heavily influenced by readings in sociolinguistics and in ethnomethodology. In particular, I felt that the work of the late Harvey Sacks represented the closest one could probably get to a 'mathematically precise' description of everyday cognitive phenomena. In my work with the linguist Duska Rosenberg, particularly our monograph *Language at Work*, we exemplified that judgment. I still feel my work with Rosenberg is some of my finest work ever, though the majority of my fellow mathematicians probably see it as marking my final "loss" to the field.

DH: Do you support a particular philosophy of mathematics?

KD: When I was doing pure mathematics, for the first twenty years of my career, I was an out and out Platonist. I still think in those terms when engaged in mathematics. (I have also written articles that attempt to explain why it is actually not possible to do mathematics except by adopting a Platonistic approach.) But after my experiences working on the abandoned second volume of *Logic and Information*, I became firmly convinced that Platonism is merely a cognitive stance, and that mathematics is a human, social construct, at least as reflective of the human mind as of the world/universe in which we live. A slightly better way to express this is that mathematics reflects the way the human mind encounters and responds to its environment. This explains why, despite being a creation of the human mind, mathematics is highly constrained. My approach to mathematics these days is as a mental framework for thinking about the world that sometimes can yield more precise answers than any other method. (Notice I did not say 'right' answers. In most domains, there are no right answers, just better ones.)

DH: You link AI and Maths. Do you think the early promise of AI has been realized?

KD: Do I (make such a link)? The only link I recall making is that AI is what arises when you try to apply mathematics to human thinking analogous to the way you apply it to the world in physics. My book *Goodbye Descartes* is a fairly systematic attempt to explain why I believe the original AI goal of building "machines that display human intelligence" is not achievable.

DH: What is the long term plan for your research? Is your area of research growing?

KD: Well, I have three major threads to my research. Mathematical cognition is now a rapidly growing and fascinating area of study. At the moment, most of the work is being done by people trained in psychology, some in collaboration with neuroscientists. Also, the bulk of the research focuses on numerical ability, not mathematical thinking in general. My books *The Math Gene* and *The Math Instinct* tried to broaden the scope to encompass all of mathematics. I believe those books demonstrate that mathematicians can contribute to the area. By way of evidence, I'll mention that an experimental psychologist (Daniela O'Neill) has already verified one of the hypotheses that came out of *The Math Gene*.

The second thread of my research is the use of situation theory and situation-theory-inspired methods to help design reasoning-support systems for intelligence analysts, work I've been doing, off and on (depending on funding) under government sponsorship since soon after 9/11. My third research strand is the use of traditional and new media to

teach mathematics to different audiences. In particular, of late I've been spending a lot of time playing videogames with a view to using the medium to provide mathematics learning opportunities for children who are disillusioned with school.

DH: You seem always to have sought to introduce students to mathematics in a way that promotes a broad understanding of the concepts and use of mathematics rather than the ability to master mathematical techniques. What part does reasoning play in this?

KD: Well, I would not say 'rather than' in the question, but 'in addition to'. I'm a great proponent of the National Research Council's 'five threads of mathematical competency' approach to mathematics education, as described in their book 'Adding it Up'. It is, however, true that I have put a lot of effort into promoting a broad understanding of mathematics. For that is where humans differ from a twenty dollar calculator (which easily outperforms us on application of many techniques). It is also, I think, by far the hardest to teach, and hence the most rewarding to attempt. But in fact the two go hand in hand: you cannot develop conceptual understanding without mastering the mechanics, and any mastery of mechanics will be brittle and short-lived unless it is supported by conceptual understanding.

DH: You are well known as an educator and a communicator. What teaching opportunities do you particularly value? Do you still teach?

KD: I love teaching to all kinds of audience in any venue. Every term I apply to teach mathematics courses at Stanford, but I've been turned down on every occasion but one. The problem is, my position at Stanford is a research and research administration position, with neither the right nor the obligation to teach. Consequently, I need to persuade the dean to 'buy my time' from the research budget in order to give a course, something that I've succeeded in doing only once in the past several years.

DH: You are known to the greater public as "The Math Guy". How did you get into radio?

KD: Way back in 1994, soon after Andrew Wiles proved Fermat's Last Theorem, NPR asked me to go on to be interviewed about the result. (They had been given my name by the press agent at the Joint Policy Board for Mathematics in Washington, who knew from my general audience books and magazine articles that I seem to have a knack of putting complicated, abstract ideas into terms that laypeople can relate to and understand.) The interview was such a hit, the producer asked me to appear regularly, and from then on I was a 'radio personality'. In fact, I'd done some radio for the BBC back when I lived in England, as a result of the twice-monthly column I wrote for The Guardian newspaper for many years, but my BBC work was not known in the US.

DH: Statistics and probability graduate students rarely get the opportunity to study logic and philosophy; do you think it is important that they should? Are there any particular topics that you would recommend to statistics and probability graduate students starting out today?

KD: I'm not a great advocate for teaching logic. It provides a passable model of mathematical reasoning but tells you little about everyday human reasoning. I can't see any particular benefit from teaching it to students of statistics and probability. Philosophy, on the other hand, is something altogether different. One of the thorniest philosophical problems I know of is, just what exactly is probability? Or more precisely, what are the various different flavors of probability? None of the standard explanations

of frequentist probability, epistemic probability, and the like, stand up to much analysis. Yet probability calculations present philosophical issues of enormous importance to society. For instance, there are a number of capital cases in appeals courts around the land at the moment that hinge on the correct application of probability calculations to evidence presented in court, particularly DNA evidence. And as of now, the experts have disagreed as to what probability calculation is applicable.

DH: Finally, in your view, what is an important open problem in situation theory?

KD: Find good real-world applications. I no longer see situation theory as a 'mathematical theory', rather as a framework for codifying and analyzing complex human and/or machine interactions. Its power is, I am sure, in its application. It's the only framework we have that brings any degree of mathematical formality and precision to issues of context and culture in human activity. Rosenberg and I hit paydirt with our first two applications, both described in *Language at Work* (and summarized in my easier-to-read book *Infosense*). Since then, we have found it much harder to make similar progress with other real-world problems. The social domain is a huge challenge for mathematical-based analytic approaches.

DH: Thank you.

Slingshot arguments: two versions

Slingshot arguments (in the sense employed in this piece) are arguments to the effect that all true sentences denote the same object, if sentences denote at all. There are various classical versions of slingshot arguments but they all share two assumptions:

(Sub) Substitution of co-referential expressions within a sentence doesn't change the reference of the whole sentence.

(Log) Logically equivalent sentences are co-referential.

Here's one version, based on Gödel's argument (1964: Russell's Mathematical Logic, in Benacerraf P., *Philosophy of Mathematics. Selected Readings*, 211-232). Take two true sentences A and B. Let a denote an arbitrary object, $D(A)$ is the denotation of A (since there is no serious danger of ambiguity, I don't use quotation marks).

(G1) A is logically equivalent to $a = (ix)(x = a \wedge A)$.

Indeed, if A is true, $(ix)(x = a \wedge A)$ will denote the same object as a, and if A is false, $(ix)(x = a \wedge A)$ will fail to denote an object, and *a fortiori*, it will fail to denote the same object as a. Similarly:

(G2) B is logically equivalent to $a = (ix)(x = a \wedge B)$.

(Log) allows to infer from (G1) and (G2):

(G3) $D(A) = D(a = (ix)(x = a \wedge A))$

(G4) $D(B) = D(a = (ix)(x = a \wedge B))$

Thanks to (G1) and (G2) (A and B are assumed to be true), we proceed:

(G5) $a = (ix)(x = a \wedge A)$

(G6) $a = (ix)(x = a \wedge B)$

(G7) $(ix)(x = a \wedge A) = (ix)(x = a \wedge B)$

(Sub) and (G7) yield:

(G8) $D(a = (ix)(x = a \wedge A)) = D(a = (ix)(x = a \wedge B))$

(G3), (G8) and (G4) give us:

(G9) $D(A) = D(B)$

Even if we accept (Sub), (Log) seems problematic. If we think of sentences as referring to states of affairs which they state, (Log) seems to come out false. Every two logically necessary sentences are logically equivalent, even if they do not seem to state the same things (compare '2+2=1' and the undecidability theorem for first-order classical logic).

Dalia Drai (2002: The Slingshot Argument: an Improved Version, *Ratio* (new series), XV(2)) has recently suggested an improvement to the slingshot argument, which employs the notion of doxastic synonymy of non-indexical expressions, and replaces (Log) with what is intended as a weaker principle:

(Dox) Doxastically synonymous expressions are co-referential.

where two sentences A and B are doxastically synonymous ($A \sim_d B$) iff it is not possible for someone who understands A and B to believe one of them without believing the other (2002: 196-197, 200). Drai has not defined doxastic synonymy of non-sentential expressions, but filling in those details is not crucial for the further development. Assume (Sub), (Dox) and the following:

(D1) $A \wedge B$

(D2) $A \sim_d$ the truth value of A is True

(D3) $B \sim_d$ the truth value of B is True

By (Dox) we get:

(D4) $D(A) = D$(the truth value of A is True)

(D5) $D(B) = D$(the truth value of B is True)

From (D1) it follows:

(D6) the truth value of A = the truth value of B

Thus, by (Sub), we can substitute 'the truth value of B' for 'the truth value of A' in (D4).

(D7) $D(A) = D(\text{the truth value of } B \text{ is True})$

From the transitivity of identity, (D5) and (D7) we derive:

(D8) $D(A) = D(B)$

Drai, who wants to be able to say that the slingshot argument that employs (Dox) instead of (Log) is more compelling, suggests that some logically equivalent sentences are not doxastically synonymous (well, we aren't logically omniscient), but not the other way round (2002: 200). The second half of this claim, however, sounds suspicious. It seems that there are *doxastically synonymous* sentences which are not logically equivalent. For instance, take the sentences:

(S1) Someone believes a sentence.

(S2) Every sentence is logically equivalent to itself.

There is quite an intuitive meaning of the verb 'to believe' in which one can hardly believe one of these without believing the other one. Thus, (S1) and (S2) seem doxastically synonymous, even though it is far from obvious that (S1) is logically equivalent to (S2). In a possible world where no conscious intelligent beings exist, or in a possible world where there are intelligent and conscious beings but they do not believe in any sentence, (S2) is still true, even though (S1) is false.

In general, if you believe that there are true *a priori* equivalences which are not logically necessary, or you believe that there are pairs of sentences that are assertible in exactly the same situations but this is so for pragmatic and not logical reasons, this is enough to reject the claim in question.

Drai suggests also that there is another reason to prefer (Dox) over (Log): the former can be justified as an extension of a rule that applies to names, and the latter cannot be justified this way. This claim will be discussed in more detail (and argued against) in "Doxastic synonymy vs logical equivalence" (*The Reasoner*, 3(5)). Another interesting issue is whether one can (rationally) simultaneously hold that (D6) follows from (D1), (Sub) is correctly applied in the argument, and (D2) and (D3) are true. In "Bogus singular terms and substitution *salva denotatione*" (*The Reasoner*, 3(6)) I will argue that the answer to this question should be negative.

Rafal Urbaniak
Philosophy, Ghent

§3
News

ProbNet09: The Logic of Causal and Probabilistic Reasoning in Uncertain Environments, 19–23 February

The ProbNet series of workshops emerged within the Aktion exchange programme between Czech and Austrian researchers to provide a forum for interaction between math-

ematicians, philosophers, and psychologists working in the field of uncertain reasoning. This year's workshop took place at the Department of Psychology of the University of Salzburg, and was organised within the Logic of Causal and Probabilistic Reasoning in Uncertain Environments (LcpR) project, part of the European Science Foundation programme "Modelling Intelligent Interaction—Logic in the Humanities, Social and Computational Sciences" (LogICCC).

Radim Jiroušek (Prague, Jindřichův Hradec) opened the workshop with a general discussion of the problems with probabilistic models of high dimensional data, and an introduction to probabilistic compositional models as a tool for knowledge representation and inference. Angelo Gilio (Rome) gave a tutorial on an approach to probabilistic reasoning in the tradition of De Finetti that uses *coherence* as the only axiom. Gilio described a general algorithm for checking the coherence of arbitrary sets of conditional events and computing lower and upper bounds of probabilities for putative conclusions. Jiří Vomlel (Prague) gave a hands-on tutorial to Bayesian networks, focussing on models of noisy logical connectives (e.g., noisy-or), which have found applications in cognitive science.

David Over (Durham) noted that in psychological experiments on conditional reasoning typically the task requires the elimination of the conditional, e.g., by modus ponens. He discussed work on how people deal with the introduction of a conditional from disjunctions and reported evidence in favour of the conditional probability interpretation of natural language conditionals. In line with these findings, Niki Pfeifer and Leon Kratzer (joint work with Gernot Kleiter; Salzburg), reported experiments on how people reason about the paradoxes of the material conditional in a probability logical framework.

Eva Rafetseder (joint work with Josef Perner; Salzburg) gave a talk on disentangling counterfactual reasoning from hypothetical reasoning in children, focussing on when the different competencies develop. Patrick Burns (joint work with Sarah Beck; Birmingham) discussed recent experiments exploring the effect of the number of counterfactual possibilities on children's ability to perform counterfactual reasoning. Anton Kühberger (Salzburg) reported work investigating framing effects in risky decision making and proposed to distinguish between judgement and choice processes for investigating the framing effect. Andy Fugard (Salzburg; joint work with Keith Stenning and Mary Stewart, Edinburgh) discussed work on inter-individual differences in conditional and quantifier reasoning as a function of autistic-like traits in typically developing individuals.

Gernot Kleiter (Salzburg) discussed the well known problem that Bayesian networks do not necessarily represent a conditional independence model by a unique graph since some of the graphs may be Markov equivalent. Kleiter described his work on enumerating essential graphs, which are unique representations. Angelo Gilio (Rome) discussed various probabilistic generalisations of inference rules of the nonmonotonic System P. Matthias Unterhuber (joint work with Gerhard Schurz; Düsseldorf) explored Chellas-type semantics for System P. The workshop closed with a discussion by Helmut Mayer (Salzburg) of work on combining evolutionary algorithms and artificial neural networks in robotic systems for navigating in noisy environments.

ACKNOWLEDGEMENTS We thank the Austrian Science Fund, the German Research Foundation, and the Czech Science Foundation for supporting the LcpR project.

Niki Pfeifer, Andy Fugard and Gernot D. Kleiter
Psychology, Salzburg

PhD's in Logic, 19–20 February

PhD's in Logic, a workshop in mathematical and philosophical logic, took place on February 19–20 2009 at Ghent University, Belgium (more information is available here). This piece is meant as a short survey of philosophically-minded talks and tutorials. We do not comment on mathematically oriented presentations.

Benedikt Löwe (Amsterdam) gave an entertaining and really informative tutorial about inaccessible cardinals. The main point was that we can relate the existence of something as abstract and prima facie useless as inaccessible cardinals to certain problems pertaining to the real number line.

Reinhard Muskens (Tilburg) discussed type theory and introduced intensional models for type theory. They are meant to serve as a formal model of intensional contexts. Muskens also discussed a way one can construct possible worlds out of these intensional models. Jean Paul Van Bendegem (Brussels/Ghent) delivered a very neat and quite accessible introduction to paraconsistent logics and their many uses.

Karl-Georg Niebergall (Berlin) gave an entertaining talk about Gödel's incompleteness theorems. Niebergall raised an interesting philosophical problem by discussing quite a few prima facie plausible definitions of what it is for a formula to express consistency of a system, and showed why none of these definitions can be accepted.

Marek Czarnecki (Warsaw) talked about "semantics coded by coprimality in finite models". Arithmetic can be modelled not only in infinite domains but also in finite but potentially infinite models (roughly, instead of the standard model, one takes a set of its finite initial segments, making sure that all needed segments are in the domain). The weakest known arithmetic for which undecidability in finite models is proven is the arithmetic of coprimality. Czarnecki shows that even though this system is quite poor, it is still possible obtain the undefinability of truth theorem for that system.

Martin Mose Bentzen (Roskilde/ILLC) talked about game-theoretic formalizations of situations where it seems that situation participants would be better off if they trusted each other. Martin introduced neat formal tools to represent some of the examples he discussed intuitively, and explained how those situations are to be assessed. Christian Straßer (Ghent) developed an adaptive logic for deontic dilemmas allowing for factual detachment. He explained why usually dyadic deontic operators are preferred to monadic ones, discussed one of the key difficulties for the dyadic approach. To deal with these issues, Christian "adaptivized" Lou Bogle's CDPM logics.

Rafal Urbaniak (Ghent/Gdansk) introduced the notions of (informative) i-aboutness and i-circularity in order to shed light on the alleged circularity in Yablo's paradox. S is i-about x iff S contains contingent information about x and S is i-cirular iff (S,S) is in the transitive closure of the i-aboutness relation. It turns out that i-aboutness is

preserved under logical equivalence while *i*-cirularity is not, a situation for which Rafal presented an interesting rationale.

Elia Zardini (St Andrews) talked about tolerant logics, which he developed to deal with the phenomenon of vagueness. Tolerant logics restrict the transitivity of the consequence relation without need to give up its other usual structural properties. A nice feature of tolerant logics is that they provide the material for a consistency proof for the so called 'naive theory of vagueness'. In particular, one can assert that 'bald' has both positive and negative applications and that the term is tolerant-in the sense that one-hair differences do not make a difference to its positive or negative application-without running into the notorious sorites paradox.

N.B.: Comments on Urbaniak's and Zardini's talk by Stefan Wintein. All other comments by Rafal Urbaniak.

Stefan Wintein
Philosophy, Tilburg

Rafal Urbaniak
Philosophy, Ghent

§4
What's Hot in ...

Formal epistemology

Handy tips and helpful advice from the Formal Philosophy Seminar series at the Formal Epistemology Project, University of Leuven.

Hans Rott's 'The Ramsey Test for Conditionals and Iterated Theory Change' led to conversation that carried over to lunch to following day! The methodological moral of Hans' paper is that we should read off a new logic based on belief-change, as opposed to basing a theory of belief change on our favourite logic. This is a strong logical pluralist position. Logical pluralism has been the norm in logic circles for decades, especially in computer science and mathematics departments. Less so in philosophy. Another healthy methodological point from Hans is that the belief revision (computer science) and conditionals (philosophy) communities should come together again, as they can learn from each other.

Elia Zardini's 'Inexact Knowledge, Positive Introspection, and Closure', was a high-powered exploration of the effect of models of our naturalistically constrained discriminatory powers on the properties we should assign to certain epistemic logics. A weakened-hence-less-destructive version of the KK-principle, where K = "being in a position to know" (as opposed to "knows") was outlined. It is weakened since "being in a position to know" is less idealised than a brute "know". The former sits more easily

than the latter when understanding the consequent of the conditional in the KK-thesis as stipulating a necessary condition.

Luciano Floridi's 'Semantic Information and the Correctness Theory of Truth' proposes an information-based theory of truth, whose network-based approach shares properties (namely commutative diagrams) with category theory. This leads to novel evasions of the paradoxes. Luciano's CTT is part of his larger systematic approach to the philosophy of information, soon to appear in book-form.

Bjorn Jespersen's 'How Hyper are Hyperpropositions' illuminated the extent to which models of procedural/a priori reasoning (logical and mathematical etc.) need to take the procedures seriously at the logical level. This is accomplished via the type-theoretical approach stipulated by transparent intensional logic, and has obvious connections with a range of dynamic systems.

Stephan Hartmann's 'Disagreement and Consensus in Science' made the case for a difference in modeling requirements between disagreement and consensus in the hard sciences on the one hand, and scientific policy decision scenarios on the other. A normative model for disagreement and consensus in the latter was proposed.

What has the thread been? That we should take fine-grained epistemic phenomena seriously, and pay attention to the subtle requirements of adequate models. The age of starting with one's favourite formalism, and then trying to explain away the missed components, has hopefully had its day.

Next month: Ofra Magidor and lots lots more!

Click for the pics of the FPS seminars and for the full FPS program.

Sebastian Sequoiah-Grayson
Formal Epistemology Project, Leuven

Logic and Rational Interaction

The Logic and Rational Interaction (LORI) website is intended at gathering information for all researchers working at the intersection of logic and the theory of rational interaction. In this monthly column I will summarize for the readers of *The Reasoner* some of the key items that appeared on the website. You can read more about each of them on loriweb.org.

This month Richard Bradley (LSE) gave a short interview to LORI, where he described what are for him the most urgent questions to be addressed by the theory of rationality and rational decision-making.

LSE faculty members were definitely quite busy this month, as Christian List's research on social choice and the behavior of honey bees was covered in The Economist. You can read here extracts of the piece, and link to the full piece.

LORI is also intended to provide a platform where researchers can exchange ideas and make various announcements. In this category there has been an interesting discussion between J. Taylor and J. Huggins about the notion of logical validity and deontic statements, and the announcement of a fresh arrival of logicians in Groningen. Interesting new publications that have been announced on the website include: two new

volumes of the "5 Questions" series, Mind and Consciousness and Philosophy of Action, a new book on degrees of beliefs edited by F. Huber and C. Schmidt-Petri, some new working papers by J. van Benthem and a working paper by Patrick Allo on adaptive logic and conditional belief.

Let me finish by stressing that Logic and Rational Interaction is a collaborative venture. We welcome any contributions relevant to the theme, and are also constantly looking for new collaborators. So, if you would like to join the team, or if you have information to share with the broader research community, please do not hesitate to contact our web manager, Rasmus Rendsvig.

Olivier Roy
Philosophy, Groningen

Calls for Papers

Just Reason: Special issue of *Studies in Social Justice*, deadline 1 April.
The Role of Intuitions in Philosophical Methodology: Special issue of *Studia Philosophica Estonica*, 1 April.
Commmonsense Reasoning in the Semantic Web: Special issue of *Annals of Mathematics and Artificial Intelligence*, 4 April.
Intuitionistic Modal Logics and Applications: Special issue of *Information and Computation*, deadline 31 May.
Logic and the Foundations of Physics: Special issue of *Studia Logica*, 31 May.
Deconstruction and Science: Special issue of *Derrida Today*, 30 June.

Causality in the Sciences
A volume of papers on causality across the sciences Deadline 1 July

Experimental Philosophy: Forthcoming issue of *The Monist*, deadline April 2011.

§5
Introducing ...

In this section we introduce a selection of key terms, texts and authors connected with reasoning. Entries will be collected in a volume *Key Terms in Logic*, to be published by Continuum. If you would like to contribute, please click here for more information. If you have feedback concerning any of the items printed here, please email thereasoner@kent.ac.uk with your comments.

Proof Theory

Proof theory is a branch of logic that began with work by David Hilbert and that has as central the notion of proof in a formal system.

The notion of formal system is the result of a process of formalization of axiomatic theories. Generally speaking, a formal system is based on a language in which we fix the primitive symbols and the rules that determine its terms and its formulas, and consists of a decidable set of axioms and a decidable set of rules of inference (a set S is said to be decidable if, and only if, there exists an uniform procedure by means of which it is possible to establish, in a finite number of steps, if, for each object x, x belongs to S or not). A proof in a formal system is simply a finite sequence of formulas, each of which is either an axiom, or is derived by one of the inference rules from the preceding formulas. The last formula of a proof is said to be a theorem.

Hilbert's program consisted in the attempt to: 1) formalise mathematical theories, i.e., reduce mathematics to formal systems, 2) prove, by means of finitary methods (that is to say methods that use only finite or verifiable means), their consistency, i.e. prove that formal systems do not imply any contradiction. This way Hilbert believed that mathematics could be justified. Note that once intuitive mathematical theories have been substituted by corresponding formal systems, they become rigorously defined objects in their own right, meriting the same sort of treatment as other, more traditional and familiar, mathematical objects. Their study usually takes the name of "meta-mathematics;" the proof of the consistency of a formal system, for example, is a meta-mathematical result.

Hilbert's program was brought to a halt by Gödel's results, according to which it is impossible to prove by means of finitary methods the consistency of the elementary theory of numbers.

It was Hilbert's student Gerhard Gentzen who picked up the themes of Hilbertian proof theory, and put them through a new analysis, in order to revive them despite Gödel's negative results. Gentzen created a new type of formal system, namely natural deduction systems, in which we can construct mathematical proofs that are closer simulations of our actual way of reasoning in mathematics. Furthermore, by generalizing these systems and by obtaining this way the calculi called the sequent calculi, he proved some important results. One (the Hauptsatz) says that, for any a provable formula, there exists a proof in which the only expressions that occur in it are subformulas of the formula that we want to prove; that is to say, for any provable formula, there exists an analytic proof of it. The second important result concerns the consistency of arithmetical formal systems that he managed to prove by using the transfinite induction. This principle, though it was not finitary, and therefore did not fit with Hilbert's program, nevertheless presents characteristics of high constructivity and it is intuitionistically acceptable.

These results are the basis of the important developments of the modern, post-Hilbertian proof theory, some of which constitute real and autonomous fields.

Francesca Poggiolesi
Center for Logic and Philosophy of Science, Brussels

§6
Events

April

Sparsity in Machine Learning and Statistics: Cumberland Lodge, UK, 1–3 April.
Foundations of Math: New York University, 3–5 April.
Bi-Annual Konstanz-Leuven Series in Formal Epistemology: Konstanz, Germany, 6 April.
Matching and Meaning: Automated development, evolution and interpretation of ontologies, Edinburgh, 9 April.
Too Funky: an international workshop on sympathy and emanation, Leiden Institute of Philosophy, The Netherlands, 10–11 April.
EuroGP: 12th European Conference on Genetic Programming, Tübingen, Germany, 15–17 April.
Semantics and Philosophy in Europe: Institute of Philosophy, University of London, 16–18 April.
AISTATS: Twelfth International Conference on Artificial Intelligence and Statistics, Clearwater, Florida, 16–19 April.
ESANN: 17th European Symposium on Artificial Neural Networks Advances in Computational Intelligence and Learning, Bruges (Belgium), 22–24 April.
Symposium: Games, Argumentation and Logic Programming, University of Luxembourg, 23–24 April.
Philosophical Methodology: AHRC Project on 'Intuitions and Philosophical Methodology' at the Arché Philosophical Research Centre, University of St. Andrews, 25–27 April.
PAKDD: The 13th Pacific-Asia Conference on Knowledge Discovery and Data Mining, Imperial Queen Park Hotel, Bangkok, Thailand, 27–30 April.
Scientific Realism Revisited: London School of Economics and Political Science, 28–29 April.

May

Foundations of Mathematics: Philosophy and Foundations of Mathematics—Epistemological and Ontological Aspects, SCAS, Uppsala, 5–8 May.
Logic of John Duns Scotus: 44th International Congress on Medieval Studies at Western Michigan University, 7–10 May.
Metaphysical Indeterminacy, the State of the Art: University of Leeds, 9 May.
AAMAS: The Eighth International Joint Conference on Autonomous Agents and Multi-Agent Systems, Budapest, 10–15 May.
ACL2: International Workshop on the ACL2 Theorem Prover and Its Applications, Northeastern University, Boston, 11–12 May.
MSDM: Multi-agent Sequential Decision-Making in Uncertain Domains, AAMAS, Budapest, 11 or 12 May.

Philosopher's Rally: University of Twente campus, Enschede, the Netherlands, 12–13 May.
PhiLang: International Conference on Philosophy of Language and Linguistics, Lódź, Poland, 14–15 May.
Philosophy and Cognitive Science: The XIXth edition of the Inter-University Workshop, Zaragoza, 18–19 May.
Benelearn: 18th Annual Belgian-Dutch Conference on Machine Learning, Tilburg University, 18–19 May.
UR: Uncertain Reasoning, Special Track of FLAIRS, Island, Florida, USA, 19–21 May.
Evidence in Context: Fifth annual conference of the Graduate Student Society at the Institute for the History and Philosophy of Science and Technology, University of Toronto, 23 May.
AI: The twenty-second Canadian Conference on Artificial Intelligence, Kelowna, British Columbia, 25–27 May.
Science and Values—The Politicisation of Science: Center for Interdisciplinary Research (ZiF), Bielefeld, Germany, 25–30 May.
CSHPS: The Canadian Society for History and Philosophy of Science, annual conference as part of the Congress of the Humanities and Social Sciences (CFHSS), Carleton University, Ottawa, 26–28 May.
Preference Change Workshop: London School of Economics, 28–30 May.
Second Formal Epistemology Festival: Causal Decision Theory and Scoring Rules, University of Michigan, 29–31 May.

June

IRMLeS: Inductive Reasoning and Machine Learning on the Semantic Web, Heraklion, Crete, 1 June.
Argument Cultures: Ontario Society for the Study of Argumentation, Windsor, Canada, 3–6 June.
O-Bayes: International Workshop on Objective Bayes Methodology, Wharton School of the University of Pennsylvania, Philadelphia, PA, 5–9 June.
MODGRAPH: Probabilistic graphical models for integration of complex data and discovery of causal models in biology, Nantes, France, 8 June.
Philosophy of Probability II: Graduate Conference, Centre for Philosophy of Natural and Social Science, London School of Economics, 8–9 June.
CNL: Controlled Natural Languages, Marettimo Island, Sicily, 8–10 June.
Groups and Models: Cherlin Bayrami, Bilgi University, Istanbul, Turkey, 8–12 June.
Formal methods in the epistemology of religion: KULeuven (Leuven, Belgium), 10–12 June.
Toward a Science of Consciousness: Hong Kong, 11–14 June.
Vagueness: Predication and Truth: Workshop on Vagueness organised by the Vagueness Research Group, University of Navarra, 12–13 June.
Society for Philosophy and Psychology: Indiana University, Bloomington, 12–14 June.
NA-CAP: Networks and Their Philosophical Implications, Indiana University in Bloomington, 14–16 June.

NAFIPS: 28th North American Fuzzy Information Processing Society Annual Conference, University of Cincinnati, Cincinnati, Ohio, 14–17 June.
ICML: The 26th International Conference On Machine Learning, Montreal, Canada, 14–18 June.
SPSP: Society for Philosophy of Science in Practice, University of Minnesota, Minneapolis, 18–20 June.
Formal Epistemology Workshop: Carnegie Mellon University, 18–21 June.
UAI: The 25th Conference on Uncertainty in Artificial Intelligence, Montreal, Canada, 18–21 June.
Non-Classical Mathematics: Hejnice, Czech Republic, 18–22 June.
Pragmatism & Science Conference: Center for Inquiry, Amherst, NY, 19–20 June.
PNSE: International Workshop on Petri Nets and Software Engineering, Paris, 22–23 June.
WoLLIC: 16th Workshop on Logic, Language, Information and Computation, Tokyo, Japan, 21–24 June.
LOGICA: The 23rd in the series of annual international symposia devoted to logic, Hejnice (northern Bohemia, 22-26 June.
Consciousness and the Self: Department of Philosophy, University of Liverpool, 25 June.

Multiplicity and Unification in Statistics and Probability

University of Kent, Canterbury, UK, 25–26 June

July

Two Streams in the Philosophy of Mathematics: Rival Conceptions of Mathematical Proof, University of Hertfordshire, Hatfield, UK, 1–3 July.
EDM: Educational Data Mining, Cordoba, Spain, 1–3 July.
ECSQARU: 10th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty, Verona (Italy), 1–3 July.
E-CAP: Computing and Philosophy, Universitat Autònoma de Barcelona, 2–4 July.
Metaphysics of Science: University of Melbourne, 2–5 July.
Proof Theory and Constructivism: Leeds, 3–16 July.
Set Theory Meeting: in Honour of Ronald Jensen, Mathematical Research and Conference Center, Bedlewo, Poland, 5–10 July.
TARK: Twelfth Conference on Theoretical Aspects of Rationality and Knowledge, Stanford University, 6–8 July.
CALCULEMUS: 16th Symposium on the Integration of Symbolic Computation and Mechanised Reasoning, Ontario, Canada, 6–7 July.
Information Fusion: 12th International Conference, Grand Hyatt, Seattle Washington, 6–9 July.
TABLEAUX: Automated Reasoning with Analytic Tableaux and Related Methods Oslo, Norway, 6–10 July.

SPT: Converging Technologies, Changing Societies, 16th International Conference of the Society for Philosophy and Technology, University of Twente, Enschede, The Netherlands, 8–10 July.
IC-EpsMsO: 3rd International Conference on Experiments / Process / System, Modelling / Simulation / Optimization, Athens, Greece, 8–11 July.
Interdisciplinary Social Science: Athens, 8–11 July.
ARCOE: Automated Reasoning about Context and Ontology Evolution, Pasadena, 11-12 July.
IJCAI: 21st International Joint Conference on Artificial Intelligence, Pasadena, CA, 11–17 July.
ISHPSSB: International Society for the History, Philosophy, and Social Studies of Biology, Emmanuel College, St. Lucia, Brisbane, Australia, 12–16 July.
Logic and Heresy in the Middle Ages: Leeds Medieval Congress, 13–16 July.
DMIN: International Conference on Data Mining, Las Vegas, 13–16 July.
ICAI: International Conference on Artificial Intelligence, Las Vegas, 13–16 July.
ICLP: 25th International Conference on Logic Programming, Pasadena, California, 14–17 July.
ISIPTA: 6th International Symposium on Imprecise Probability: Theories and Applications, Durham University, 14–18 July.
ISSCSS: First Graduate International Summer School in Cognitive Sciences and Semantics, University of Latvia, Riga, 16-26 July.
AIME: 12th Conference on Artificial Intelligence in Medicine, Verona, Italy, 18–22 August.
ViC: Vagueness in Communication, Bordeaux, France, 20–24 July.
IWSM24: 24th International Workshop on Statistical Modelling, Cornell University in Ithaca, NY, 20–24 July.
LMSC: Workshop Logical Methods for Social Concepts, Bordeaux, France, 20–31 July.
ICCBR: Eighth International Conference on Case-Based Reasoning, Seattle, Washington, 20–23 July.
Case-Based Reasoning in the Health Sciences: Seattle, Washington, 21 July.
History of Science and Technology: XXIII International Congress of History of Science and Technology: Ideas and Instruments in Social Context, Budapest, Hungary, 28 July–2 August.
Logic Colloquium: Sofia, 31 July–5 August.

August

CADE-22: 22nd International Conference on Automated Deduction, McGill University, Montreal, 2–7 August.
Logic and Mathematics: University of York, 3–7 August.
Science in Society: University of Cambridge, United Kingdom, 5–7 August.
Meaning, Understanding and Knowledge: 5th International Symposium of Cognition, Logic and Communication, Riga, Latvia, 7–9 August.
LICS: Logic in Computer Science, Los Angeles, 9–11 August.

FSKD: 6th International Conference on Fuzzy Systems and Knowledge Discovery, Tianjin, China, 14–16 August.
ICNC: The 5th International Conference on Natural Computation, Tianjin, China, 14–16 August.
ASAI: X Argentine Symposium on Artificial Intelligence, Mar del Plata, Argentina, 24–25 August.
LGS6: Logic, Game Theory, and Social Choice 6, Tsukuba Center for Institutes, Japan, 26–29 August.
PASR: Philosophical Aspects of Symbolic Reasoning in Early Modern Science and Mathematics, Ghent, Belgium, 27–29 August.
EANN: Artificial Neural Networks in Engineering, University of East London, 27–29 August.
Practice-based Philosophy of Logic and Mathematics: ILLC, Amsterdam, 31 August–2 September.

September

Foundations of Uncertainty: Probability and Its Rivals, Villa Lanna, Prague, Czech Republic, 1–4 September.
Trends in Logic VII: Trends in the Philosophy of Mathematics, Goethe-University Frankfurt, 1–4 September.
SOPHA: Triannual congress of the SoPhA, the Société de Philosophie Analytique, University of Geneva , 2–5 September.
UC: 8th International Conference on Unconventional Computation, Ponta Delgada, Portugal, 7-11 September.

Mechanisms and Causality in the Sciences University of Kent, Canterbury, UK, 9–11 September

Phloxshop II: Humboldt-Universität, Berlin, 9–11 September.
MoS: Grand Finale Conference of the Metaphysics of Science AHRC Project, Nottingham, 12–14 September.
The New Ontology of the Mental Causation Debate: Old Shire Hall, Durham University, 14–16 September.
ISMIS: The Eighteenth International Symposium on Methodologies for Intelligent Systems, University of Economics, Prague, Czech Republic, 14–17 September.
LPNMR: 10th International Conference on Logic Programming and Nonmonotonic Reasoning, Potsdam, Germany, 14–18 September.
KI: 32nd Annual Conference on Artificial Intelligence, Paderborn, Germany, 15–18 September.
FroCoS: Frontiers of Combining Systems, Trento, Italy, 16–18 September.

Progic 4th Workshop on Combining Probability and Logic, special focus: new approaches to rationality in decision making, Groningen, The Netherlands, 17–18 September

Evolution, Cooperation and Rationality: Bristol, 18–20 September.
ICAPS: 19th International Conference on Automated Planning and Scheduling, Thessaloniki, Greece, 19–23 September.
KES: Knowledge-Based and Intelligent Information & Engineering Systems, Santiago, Chile, 28–30 September.
ASCS: The 9th conference of the Australasian Society for Cognitive Science, Macquarie University, Sydney, 30 September–2 October.

October

Joint Attention: Developments in Philosophy of Mind, Developmental and Comparative Psychology, and Cognitive Science, Bentley University, Greater Boston, 1–3 October.
KMIS: International Conference on Knowledge Management and Information Sharing, Madeira, Portugal, 6–8 October.
The Hugh MacColl Centenary Conference: Boulogne sur Mer, 9–10 October.
Case Studies of Bayesian Statistics and Machine Learning: Carnegie Mellon University, Pittsburgh, PA, 16–17 October.
Breaking Down Barriers: Blackwell Compass Interdisciplinary Virtual Conference, 19–30 October.
EPSA: 2nd Conference of the European Philosophy of Science Association, 21–24 October.
RR 2009: Third International Conference on Web Reasoning and Rule Systems, 25–26 October.

November

ACML: 1st Asian Conference on Machine Learning, Nanjing, China, 2–4 November.
AICI: The 2009 International Conference on Artificial Intelligence and Computational Intelligence, Shanghai, China, 7–8 November.
Epistemology, Context, and Formalism: Université Nancy 2, France, 12–14 November.
SPS: Science and Decision, Third Biennial Congress of the Societe de Philosophie des Sciences, Paris, 12–14 November.
M4M-6: 6th Workshop on Methods for Modalities, Copenhagen, Denmark, 12–14 November.
VI Conference: Spanish Society for Logic, Methodology and Philosophy of Science, Valencia, Spain, 18–21 November.
ISKE: The 4th International Conference on Intelligent Systems & Knowledge Engineering, Hasselt, Belgium, 27–28 November.

December

ICDM: The 9th IEEE International Conference on Data Mining, Miami, 6–9 December.
Interpretation and sense-making: University of Rouen, France, 9–11 December.
MBR: Abduction, Logic, and Computational Discovery, Campinas, Brazil, 17–19 December.

§7
Jobs

Postdoctoral Mellon teaching fellow: AOS: Experimental Philosophy, Lewis & Clark College, Portland, OR, Review of application begins, 1 April.
Permanent position: History and philosophy of science starting Fall 2009, University Paris 1 Panthon-Sorbonne, 2 April.
Junior-Professorship: Theoretical Philosophy with a Focus in the Philosophy of Cognition and the Philosophy of Mind, Heinrich Heine University, Düsseldorf, 2 April.
Postdoc Positions: Epistemology and Philosophy of Mind, Institut Jean-Nicod, Paris, 10 April.
PostDoc Studentship: Analysis Committee, 15 April.
Sessional Lecturer: Philosophy, History & Politics, Kamloops, British Columbia, review of application commencing 15 April.

§8
Courses and Studentships

Courses

HPSM: MA in the History and Philosophy of Science and Medicine, Durham University.
Master Programme: Philosophy of Science, Technology and Society, Enschede, the Netherlands.
MSc in Mathematical Logic and the Theory of Computation: Mathematics, University of Manchester.

MA in Reasoning

An interdisciplinary programme at the University of Kent, Canterbury, UK. Core modules on logical, causal, probabilistic, scientific, mathematical and machine reasoning and further modules from Philosophy, Psychology, Computing, Statistics, Social Policy and Law.

MSc in Cognitive & Decision Sciences: Psychology, University College London.
Master of Science: Logic, Amsterdam.
Summer Institute on Argumentation: University of Windsor, Canada, contact H.V. Hansen or C.W. Tindale, 25 May–6 June.
Summer School in Logic and Formal Epistemology: Canergie Mellon University, 8–26 June.
NN: Summer School in Neural Networks in Classification, Regression and Data Mining, Porto, Portugal, 6–10 July.
ACAI: Advanced Course in Artificial Intelligence, School of Computing and Mathematics, University of Ulster, Northern Ireland, 23–29 August.
Fourth Cologne Summer School: Reliabilism and Social Epistemology: Problems and Prospects, Cologne, 24–28 August.

Studentships

PhD Position: TiLPS/Tilburg, deadline 1 April.
PhD Studentship: School of Philosophy, University of East Anglia, Norwich, 15 April.
PhD Scholarship in Logic: University of Groningen, The Netherlands, deadline 1 May.
3 PhD fellowships: Department of Economics (IRES) and the Hoover Chair in Economic and Social Ethics, Louvain-la-Neuve, 15 May.
PhD Studentship: 3-year AHRC studentship in the Foundations of Logical Consequence project, University of St Andrews, until filled.