THE BULLETIN OF SYMBOLIC LOGIC
Volume 12, Number 3, Sept. 2006

2005 ANNUAL CONFERENCE OF THE AUSTRALASIAN ASSOCIATION FOR LOGIC

SPONSORED BY THE ASSOCIATION FOR SYMBOLIC LOGIC

Perth, Australia
September 24–25, 2005

The 2005 Annual Conference of the Australasian Association for Logic took place in Perth, Australia, on September 24–25, 2005. The conference was organized by Hartley Slater, with help from Tim French, Mark Reynolds, and Alan Woods, all of the University of Western Australia. The program consisted of contributed talks of 45 minutes in length. Conference participants came from Australia, Belgium, Germany, India, The Netherlands, and New Zealand. The conference was run in conjunction with the Australian Mathematics Society's annual meeting, at which there were also special sessions on Logic.

Abstracts follow of the contributed talks that were presented at the conference.

For the Organizing Committee
HARTLEY SLATER

Abstracts of contributed talks

▶ ROSS BRADY, *4 basic logical issues*.
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Among the diversity of logical issues, the most profound and fundamental issues in logic concern the choice of the inferential logic itself. I will discuss the following four issues that need to be addressed in association with the choice of logic. (1) Classical versus non-classical logic. (2) The determination of a particular non-classical logic (given discussion of (1)). (3) Classical versus non-classical deduction. (4) Classical versus non-classical meta-logic. I will also address the following two sub-issues whilst discussing (I). (i) What is deductive logic all about? (ii) Is there a guaranteed domain of classicality?

▶ MARTIN BUNDER, MOHUA BANERJEE, AND M. K. CHAKRABORTY, *Some rough consequence logics and their interrelations*.
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1079-8986/06/1203-0006/$1.70

Chakraborty and Banerjee have defined a notion of rough equivalence:

$$\alpha \approx \beta = (L\alpha \leftrightarrow L\beta) \wedge (M\alpha \leftrightarrow M\beta)$$

to correspond to a known notion of rough equality.

Their preferred rough modus ponens was given by:

$$\text{(RMP)} \qquad \frac{\Gamma \mid\!\sim \alpha \quad \Gamma \mid\!\sim \beta \to \gamma \quad \Gamma \vdash \alpha \approx \beta}{\Gamma \mid\!\sim \gamma}.$$

where $\mid\!\sim$ is provability in "rough consequence logic" and $\vdash$ provability in S5.

However they studied a logic L_r with, instead of (RMP):

$$\text{(RMP}_1\text{)} \qquad \frac{\Gamma \mid\!\sim \alpha \quad \vdash \beta \to \gamma \quad \vdash M\alpha \to M\beta}{\Gamma \mid\!\sim \gamma}.$$

and a stronger logic L_R which also has:

$$\text{(R}_2\text{)} \qquad \frac{\Gamma \mid\!\sim M\alpha \quad \Gamma \mid\!\sim M\beta}{\Gamma \mid\!\sim M\alpha \wedge M\beta}.$$

and is equivalent to Jaskowski's discussive logic D2.

In this paper we look at alternative rough consequence logics obtained by varying the $\Gamma \vdash \alpha \approx \beta$ in (RMP). It turns out that two of these are equivalent to the trivial modal logic Triv of Hughes and Cresswell, others are equivalent to known natural deduction versions of $S5$ and one seems new. All except the first two are independent of L_r and L_R.

► JONATHAN COHEN, *Two forms of deep inference*.
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The Calculus of Structures (CoS) is a relatively new proof-theoretic formalism in which inferences are applicable arbitrarily deep within a structure, as opposed to only at the root. I shall introduce this formalism and discuss its relationship with Belnap's Display Calculus. This includes the simulation of certain novel features of CoS within Display calculus, was well as the problem of deriving a general cut-elmination theorem for CoS.

► TIM FRENCH, *On the interpretation of propositional quantification in modal logic*.
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In 1970 Kit Fine examined modal logics augmented with propositional quantification. He applied a standard notion of propositional quantification that ranged over all interpretations of a propositional atom in the given model. Such propositional quantification was shown to be very powerful, making relatively simple logics, such as ***K*** or ***S4*** expressively equivalent to full second order logic.

In this work we examine an alternative semantic interpretation for propositional quantification in modal logics. *Bisimulation quantifiers* are defined to quantify over the interpretation of atoms, not only in the given model, but in all bisimilar models that belong to class of frames over which the logic is defined. Consequently they are weaker than standard propositional quantifiers and more likely to produce decidable logics.

Bisimulation quantifiers have previously been considered in the case of isolated logics, such as intuitionistic logic (Pitts, 1992) and dynamic logic (D'Agostino and Hollenberg, 2000). Here we examine the application of bisimulation quantifiers to general modal logics.

We examine the expressivity of bisimulation quantifiers in modal logics, comparing them to least fixed-point logics, monadic second-order logics, and unquantified modal logics. We argue that bisimulation quantifiers are a natural extension of modal logics.

However we also add a cautionary note. There are instances of logics for which bisimulation quantifiers are not "well behaved". We give examples of logics for which the standard axioms of propositional quantification are not valid. We also give examples of decidable modal logics that are undecidable when augmented with bisimulation quantifiers.

Therefore it is natural to ask when is it sensible to apply bisimulation quantifiers to a modal logic. We provide a partial answer to this question.

► ROD GIRLE, *The "can do" principle and Classical First Order Logic*.
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The "can do" principle, set out in [1, p. 49], is discussed in terms of what it means for the use of Classical First Order Logic in the analysis and evaluation of Premise-conclusion arguments. The question of reliability of analysis and evaluation, in terms of Staines' principles [2], is discussed. Some interesting puzzles generated for Predicate Logic are considered.

[1] DOV M. GABBAY AND JOHN WOODS, ***Agenda relevance: A study in formal pragmatics***, Elsevier, Amsterdam, 2003.

[2] PHILLIP STAINES, *Some formal aspects of the argument—Symbolization relation*, ***Australian Logic Teachers' Journal***, vol. 5, (1981) no. 3.

► GUIDO GOVERNATORI, *On the relative complexity of two labelled modal tableaux*.
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We investigate the relative complexity of two free-variable labelled modal tableaux (KEM [1] and Single Step Tableaux, SST [5, 4, 2]). We discuss the reasons why p-simulation is not a proper measure of the relative complexity of tableaux-like proof systems, and we propose an improved comparison scale (p-search-simulation). The main result of the paper is that KEM p-search-simulates SST while SST cannot p-search-simulate KEM. Finally we give a novel completeness proof for KEM based on labelled models.

[1] ALBERTO ARTOSI, PAOLA BENASSI, GUIDO GOVERNATORI, AND ANTONINO ROTOLO, *Shakespearian modal logic: A labelled treatment of modal identity*, ***Advances in Modal Logic***, vol. 1, (Marcus Kracht, Maarten de Rijke, Heinrich Wansing, and Michael Zakharyaschev, editors), pp. 1–21, CSLI Publications, Stanford, 1998.

[2] BERNARD BECKERT AND RAJEEV GORÉ, *Free variable tableaux for propositional modal logics*, ***Studia Logica***, vol. 69 (2001), no. 1, pp. 59–96.

[3] GUIDO GOVERNATORI, *On the relative complexity of modal tableaux*, ***CATS'03***, ***Electronic Notes in Theoretical Computer Science***, vol. 78 (James Harland, editor), Elsevier, pp. 36–53.

[4] FABIO MASSACCI, *Strongly analytic tableaux for normal modal logic*, ***CADE-12***, (Alan Bundy, editor), vol. 814 of LNAI, pp. 723–737, Springer-Verlag, Berlin, 1994.

[5] ——— *Single step tableaux for modal logic*, ***Journal of Automated Reasoning***, vol. 24 (2000), no. 3, pp. 319–364.

► THIERRY LIBERT, *Positive set theory: a survey*.
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Positive Set Theory encompasses those extravagant set-theoretic systems that block the paradoxes by proscribing the use of the classical negation connective. The talk will describe such systems, with their variety of merits and defects, to make known a few open problems that belong to the folklore of the subject. A reference, where many others can be found, is the following:

TH. LIBERT, *More Studies on the Axiom of Comprehension*, Ph.D. Thesis, Université Libre de Bruxelles, 2004 (to be published in the collection 'Cahiers du Centre de Logique', Academia-Bruylant, Louvain).

► CHUCHANG LIU, MARIS OZOLS, AND MEHMET ORGUN, *Fibred belief logic for multi-agent systems*.
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Multi-agent systems consist of a number of autonomous agents (software programs) that are capable of independent action on behalf of their users. Agents communicate with one another by exchanging messages, and they have the ability to co-operate, co-ordinate and negotiate with each other to achieve their objectives. In order to develop theories to specify and reason about various aspects of multi-agent systems, many researchers have proposed the use of modal logics such as belief logics, logics of knowledge, and logics of norms. As multi-agent systems operate in dynamic environments, there is also a need to model the evolution of multi-agent systems through time. In order to introduce a temporal dimension to a belief logic, we consider a powerful technique called fibring for combining belief logics and temporal logics. In a fibred belief logic, both temporal operators and belief operators are treated equally. This paper in particular discusses a combination of a belief logic called Typed-Modal Logic with a linear-time temporal logic. We show that, in the resulting logic, we can specify and reason about not only agents' beliefs but also the timing properties of a system. With this logical system one is able to build theories of trust for the description of, and reasoning about, multi-agent systems.

► MARK REYNOLDS, *Tableau reasoning for branching-time temporal logics*.
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Tableaux are a popular style of modal reasoning technique and there has been a substantial amount of work on applying them to temporal logics. They can be presented in an intuitive way, they are often suitable for automated reasoning and it is usually not hard to prove complexity results for their use. Despite all the interest in tableaux for temporal logic and all the interest in the standard computing branching-time temporal logic, CTL*, tableaux do not exist for deciding validity in CTL*. In this talk we will examine tableau approaches to temporal logics like CTL* and consider the issues involved in extending the techniques to cope with CTL* itself.

► PENELOPE RUSH, *Logic and thought*.
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The problems with the rules of classical logic are well-known: explosion, the paradoxes of material implication, etc. But can the rules that entail such problems themselves be dispensed with, revised, or even viewed as derivative? This paper explores the problem of choosing which logical rules we need or ought to have in a good logic. Are there rules we simply cannot do without? Can any be thought of as pre-conditions for thought or intelligence? What does human thought necessarily involve? Poincare posited the intuition of indefinite iteration, and of continuity as essential for logic and mathematics. Perhaps a similar case can be made that the DS and DN are at the heart of experimentation and pattern recognition fundamental to thought. The notion of 'common sense', or the innate structure of the mind, might be the modern equivalent to Poincare's 'intuitions'. Steven Pinker [1997], discussing common sense, says: "no database could ever list all the facts we tacitly know, and no one ever taught them to us. You know when Irving puts the dog in the car, it is no longer in the yard. If Doug is in the house, he must have gone in through some opening unless he was born there and never left" (p. 13). Both these examples utilize the DS. How much should logic mirror real thought? Which components of thought are components of reason? Do either thought or reason have foundations or pre-conditions? Is the best representation or capture of reason the best mirror or analogy of thought? Maybe logic's job is not to capture (even part of) the mind's working, but to capture reason per se, if there is such a thing. If there is, how far can 'reason' be disassociated from thought or from, say, the ambit of the philosophy of mind and cognitive science?

[1] S. Pinker, ***How the mind works***, Penguin Books, W. W. Norton, USA, 1997.

► MARTIN SMITH, *Ceteris paribus conditionals and comparative normalcy*.
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A ceteris paribus conditional is a subjunctive conditional in which the relationship between antecedent and consequent is mediated by a ceteris paribus clause. That is, a ceteris paribus conditional is a conditional of the form 'If A were the case then ceteris paribus B would be the case'. Many law-statements in the sciences have the form of ceteris paribus conditionals, so defined. In this paper I outline a possible worlds semantics for ceteris paribus conditionals modelled upon David Lewis's possible worlds semantics for counterfactual conditionals. Lewis suggests that a counterfactual conditional 'If A were the case then B would be the case' should be deemed true at a world w just in case, at all A-worlds that are most similar to w, B holds true. What I suggest is that a ceteris paribus conditional 'If A were the case then ceteris paribus B would be the case' should be deemed true at a world w just in case, at all A-worlds that are most normal from the perspective of w, B holds true. I go on to explore some of the structural differences between the relation of comparative similarity and the relation of comparative normalcy and suggest an apposite logic for ceteris paribus conditionals.

[1] D. Lewis, ***Counterfactuals***, Blackwell, Oxford, 1973.
[2] P. Pietroski and G. Rey, *When other things aren't equal: Saving "ceteris paribus" laws from vacuity*, ***British Journal for the Philosophy of Science***, vol. 46, (1995), pp. 81–110.

► HARTLEY SLATER, *Frege's error identified*.
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It is well known that it was Russell's Paradox that alerted Frege to the trouble with his system. It is less well known that there is no trouble when 'x is not a member of x' is analysed relationally, i.e., as saying that $\langle x, x\rangle$ is a member of $\{\langle y, z\rangle \mid y$ is not a member of z$\}$. For substitution of that set abstract for 'x' does not produce a contradiction. What Russell's Paradox shows, therefore, is merely that not all relations between a thing and itself can be a matter of that thing falling under a concept, i.e., $-(R)(EP)(x)(Rxx \text{ iff } Px)$. Taking off from this, it is what might have led Frege to think otherwise which is the concern of the present paper.

Clearly, given a two-valued function $f(x, y)$, one can invariably obtain a function of one variable $f(x, x) = g(x)$. So it was Frege's analogy between functions and predicates, in 'Function and Concept', which led him astray. Predicates are not functions in the required way. First, if anything like '$Pa = \mathrm{T}$', or '$Rab = \mathrm{F}$' holds it is with '=' as material equivalence, 'T' a tautology, and 'F' a contradiction (thus sentences are not referential terms with the same reference as 'The true' or 'The false'). But then one has that '*Pa* iff T' and '*Rab* iff F' are equivalent to '*Pa*' and '$-Rab$' respectively, making '*Pa*' and '*Rab*' quite unlike mathematical functions, and 'T' and 'F' nothing like their values. Indeed, the values of predicative expressions are thoughts, not truth values. But such inaccuracies in the parallel between predicates and functions get dramatically enlarged upon the introduction of reflexive expressions. A relational expression like 'Rxy' generates a thought about x and y, and so the diagonal expression 'Rxx' generates a thought about x and itself. That thought still has two subjects, and is not expressible by a one-place constant predicate with x as subject. If each of A, B, and C shaves D they do the same thing—shave D—but if each shaves himself, or say, in a ring, shaves his neighbour on his left, then they only do the same kind of thing, i.e., what they do merely has a common functional expression: shave $f(s)$ where s is the subject.

► KAILE SU, ABDUL SATTAR AND KEWEN WANG, *Observation-based model for BDI-agents*.
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We present a new computational model of BDI-agents, called the observation-based BDI-model. The key point of this BDI-model is to express agents' beliefs, desires and intentions as a set of runs (computing paths), which is exactly a *system* in the interpreted system model, a well-known agent model due to Halpern and his colleagues. Our BDI-model is *computationally grounded* in that we are able to associate the BDI-agent model with a computer program, and formulas, involving agents' beliefs, desires (goals) and intentions, can be understood as properties of program computations. We present a sound and complete proof system with respect to our BDI-model and explore how symbolic model checking techniques can be applied to model checking BDI-agents. In order to make our BDI-model more flexible and practically realistic, we generalize it so that agents can have multiple sources of beliefs, goals and intentions.

► HEINRICH WANSING, *Negation in Categorial Grammar*.
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In [1] three ways of using negative information in Categorial Grammar are explored: (a) admitting negative data about type assignments in a unification based procedure for learning a categorial grammar, (b) using restrictions of language models, and (c) admitting negated syntactic types. Since negative information may be available in the process of defining or learning a categorial grammar's type assignment for some natural language, the introduction of negated syntactic types is of interest. Whereas Buszkowski adds the axioms characteristic of De Morgan negation to an axiom system for the associative Lambek calculus and then investigates the semantical effects of this addition, in the present paper the effects of falsifying the defining properties of the powerset operations used in the semantics of the Lambek calculi are considered. The result is a kind of strong, constructive negation that gives rise to connexive implications. This is interesting, because connexive implication previously has been discussed completely independently of Categorial Grammar. The resulting syntactic calculi have the advantage of admitting cut-elimination and, as a result, being decidable. In the talk, before considering Categorial Grammar, I shall make some introductory remarks about connexive logic.

[1] W. Buszkowski, *Categorial Grammars with negative information*, ***Negation. A notion in focus***, H. Wansing (editor), de Gruyter, Berlin, pp. 107–126, 1996.

► ANDREAS WEIERMANN, *Analytic combinatorics of the transfinite*.
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We investigate the number theoretic fine structure of ordinals not exceeding the proof-theoretic ordinal of first order Peano arithmetic PA. Given an ordinal α and a nonnegative integer m we consider the number of ordinals $\beta < \alpha$ such that the term length of β does not exceed m. This count function has very nice properties which can be used to apply a fascinating machinery developed by A. Woods to prove (jointly with A. Woods) logical limit laws for ordinals.

We further treat independence results for PA (and some of its fragments) which are related to Goodstein sequences, Hydra games and Hilbert's basis theorem from commutative algebra. If time is left we also present some surprising results concerning so called slow growing hierarchy.

► ALAN WOODS, *On the probability of absolute truth for and/or formulas*.
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An *and/or formula* such as $((X_1 \vee \overline{X}_2) \wedge X_3) \vee (\overline{X}_1 \wedge X_3)$ is a Boolean formula formed from literals using binary $\wedge$ and $\vee$ connectives (and brackets). Its *size* m is the number of occurrences of literals. ($m = 5$ in the example.)

Suppose the variables are drawn from among $X_1, \dots, X_n$. Let T_m denote the total number of and/or formulas of size m in these n variables, and $T_m(\mathit{True})$ be the number of these which are *tautologies*. A natural definition of the probability of a tautology is

$$P_n(\mathit{True}) = \lim_{m\to\infty} \frac{T_m(\mathit{True})}{T_m}\ .$$

A second natural notion of probability is defined by generating a formula by means of a *Galton–Watson random branching process*. Throw a fair coin. If it's *heads*, throw a fair $2n$-sided die to choose a literal and then stop. If it's *tails*, throw the coin again to choose $\wedge$ or $\vee$ as the principal connective; then repeat the process to construct the two subformulas. Let $\pi_n(\mathit{True})$ be the probability that the formula generated is a tautology.

Theorem 1. *$\pi_n(\mathit{True}) < P_n(\mathit{True})$ for all n.*

Theorem 2. *$\pi_n(\mathit{True}) \sim \dfrac{1}{4n}$ and $P_n(\mathit{True}) \sim \dfrac{3}{4n}$ as $n \to \infty$.*

The probability that a random formula defines other simple Boolean functions such as a literal (as in the example above) can also be analysed.

This is mostly joint work with Danièle Gardy and/or Brigitte Chauvin. A survey of other recent work on and/or formulas and related topics will be included.