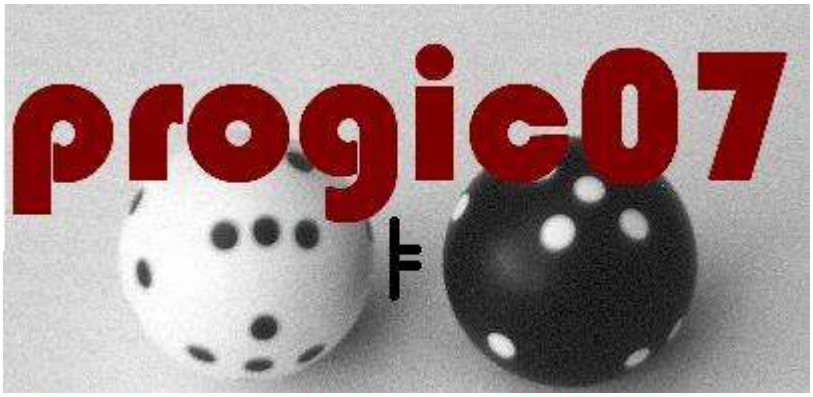

Progic 2007

The 3rd Workshop on Combining Probability and Logic

http://www.kent.ac.uk/secl/philosophy/jw/2007/progic/

Organisers:

Rolf Haenni Sola, Jan-Willem Romeijn,

Federica Russo, Gregory Wheeler, Jon Williamson

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Programme

Wednesday 5 September

9.00-9.30 *Registration & introduction*
9.30-10.15 *Invited speaker*: David Makinson - How different are quantitative and qualitative consequence relations for uncertain reasoning?
10.15-10.45 Bert Leuridan - Two logics for causal discovery

coffee (Dolce Vite Cafe)

11.15-11.45 Amit Pundik - What Went Wrong in the Case of Sally Clark?
11.45-12.30 *Invited speaker*: Jeff Paris - Relevance and irrelevance in inductive logic (joint work with Pete Waterhouse)

lunch

2.00-2.45 *Invited speaker*: Manfred Jaeger - Towards a (Model) Theory for Probabilistic Logical Models
2.45-3.15 Joana Hois - Towards Combining Ontologies and Uncertain Knowledge

coffee (Dolce Vite Cafe)

3.45-4.15 Ondrej Majer - Probabilistic extension of IF logic (joint work with Tero Tulenheimo)
4.15-5.00 *Invited speaker*: Lise Getoor - Statistical Relational Learning

Conference dinner (Old Weaver's Restaurant, 1 St Peter's Street)

Thursday 6 September

9.30-10.15 *Invited speaker*: Fabio Cozman - Independence Relations in Probabilistic Logic (joint work with Cassio Polpo de Campos and Jose Eduardo Ochoa Luna)
10.15-10.45 Marco Valtorta - Logic and Probabilistic Reasoning to Support Information Analysis in Uncertain Domains (joint work with Michael Huhns and John Byrnes)

coffee (Dolce Vite Cafe)

11.15-11.45 Ulrike Hahn - The Relationship between Probability and Logic in Argumentation (joint work with Mike Oaksford)
11.45-12.30 *Invited speaker*: Stephan Hartmann - Merging judgements and the problem of truth-tracking (joint work with Gabriella Pigozzi)

lunch

2.00-2.45 *progicnet session*: Rolf Haenni - Probabilistic Logic and Probabilistic Networks
2.45-3.15 Emil Weydert - Probabilistic logics of trust

coffee (Dolce Vite Cafe)

3.45-4.15 Gábor Hullám - A probabilistic logic incorporating posteriors of hierarchic graphical models (joint work with Andras Millinghoffer and Peter Antal)
4.15-4.45 Evan Tzanis - A note on probabilistic logics

Friday 7 September

9.30-10.15 *Invited speaker*: Gert de Cooman - Belief structures as an abstract framework for studying formal aspects of uncertain reasoning
10.15-10.45 Olivier Teytaud - Inductive-Deductive Systems: A mathematical logic and statistical learning perspective (joint work with Nicolas Baskiotis and Michele Sebag)

coffee (Dolce Vite Cafe)

11.15-11.45 Jan Sprenger - Statistics between inductive logic and empirical science
11.45-12.30 *Invited speaker*: Colin Howson - Combining Probability and Logic: Some Questions
lunch

2.00-2.45 *Invited speaker*: Pedro Domingos - Markov Logic: A Simple and Powerful Unification of Logic and Probability (Joint work with Stanley Kok, Daniel Lowd, Hoifung Poon, Matt Richardson, Parag Singla, Marc Sumner, and Jue Wang.)
2.45-3.15 Gernot Kleiter - Framing human inference by coherence based probability logic (joint work with Niki Pfeifer)

coffee (Dolce Vite Cafe)

3.45-4.45 *Round table*: The normative status of progic and its relation to decision (facilitators: Jan Willem Romeijn and Gregory Wheeler)

Titles and abstracts

David Makinson

How different are quantitative and qualitative consequence relations for uncertain reasoning?

It is widely recognized that probabilistically generated consequence relations for uncertain inference are typically less well behaved than qualitatively generated ones. But how wide is the gap -- what closure conditions hold for the latter but not the former? Conversely, are there any such conditions that hold for the former but not the latter? We review some recent results in the area, and publicize a big open question.

Bert Leuridan

Two logics for causal discovery

In this paper, I want to substantiate three related claims regarding causal discovery from non-experimental data. Firstly, in scientific practice, the problem of ignorance is both ubiquitous, persistent, and far-reaching. Intuitively, the problem of ignorance bears upon the following situation. A set of random variables V is studied but only partly tested for (conditional) independencies; i.e. for some variables A and B it is not known whether they are (conditionally) independent. Secondly, Judea Pearl's most meritorious and influential algorithm for causal discovery (the IC algorithm) cannot be applied in cases of ignorance. It presupposes that a full list of (conditional) independence relations is on hand and it would lead to unsatisfactory results when applied to partial lists. Finally, the problem of ignorance is successfully treated by means of ALIC, the adaptive logic for causal discovery presented in this paper.

Amit Pundik

What Went Wrong in the Case of Sally Clark?

Sally Clark's two baby boys, Christopher and Harry, were each found dead on separate occasions. Sally was convicted of their murder. The prosecution brought Professor Sir Roy Meadow, an expert paediatrician, who testified that the chance of two cot deaths in one family is 1 per 73 million. However, Sally Clark was later set free based on fresh evidence (R v Clark (No 2) [2003] EWCA Crim 1020). This case is particularly troubling because the mistaken conviction did not happen due to lack of thorough treatment of the scientific evidence, but despite such treatment. This paper examines possible explanations for the miscarriage of justice in the case of Sally Clark, and questions whether and how the miscarriage of justice could have been avoided. The presentation in this conference will focus the part of the paper which examines three possible explanations related to the statistical evidence. The first is that the error resulted from the flaws in Meadow's statistical analysis. The second explanation is that the error resulted from the stubborn legal resistance to use Bayes Theorem. The last explanation is that the impressive figure of 1 per 73 million had a strong psychological impact on the fact-finders which caused then to underestimate and even ignore other non-statistical evidence which is more favourable to Sally. Alternatively, a similar explanation suggests that the statistical evidence may have been misunderstood as referring directly to chance of guilt (aka "prosecutor fallacy"). I show that none of these explanations is tenable and I argue that the role of statistical evidence was overrated both by scholars and by the public media.

Jeff Paris

Relevance and irrelevance in inductive logic

(joint work with Pete Waterhouse)

The fact that the *Principle of Instantial Relevance* (saying, roughly, that the more often you have seen something in the past the more often you should expect to see it in the future) actually followed in Carnap and Johnson's formulation of (unary) Inductive Logic from the simple and apparently uncontentious assumption of *Constant Exchangeability* was viewed as something of a triumph and a vindication that the programme was on the right lines. However there are several other straightforward formulations of the idea that `the more often you have seen something in the past the more often you should expect to see it in the future' apart from the Principle of Instantial Relevance and for these the situation is sometimes far from being so simple. In my talk, which very largely covers joint research with Pete Waterhouse, I shall consider some such variations of `relevance', and also its counterpart, `irrelevance', mainly in the case of traditional unary Inductive Logic but also touching on the situation in the binary and higher arity case.

Manfred Jaeger

Towards a (Model) Theory for Probabilistic Logical Models

In recent years there has been a growing interest in probabilistic models for structured data. These models typically combine elements of probabilistic logic with elements of conventional statistical models. Many different representation languages for such probabilistic logical models have been proposed, usually with a view towards applications in machine learning. While, thus, on the practical and application-oriented side much progress has been made, there is not very much theoretical understanding of these models. In this talk I am going to argue that a model theory for probabilistic logical models is needed in order to analyze and compare issues like expressivity, complexity and learnability of different representation languages. I will outline a general semantic framework on which such a model theory can be based, and present some initial results on expressivity and complexity. Two different concrete representation languages (relational Bayesian networks and Markov logic networks) will be used to illustrate the general concepts.

Joana Hois

Towards combining ontologies and uncertain knowledge

In the field of AI, an ontology specifies concepts and relations about some domain of interest. As its categories are defined clearly and precisely, there does not occur any uncertain information. However, as soon as a real world system uses such an ontology and instantiates the ontology's categories and relations, it has to deal with uncertain, imprecise and vague information from various sources. In this talk, we will have a look at the possibility to combine ontologies, which can be formalized in different sorts of logic, and probabilities, which can represent different sorts of uncertainty, with respect to their meaning.
An example for an application that motivates this combination will be given.

Ondrej Majer

Probabilistic extension of IF logic

In Independence Friendly (IF) logic, introduced by Hintikka and Sandu [2,4], a distinction is made between two relations among logical expressions: syntactical subordination ('syntactic scope') and logical dependence ('semantic scope'). The semantics of IF logic is naturally given using two-player zero-sum games of imperfect information. The truth (falsity) of a formula in a model corresponds to existence of a winning strategy for one of the players (if such exists). IF logic is abundant with examples of formulas which evaluate as non-determined relative to various models (cf. esp. [5]). A fine-grained analysis of non-determinacy is obtained if we allow players to use mixed

strategies and define the value of a formula as the Nash equilibrium of the corresponding semantic game. This extends the three-valued evaluation (true, false, non-determined) of IF logic to the real interval [0, 1]. The idea of a probabilistic interpretation of IF logic has been mentioned in the literature several times, cf. [1, 3], however up to our knowledge it has not been worked out in a detail from the mathematical viewpoint. This article aims to take first steps towards providing a solid formal framework to meet the mentioned intuitions and explore the resulting many-valued logics.

[1] J. van Benthem (2004): "Probabilistic features in logic games" in Kolak et al. (eds.): Quantifiers, Questions and Quantum Physics, Springer, 189-94.
[2] J. Hintikka (1995): "What is elementary logic?," in K. Gavroglu et al. (eds.): Physics, philosophy and the scientific community, Kluwer, 301-26.
[3] J. Hintikka (2005): "IF logic in a wider setting," manuscript.
[4] J. Hintikka, and G. Sandu, "Informational independence as a semantical phenomenon", in J. Fenstad et al. (eds.): ``Logic, Methodology and Philosophy of Science" 8, Elsevier, 571-589, 1989.
[5] J. Väänänen (2006), "A Remark on Nondeterminacy in IF Logic," Acta Philosophica Fennica 78, 71-77.

Lise Getoor

Statistical relational learning

I will survey several of the major branches of the newly emerging field of statistical relational learning (SRL). I will describe representational issues, learning and inference. Many of the approaches are based in some way on combining rich logical representations with probabilistic graphical models, and I will describe approaches which are based on both directed and undirected graphical models. I will describe several useful inference tasks such as link prediction, group detection and entity resolution.

Fabio Cozman

Independence Relations in Probabilistic Logic

(joint work with Cassio Polpo de Campos and Jose Eduardo Ochoa Luna)
This talk investigates probabilistic logics endowed with independence relations. We review propositional probabilistic languages without and with independence. We then consider graph-theoretic representations for propositional probabilistic logic with independence; complexity is analyzed, algorithms are derived, and examples are discussed. We then consider relational logics with applications in knowledge representation and automated planning. During the talk, the basic elements of the theory of sets of probability measures will be discussed, and the challenges in finding adequate definitions of independence and appropriate Markov conditions will be examined.

Marco Valtorta

Logic and Probabilistic Reasoning to Support Information Analysis in Uncertain Domains

(joint work with Michael Huhns and John Byrnes)
Formal logical tools are able to provide some amount of reasoning support for information analysis, but are unable to represent uncertainty. Bayesian network tools represent probabilistic and causal information, but in the worst case scale as poorly as some formal logical systems and require specialized expertise to use effectively. We describe a framework for systems that incorporate the advantages of both Bayesian and logical systems. We define a formalism for the conversion of automatically generated natural deduction proof trees into Bayesian networks. We then demonstrate that the merging of such networks with domain-specific causal models forms a consistent Bayesian network with correct values for the formulas derived in the proof. In particular, we show that hard

evidential updates in which the premises of a proof are found to be true force the conclusions of the proof to be true with probability one, regardless of any dependencies and prior probability values assumed for the causal model. We provide several examples that demonstrate the generality of the natural deduction system by using inference schemas not supportable in Prolog.

Ulrike Hahn

The Relationship between Probability and Logic in Argumentation

(joint work with Mike Oaksford)
Classical informal reasoning "fallacies," for example, begging the question or arguing from ignorance are ubiquitous in everyday argumentation, but have evaded systematic, formal treatment. We present a Bayesian treatment of these classic fallacies, and present experimental evidence demonstrating that E people's judgments of the strength of 3 fallacies—the argumentum ad ignorantiam, the circular argument or petitio principii, and the slippery slope argu- ment—are affected by the factors a Bayesian account predicts. This suggests that Bayesian accounts of reasoning can be extended to the more general human activity of argumentation.

Stephan Hartmann

Merging judgements and the problem of truth-tracking

(joint work with Gabriella Pigozzi)
Belief revision investigates the dynamics of the process of belief change: when an agent is faced with new information which contradicts her current beliefs, she will have to retract some of the old beliefs in order to accommodate the new information consistently. Recently, the problem of belief revision has been generalized to consider the aggregation of potentially conflicting individual belief bases into a collective one. This new area is called belief merging. Judgment aggregation, on the other hand, studies how to aggregate consistent individual judgments on several logically interconnected propositions into a consistent collective judgment on the same propositions. In particular, a paradox (the discursive dilemma) can arise when individual judgments are aggregated. To avoid the paradox, several aggregation procedures have been investigated. One of the proposals is to import the belief merging approach and apply it to judgment aggregation. This raises the question how the different aggregation procedures can be evaluated. If we assume that the decision, which the group is trying to reach, is factually right or wrong, one possible dimension of the evaluation is to assess how well each approach is in tracking the truth. In this talk I will present results on the truth-tracking power of the merging operators and compare it with other procedures.

Rolf Haenni

Probabilistic Logic and Probabilistic Networks

While in principle probabilistic logics might be applied to solve a wide range of problems, in practice they are rarely applied at present. This is perhaps because they seem disparate, complicated, and computationally intractable. We shall argue though that several approaches to probabilistic logic fit into a simple unifying framework, where probability intervals or probabilities are associated with sentences. Further, we argue, there is the potential to develop computationally feasible methods to mesh with this framework. In particular, we suggest that credal and Bayesian networks can naturally be applied as a calculus for probabilistic
logic. As an example, this talk gives particular attention to the application of this framework to probabilistic argumentation.

Emil Weydert

Probabilistic logics of trust

Trust is a multifaceted concept which has received considerable attention in the last years. However, the existing logics of trust, primarily aimed at multi-agent systems, turn out to be rather rudimentary. In this talk, we are therefore going to formulate and discuss some desiderata for more expressive probabilistic logics of epistemic trust which are able to describe the quality of sources.

Gábor Hullám

A probabilistic logic incorporating posteriors of hierarchic graphical models

(joint work with Andras Millinghoffer and Peter Antal)

The handling of accumulating data and literature in fields like biomedicine create a challenging problem. Literature and curated ontologies offer a tremendous amount of factual knowledge, which can be formed into a logical knowledge base, while the posterior distribution over Bayesian networks represents the uncertain knowledge. First, I will introduce a first-order probabilistic logic language with predicates and functions oriented towards graphical models. Second, I will describe a method and a system for fusing logical knowledge bases and posteriors defined by probabilistic graph-grammars over Bayesian networks. The method induces probability for first-order sentences, which are approximated by Monte Carlo methods. Third, I will formulate the inference problem of the "most probable sentences"

(MPSs), discuss the statistical challenge it poses and describe an integrated search and estimate method to solve the MPSs problem. Then I will show the specialization of the MPSs problem to the feature subset selection problem, and to the feature subgraph selection problem. Finally, I will present some results for real-world biomedical problems.

Evan Tzanis

A note on probabilistic logics

We introduce a probabilistic modal logic extending the work of [FHM90],[FH94] by allowing arbitrary nesting of a path probabilistic operator. We prove its completeness and we prove that the validity problem can be solved in EXPSPACE. The talk will contain a number of worked examples and some possible applications of the given logic to probabilistic XML documents [NJ02] and real time systems [HJ94].

References

[FH94] Ronald Fagin and Joseph~Y. Halpern. Reasoning about knowledge and probability. 41(2):340--367, 1994.

[FHM90] Ronald Fagin, Joseph Y. Halpern, and Nimrod Megiddo. A logic for reasoning about probabilities. Information and Computation 87(1,2):78--128, 1990.

[HJ94] Hans Hanssohn and Bengt Johnsson. A logic for reasoning about time and reliability. Formal Aspects of Computing 6(5):512--535, 1994.

[NJ02] A. Nierman and H. Jagadish. Protdb: Probabilistic data in xml. In Proceedings of VLDB02, Lecture Notes in Computer Science volume 2590, pages 646--657, 2002.

Gert de Cooman

Belief structures as an abstract framework for studying formal aspects of uncertain reasoning

In a recent (2005) paper, I have advanced the notion of a belief structure as a formal common framework in which to study and compare various systems for reasoning, including amongst others classical propositional logic, possibility theory, and various imprecise probability models. Such belief structures can also be used to give a fairly general account of belief change. I will explain the ideas behind this framework, and illustrate two special cases: classical propositional logic, and sets of desirable gambles (a type of imprecise probability

model). This will allow me to establish a clear relationship between the two, and to elucidate the fairly limited role that precise probabilities have to play. I will also discuss very recent unpublished results (in cooperation with Enrique Miranda) about incorporating conditioning into this framework.

Olivier Teytaud

Inductive-Deductive Systems: A mathematical logic and statistical learning perspective

(joint work with Nicolas Baskiotis and Michele Sebag)

The theorems about incompleteness of arithmetic have often been cited as an argument against automatic theorem proving and expert systems. However, these theorems rely on a worst-case analysis, which might happen to be overly pessimistic with respect to real-world domain applications. For this reason, a new framework for a probabilistic analysis of logical complexity is presented in this paper. Specifically, the rate of non-decidable clauses and the convergence of a set of axioms toward the target one when the latter exists in the language are studied, by combining results from mathematical logic and from statistical learning.

Jan Sprenger

Statistics between inductive logic and empirical science

Inductive logic generalises the idea of logical entailement and provides standards for the evaluation of non-recursive arguments. A main application of inductive logic is the genaralization of observational data to theoretical models. In the empirical sciences, the mathematical theory of statistics addresses the same problem. Two case studies—parameter estimation and model selection—provide evidence for my claim that the principles of statistical inference exceed the limits of an inductive logic.

Colin Howson

Combining Probability and Logic: Some Questions

There has been a lot of work in the last fifty years in trying to forge a systematic connection between probability, usually under some epistemic interpretation, and logic. The formalisms of the two disciplines are tantalisingly similar in many ways, as are their roles as domain-general theories of inference. Work done in the nineteen sixties seemed a start in showing how probability could generalise model theory and even to some extent proof theory. The work goes on but there are some issues that remain unsettled. I will make some general remarks about the following two: (i) the degree to which formal models can achieve the expressive power of the informal mathematical theory, and (ii) countable versus finite additivity and in general the status of the axioms themselves.

Pedro Domingos

Markov Logic: A Simple and Powerful Unification of Logic and Probability

(Joint work with Stanley Kok, Daniel Lowd, Hoifung Poon, Matt Richardson, Parag Singla, Marc Sumner, and Jue Wang.)

Markov logic unifies logic and probability by attaching weights to first-order formulas and viewing them as templates for features of Markov networks. First-order logic is the infinite-weight limit of Markov logic, and most widely-used probabilistic models are simple special cases of it. We have developed a suite of efficient inference and learning algorithms for Markov logic, incorporating ideas from satisfiability testing, Markov chain Monte Carlo, statistical learning, inductive logic programming, and others. Implementations of these algorithms are publicly available in the Alchemy open-source library. Markov logic has been applied

to a wide range of domains, and in a number of large AI projects. These provide empirical evidence of the benefits of combining logic and probability, and raise many fascinating questions for further research.

Gernot Kleiter

Framing human inference by coherence based probability logic

(joint work with Niki Pfeifer)

We take coherence based probability logic as the basic reference theory to model human deductive reasoning. The conditional and probabilistic argument forms are explored. We give a brief overview of recent developments of combining logic and probability in psychology. A study on conditional inferences illustrates our approach. First steps towards a process model of conditional inferences conclude the paper.