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Automated Practical Reasoning and Argumentation

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Seminar on Argumentation and Reasoning

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There is an increasing research interest and activity in artificial intelligence, philosophy, psychology and linguistics in the analysis and mechanization of human practical reasoning. Philosophers and linguists, continuing the ancient quest that began with Aristotle, are vigorously seeking to deepen our understanding of human reasoning and argumentation. Significant communities of researchers, faced with the shortcomings of traditional deductive logic in modelling human reasoning and argumentation, are actively engaged in developing new approaches to logic (informal logic, dialogue logic) and argumentation (rhetoric, pragmatic and dialectical), which are better suited for the task. In parallel and with equal dedication and ingenuity, many software engineering and AI researchers are pursuing similar goals. These computer scientists are in urgent need of some models of human reasoning and argumentation in order to develop better software tools for aiding and for replacing the human or his activities.

A quick look at the research programs of theses communities instantly reveals that there is a close conceptual connection and complementary mutual research interest among these diverse communities. Indeed there are strong similarities in aims and case studies between the non-monotonic logic community in AI and the informal logic community in philosophy, between the planning community and the practical reasoning and action community, between the dialogue community and the human computer interaction and user modelling communities.

It is therefore necessary and urgent to overview, summarize and organize the current state of research in these areas in the form of a thematic multi-volume Handbook, and to make it available to all researchers involved. Such

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an enterprise will enhance and accelerate the interaction between the communities. First contact was achieved in an initial research seminar held in Dagstuhl in August 1993 involving researchers from several of these communities. The talks given during this seminar were intended to give an overview of the various aspects of argumentation and reasoning from point of view of philosophy, psychology, logic and AI. The evenings were used to work out the precise table of contents of various volumes of the Handbook. A follow up meeting is planned on the 20th and 21st of June 1994 in Amsterdam.

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Limitations on Logic as a Theory of Argument

John Woods

Basic classical systems of logic define validity and invalidity on the Standard Grammars (Quine) of natural languages. A standard grammar of a (fragment of a) natural language N maps subsets of expressions of N into sets of logical forms. Standard grammatization (SG) is held to have the *backwards reflection property* with respect to validity. Thus if an argument in N has a valid form under SG, it a valid argument of N; and if it has no valid form, it is invalid in N.

No known machinery of standard grammatization applies directly to sentences of N, to sentences of N "on the hoof", as it were. In particular, simple sentences of N are ineligible as inputs to SG unless they meet the pairwise semantic-inertia condition; that is, for pairs of simple N-sentences F, Y, neither does F imply Y or Y imply F, nor is F inconsistent with Y. If for arbitrary F, Y it is possible to determine generally and in a principled way whether the semantic inertia condition is met, then we may say that there exists an satisfactory *informal logic* (IL) of implication and consistency for simple sentences of N. IL qualifies as *informal* precisely because it applies directly to structures in N without recourse to the logical forms of SG. It operates as an input to SG and thus is prior to it.

There are two schools of thought about IL. One is that it exists in principle, never mind that little has been done to date to give it precise expression. The other is that it doesn't and couldn't exist. If the later is true, then no formal system of logic is a satisfactory theory of validity for natural language arguments. If the former is true, then although there is such a thing as a formal theory of validity for natural language arguments, it is an irreducible extension of an informal core theory, an extension whose significance is largely that of efficiency of formulation. Either way, the idea that natural language validity is inherently a formal property is doomed.

The Contribution of Informal Logic to the Theory of Reasoning

Ralph H. Johnson

There are exciting times for anyone interested in logic and reasoning. Not only has logic been able to break free of some old constraints (e.g. that logic is necessarily formal) but as well the topic of reasoning has (almost suddenly, it seems) emerged as a form of investigation. The work of Harman, Finocchiaro

and Walton has been influential in this development. The question "What is reasoning?" needs to be dealt with in the context of the theory of reasoning. In this paper, I describe the theory of reasoning as a logico-philosophical inquiry and state what the contribution of informal logic might be. In order to do this, I provide an account of what informal logic is. I also identify and discuss the assumptions which have guided most traditional thinking about these matters. They are:

(A1) Logic = formal, deductive logic.

(A2) Logic = the theory of reasoning.

(A3) Reasoning is essentially inference.

(A4) Inference is essentially deductive.

In this paper, I argue that these assumptions are inadequate and put forward in their place:

(B1) Informal logic is the normative theory of argumentation

(B2) Argumentation is central to reasoning

These assumptions (which I do not argue for here) indicate the contribution of informal logic to the theory of reasoning. Without the developed theory of argument, we will not have an adequate theory of reasoning, and informal logic offers a promise of developing a theory of argument.

Informal Reasoning
David Perkins

Over the past 20 years, a number of psychologists have investigated people's everyday or informal reasoning, roughly defined as people's ability to reason about the truth of propositions concerning everyday matters (for instance involving family life or politics) or the soundness of choices in decision-making situations. As a broad generalization, these studies have revealed that most people do not reason very well. Most commonly, they largely neglect reasons on the side of the case opposite the one they lean toward, and largely neglect possible objections to their own lines of argument. These and other errors of omission by and large do not correspond to the formal or informal fallacies highlighted in the literature on reasoning. It

appears that formal logic and the formal and informal fallacies may not offer an adequate normative theory for criticizing or guiding informal reasoning.

As to why people do not reason well, the evidence implicates several contributing causes: limited intellectual aptitude, defensiveness and confirmation bias, lack of knowledge of hazards and useful moves in informal reasoning, and lack of motives, values, and commitments that incline a person to reason with care. Educational research suggests that conventional education, including education at the college and graduate levels, does not help much with these problems, but that education could do much better.

Finally, it should be noted that certain contemporary viewpoints fundamentally challenge the quest to identify and systematize weaknesses in informal reasoning. Some philosophers argue that it is simply not possible that people reason badly; the claim is either not true or not cogent. Some psychologists argue that there is little general about the enterprise of reasoning; rather, reasoning — good or bad — depends profoundly on highly developed knowledge in domains. Finally, some philosophers argue that the world is too chaotic a place for reasoning to afford people anything like the orderliness and predictiveness they hope for. Although in my judgment these concerns are overdrawn, they nonetheless constitute an important part of the dialectic around informal reasoning and its shortfalls.

The Adequacy of Inferences in Arguments

J. Anthony Blair

There is a difference between an inference, an implication, and an argument, in the sense of a set of propositions produced to assert a set of propositions as support for a claim. There are two argument adequacy questions:
(1) Are the premises adequate?
(2) Is the support for the conclusion adequate?
The latter is the question of inference adequacy. For many interesting and important arguments there is no theory to account for the adequacy of their inferences. The test of deductive validity is insufficient because there are strong inductive inferences. The test of deductive validity or inductive strength is insufficient because there are good inferences in balance-of-considerations arguments. Nellman's "conductive" reasoning and Wisdom's case-by-case reasoning fit only special cases, at best Toulmin's theory of warrants is inadequately developed, and open to objections.

It would be a mistake to expect to find a single simple account for all 'guments. Arguments with different objectives (esp. truth presentation, asonable beliefs, audience acceptance, and rational action (policy) will ave different standards. Also practical considerations (constraints of time, sks, benefits, costs) will set different inference-adequacy conditions.

There is a need for quasi-empirical, quasi-normative investigations of hat are agreed to be adequate inferences in arguments. As well, the analisis of dialogue types, of fallacies, and of argument schemes, are already-arked out paths it would be fruitful to follow. However, the problem of ference-adequacy, central to argument evaluation, is very far from being olved.

Inference and Truth

Ian Pratt

he aim of this paper is to challenge, in a modest way, some basic intuitions oncerning the role of truth and meaning in the evaluation of inference proisses. Our point of departure is what I call the "standard picture", which sserts that (i) inference consists of the manipulation of meaningful expresons, where meaningful expressions represent objective states of affairs; and lat (ii) the aims of inference should include those of acquiring many true eliefs and avoiding false ones. Pragmatists challenge tenet (ii) by arguing lat truth is not a particularly important aim of reasoning. In this talk, owever, I challenge tenet (i). Specifically I argue that default reasoning equires the use of expressions which cannot be taken to have any objective leaning, and the processing of which cannot be understood as determining le truth or falsity of any condition.

Appeal to Ignorance. Varieties of the *Argumentum ad Ignorantiam*

Eric C.W. Krabbe

he *argumentum ad ignorantiam*, or appeal to ignorance, is commonly de-:ribed as a fallacy:

(1) $\neg E \neg p$. Therefore p.   (Or: $\neg E p$. Therefore $\neg p$.)

ere E is some epistemic operator such as: $Ep :=$ it is known that p / it as been proven that p / there is something to be said for p / there are good

arguments for p / p is knowable / p is provable / ... [and more complicated readings such as:] there is a q such that it is known that (q is true and that q and p (if true) would account for fact f)..

The roots of the *argumentum ad ignorantiam* are dialectical, The term was introduced by John Locke (1690) to describe a certain way of arguing in dialogue that, though it "may dispose me, perhaps for the reception of Truth" does not help me to it. It is debatable whether Locke conceived of the ad ignorantiam as a fallacy.

The paper presents an analysis of Locke's text. The dialectical fallacy that this text (possibly) refers to is that of *denying to the Opponent a right to criticize the Proponent's argument.* Another, related, dialectical fallacy that is also called *ad ignorantiam,* is that of *answering a challenge by a challenge*:

P : p
O :   Why p?
P :   Why $\neg p$?

This would be justifiable if one accepted the following rule (it is not recommended that one should):

Ad Ignorantiam Rule. If X did not successfully defend $\neg p$, then Y's defense of p has succeeded.

This rule, again, could be "justified" by some reasoning along pattern (1). The *Ad Ignorantiam Rule* further "justifies" the evaluation type of the *argumentum ad ignorantiam,* i.e., a determination of the outcome of a critical discussion on the basis of the following principle:

> Suppose that X did not successfully defend $\neg p$. Then X should (provisionally, until further notice) accept p.

Thus there appear to exist close relationships between the various types of *ad ignorantiam.*

In the context of a critical discussion an argument of type (1) is not by itself fallacious. If the Proponent argues in this way, it is up to the Opponent to formulate a criticism on the premise- conclusion link. In many cases the Proponent will be able to parry this criticism by means of additional premises that fill the gap in the argument (bridging principles).

However, if reasoning of type (1) occurs in an argumentative text (where the Opponent is not actually present to object), this often constitutes a fallacy, viz., that of *leaving a gap in the argument (insufficiency).*

The paper concludes with an analysis of a complex case of *ad ignorantiam,* that was described (and censured) by Spinoza (Ethics I, *Appendix*).

The Study of Argumentation and Fallacies from a Pragma-Dialectical Perspective

Robert Grootendorst

In the paper it is argued that it is mistaken to analyze fallacies exclusively as logical errors. In pragma-dialectics, developed by Frans van Eemeren and Rob Grootendorst, fallacies are understood as wrong moves in argumentative discourse, i.e. as <u>faux pas</u> of communication. In the pragma-dialectical approach (PDA), a research program is developed which has a philosophical, a theoretical, an empirical, an analytical, and a practical component. In PDA, normative and descriptive insights are closely interwoven. For this, four basic meta-premises are formulated: 1) externalization, 2) socialization, 3) functionalization, and 4) dialectification. 1 - 4 are realized by making use of <u>pragmatic</u> insight from discourse and conversation analysis and <u>dialectical</u> insight from critical-rationalist philosophy and dialogical logic.

In the theoretical component of PDA, the critical-rationalist conception of reasonableness is given shape in an ideal model of a critical discussion aimed at resolving a difference of opinion. The model specifies a set of 10 rules for the performance of speech acts in the four stages of a critical discussion (confrontation, opening, argumentation, concluding).

A fallacy is defined in PDA as a speech act which violates one or more of the discussion rules, thereby frustrating the resolution of a difference of opinion. The process of detecting a fallacy starts from the interpretation of an utterance as a particular kind of speech act. The second step consists of establishing that the aim of the discourse is actually resolving a difference of opinion; the third step of establishing that the speech act is a violation of the discussion rules; and the fourth step of determining what kind of violation is entailed.

An overview of possible violations of the ten rules which is discussed in the paper, shows that the PDA analysis of fallacies is more systematic and more refined than the Standard Treatment Similarities and differences between PDA and Barth and Krabbe formal dialectics (1982) are discussed. It is concluded that, though PDA is by no means "complete" as a theory of fallacies it is better suited for the analysis of fallacies than the Logico-centric Standard Treatment because PDA takes phenomena of natural language such as implicitness and indirectness systematically into account and because it offers not only the norm of formal validity as a criterion for analysis, but also nine other norms which cover the many other things that can go wrong in argumentative discourse.

Types of Dialogue and Dialectical Shifts in Argumentation

Douglas N. Walton

Problems of judging arguments as fallacious or not in particular cases of a given text of discourse are discussed. One problem is that types of argument characteristic of traditional fallacies are, in some cases, reasonable arguments. Another problem is that such arguments need to be evaluated in a context of conversation (dialogue). Several normative models of dialogue in addition to the critical discussion are outlined, including the inquiry, the negotiation, the expert consultation dialogue, the debate, and the quarrel. Dialectical shifts, shifts in an argument in a case from one type of dialogue to another, are studied in relation to problems of evaluating some of the traditional informal fallacies like the *argumentum ad hominem, argumentum ad verecundiam, and argumentum ad baculum.* One thesis put forward is that a fallacy is an argument that *appears* valid because there has been a concealed or illicit shift from the type of dialogue in which the argument was properly supposed to be used, but where the argument is not appropriate, to some other type of dialogue in which the argument may have been quite appropriate. Thus a fallacy can be modelled as a deceptive argument.

Legislation as Logic Programs

Robert Kowalski

Legal language is a good candidate for investigating the use of logic (and other formalisms) for knowledge representation because of its intermediate formality between ordinary natural language and artificial language. In my talk I investigated extracts from the British Nationality Act (BNA), the University of Michigan lease termination clause (UMLTC) and the London underground emergency notice (LUEN).

The English of the BNA is remarkably precise. This facilitates its representation in formal logic. Interestingly these representations generally have logic programming form extended not only by the "implicit" negation of negation as failure, but also by an "explicit" negation for representing exceptions, as well as by metalogical expressions that refer both to other legislation and to other provisions in the same legislation. In some cases, the uses of logic programming form can actually simplify and clarify the English formulation of the law.

The UMLTC is quite different in character. It is highly ambiguous, and its syntax greatly obscures its logical form. Expecting the intended meaning of the English to have logic programming form very much helps to identify the intended interpretation form among the more than one hundred interpretations possible.

The LUEN exemplifies a use of English which is intended to be understood as clearly and unambiguously by as many people as possible. This English is very close to logic programming form. However, the very first sentence is formulated in procedural form: "Press the alarm signal button, to alert the driver."

The sentence also has a purely "declarative" interpretation: "You alert the driver, if you press the alarm signal button."

This example shows, in my opinion, that logic programming should cater not only for procedural interpretations of logic but also for declarative interpretations of procedures.

The Concept of Representation

Hidé Ishiguro

Reasoning is an act or a sequence of acts. Reasoning is what people do, which is done in time and probably involve mental states. Understanding reasoning is to understand a sequence of events that a person is involved in. On the other hand we express logic as a norm governing types of sentences or propositions or thoughts even if the thoughts are contents of thinking done in a certain temporal order. Recently the concept of representation has been revived and much used in order to relate the two by those who philosophize about cognitive psychology (e.g. J. Fodor's 'mental representation') about linguistics and knowledge (e.g. Chomsky's 'semantic representation'), and by those who work in model theoretical pragmatics (e.g. Kamp's 'Discourse Representation'), by those who discuss the relation of scientific theory and reality (e.g. Hacking's 'Representing and Intervening'), or about mind and reality (e.g. H. Putnam's 'Representation and Reality'). Some (e.g. R. Rorty) have criticized it as a concept which has long distorted the history of modern philosophy, but 'processing representations' is still a central phrase in A.I., influenced by cognitive psychology.

I try to show that 'representation' means many different things, and that not only in discussions between different thinkers but within the argument of a single thinker, a shift of the sense of word 'representation' can often occur,

making both the defense of, and attack on, representation in computational psychology unclear, as well as leading to unwarranted conclusions such as the defense of methodological solipsism.

1) 'Representation' can mean something experienced from a first person view, or something corresponding to a person's act of imagination. Notice that Kant's 'Vorstellung' has always been translated 'representation' in English or French. We will not discuss how universal or transcendental a feature of thinking it has to be involved with. What is essential is that it is given to a thinking person. I suspect Fodor uses the word in this sense.

2) 'Representation' can mean objects that are likenesses. Hacking says his representations are not Kant's Vorstellungen but are first of all physical likenesses such as figurines, statues, pictures and engravings. They are public objects that can be examined. Strangely he 'extends' representation to include scientific theories which are neither physical nor are likeness of nature in the same sense. (Only what they say is or is not like nature).

3) Representation can be the result of a conventional mapping. It is the sense in which a sentence is said to represent a function. Wittgenstein uses the German word 'Darstellung' to express this in the *Tractatus Logico-Philosophicus*. It seems that Putnam uses the word 'representation' in this way when he says 'thinking uses representations'. There is nothing about it that is essentially linked to a first person experience, or mental.

4) Representation can mean model i.e. the model-theory specification which makes a sentence or an assertion of the sentence true, i.e. the specification of its truth-condition. This is in effect to specify a state of affairs or a set of state of affairs in a possible world, or a collection of them. It is almost the inverse of representation in the third sense, but not vice versa. But representations in these four senses are clearly different kinds of things which require different treatment. Whatever their mutual relationship is, it is clear that unless we keep the uses apart we will get into great confusion, especially in any analysis of acts of reasoning.

For example what are called 'mental representations' are essentially mental, like mental states yet some of them are claimed have syntactical structures like sentences. It is these, so Fodor claims, that enable cognitive psychologists to entertain the doctrine "that mental states and processes are computational", which seems to mean that one can treat them by operations based merely on their syntactic forms, and hence that one can have machine models of them. Representations are taken to be identifiable independently of any assumed links to anything beyond it. Hence methodological solipsism. But the features of the acts of thinking which are mental and private

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should not, I suggest, be transposed to either the content of thought or to the language with which we think.

A Knowledge Representation System

Ullrich Hustadt

In this talk the MOTEL knowledge representation language and its implementation have been presented.

MOTEL is a logic-based knowledge representation system of the KL-ONE family. The MOTEL language, called Mod-$\mathcal{ALC}$ contains as a kernel the $\mathcal{ALC}$.language which is a decidable sublanguage of first-order predicate logic.

Whereas $\mathcal{ALC}$ is a single-agent knowledge representation language, i.e. $\mathcal{ALC}$ is only able to represent general world knowledge or the knowledge of one agent about the world, Mod-$\mathcal{ALC}$ is a multi-agent knowledge representation language. Mod-$\mathcal{ALC}$ allows modal contexts and modal concept forming operators which allow to represent and reason about the believes and wishes of multiple agents. Furthermore it is possible to represent defaults and stereotypes.

Beside the basic reasoning facilities for consistency checking, classification, and realization, MOTEL provides an abductive inference mechanism. Furthermore it is able to give explanations for its inferences.

Practical Reasoning

Dov M Gabbay

We present a view that assumptions must be structured by an external labelling.

Reasoning from the assumptions will use the labelling and give conclusions dependent on the labels. This approach allows one to adjust logical system in a way closer to human reasoning. For example, if the labels indicate source of information then attacking the source (i.e. the fallacy of Ad Hominem) can make logical sense; it strives to change the priorities among sources.

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Logics for Knowledge Representation Purposes

Hans Jürgen Ohlbach

Classical predicate logic is not very well suited for representing the knowledge of intelligent agents. Propositional attitudes as for example "knows", "believes", "wants", causality, are too vague notions which cannot be formalized very easily in predicate logic. Therefore a variety of new logics has been developed for modelling various notions occurring in everyday life.

Traditionally the way, new logics have been developed so far, is to concentrate on one or a few specific features and build a logic or a class of logics around it. For example modal logic is built around the two modal operators $\Box$ and $\Diamond$ and a corresponding possible worlds semantics. Relevance logic is built around the implication and the intuition that all assumptions should be used in the proofs. The construction and investigation of these logics was a scientific enterprise which sometimes took decades. From a practical point of view, however, the outcome is still not satisfactory. Having these different types of logics which quite often have nothing to do with each other is like for example having one programming language with recursion and another one with arrays, but no language with both. Therefore there is a need, not only for combining existing logics with different features, but also for developing new logics that suit particular applications. If the development of a new logic is application driven, it should be an engineering issue that does not divert from the work on the application itself.

We have made considerable progress in developing automated support for the development and investigation of new logics. In particular the "correspondence problem", deriving the correspondences between axiomatic specifications of a logic and properties of the semantic structure can be solved automatically. This offers the way to specifying logics on a very abstract level and automatically deriving semantic properties and form there getting translators which translate formulae into predicate logic. The talk gave an overview on the methods for supporting the development and investigation of logics.

The Implications of Recent Developments in Cognitive Science for the Future of Rational Criticism

Robert C. Pinto

In their early stages, cognitive science and cognitive psychology drew many of their models of good thinking from the paradigms developed by traditional logic. That logic was designed to deal with information that is encoded linguistically. Important recent theoretical and empirical developments (especially PDP, and more specifically connectionist accounts of cognitive processes) seem to suggest, however, that the manipulation of propositional or linguistic content is a "surface" phenomenon and that much of the cognitive "action" takes place at pre-linguistic levels. If that is true, it has profound implications for questions about the role logic should play, rational criticism and the assessment of reasoning and argumentation. This presentation (i) assesses the epistemological and critical implications of these recent developments and (ii) proposes specific strategies for making judicious use of logical concepts in the present intellectual context – a context in which our understanding of the very nature of thinking is undergoing significant evolution.

(i) The examination of recent developments in cognitive science emphasizes the Eliminative Materialist interpretation of those developments, as represented by P. M. and P. S. Churchland. Acceptance of P. M. Churchland's approach to the study of mind suggests two morals for those interested in rational criticism or the evaluation of reasoning.

(a) when we study reasoning, the restriction of interest of what has been linguistically encoded, whether the encodings be in a natural or a formal language, is probably a mistake

(b) the supposition that the semantic and, more broadly, formal features of such encodings constitute the difference between good and bad reasoning is also probably a mistake.

It is pointed out, moreover, that the importance of nonformal elements in reasoning is apparent from a number of well known problems that show no promise of a formal solution (the existence of semantic entailments, Goodman's new riddle of induction, the underdetermination of theory by evidence in empirical science, the defeasibility of nondeductive inference, and the indispensability of case–by–case reasoning in a variety of domains).

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(ii) if it is concluded that if the morals mentioned above are to be taken seriously, then the attempt to evaluate reasoning must shift its focus from attention to the products of reasoning to techniques which will test the integrity of the process of reasoning. It is argued that, for a variety of reasons, the integrity of the process cannot be assessed by appeal to rules of reasoning, but that there already exists an entrenched critical practice many of whose strategies remain appropriate within a conceptualized rational criticism. Five such strategies are identified: (a) utilization of the process of dialogue be used as the chief resource for evaluating the process of reasoning, (b) a judicious use of traditional fallacy labels as strategies to initiate, rather than terminate, extended discussion of arguable points, (c) development of and emphasis on what Walton has called "critical questions", (d) the use of argument schema, not as tests of validity, but as sources of critical questions and extended dialogue, and (e) a very limited use of formal deductive logic subject to carefully stated restrictions.

Recent Developments in Epistemic Logic

Paul Gochet

The lecture reported on the most recent developments in epistemic logic and compared four approaches to the problem. First, Philippe Lejoly's subjective logique (forthcoming in a special issue of *Logique et Analyse*) was described. Lejoly's account belongs to the model checking paradigm put forward by Moses and Vardi as an alternative to the standard proof theoretic approach of logic. Lejoly succeeds in removing some forms of logical omniscience by appealing both to specific features of model checking and by partial truth value assignment. The second part of the lecture was devoted to Elias Thijsse's combination of a hybrid semantics with a sieve theory along the lines of Fagin and Halpern. The third part of the lecture presented a revised account of awareness based on a recursive definition of "awareness up to a depth" which discloses the link between the latter and the syntactic complexity of the formula contemplated by the agent (whose limited logical competence is to be captured by an adequate epistemic logic). The logic of local reasoning was briefly examined. At the end the merits and defects of the competing theories were assessed. It was suggested that Dov Gabbay's labelled deductive system and Girard's Linear Logic might profitably be brought to bear on the issue in order to supply a more dynamic account of logical knowledge about knowledge.

Probability of Provability and Belief Functions.

Philippe Smets

Dempster-Shafer theory has received much attention recently in AI, both in favorable and unfavorable ways. Most criticisms are based on confusion resulting from an inappropriate mixing of several interpretations of the theory. No specific interpretation is 'better' than any other, each one fits a specific domain. Ruspini and Pearl have considered logical foundations of the model based on the concepts of the probability of a modal proposition (knowing) or of the probability of provability.

We analyze in detail the probability of provability interpretation and show how the conditioning rules can be derived. We first present the two conditioning rules that have been distinguished recently by Dubois and Prade, the focusing and the revision. We proceed by detailing the concept of the probability of the provability of some propositions. We show the relation of these particular probability functions with the belief functions. Finally, we study two conditioning processes that correspond to the geometrical rule of conditioning and to the unnormalized (Dempster) rule of conditioning, respectively.

Intersubjective Probability and Belief Systems

Donald A. Gillies

Reasoning, argumentation, and the assessment of new evidence or data can be taken as changing an initial belief system to a new belief system. To study this process, it is useful to try to find a method for measuring beliefs. The standard approach, introduced by Ramsey and De Finetti, is to measure the degree of belief of a Mr A that an event E will occur by the rate at which Mr A will bet on E under specified circumstances. Mr A's betting quotients have to obey the probability axioms or his opponent (Ms B say) will be able to make a Dutch book against him (i.e. arrange to win whatever happens). This paper extended the Dutch book argument from individuals to groups. Suppose Ms B is now betting against a group of n individuals. It was show that she can make a Dutch book against the group as a whole, unless they agree on a common betting quotient. Such common betting quotients are taken to measure the *consensus* or *intersubjective probabilities* of a social group. They can be generated in groups which have a common interest, and within which there is *flow of information*.

Argumentation, Nonmonotonic Reasoning and n-Person Games

Phan Minh Dung

The purpose of the paper is to study the fundamental mechanism humans use in argumentation, and to explore ways to implement this mechanism on computers.

We do so by first developing a theory for argumentation whose central notion is the acceptability of arguments. Then we argue for the correctness or appropriateness of our theory with two strong arguments. The first one shows that most of the major applications to nonmonotonic reasoning in AI and logic programming are specific forms of our theory of argumentation. The second argument demonstrates how our theory provides solutions to many human's social and economic problems. This argument is based on a result showing that our theory captures naturally the solutions of the theory of n-person games and of the well-known stable marriage problem.

To Have One's Cake and Eat it.

How To Make Sequential Choice When One's Preferences Violate Expected Utility Axioms

Wlodek Rabinowicz

If an agent's preferences are not representable by an expected utility function – if they, for example, are cyclical, or violate the Independence Axiom – the agent may appear to be prone to *dynamic inconsistency*: in some decision problems he may be expected to embark upon action plans which he is not going to follow through. Dynamic inconsistency is disadvantageous for the agent. Thus, we seem to have a good pragmatic argument against a preference structure that gives rise to such disadvantageous behaviour.

We shall see that this pragmatic argument is not especially convincing. An agent with a "troublesome" preference structure may still be "dynamically rational" – still avoid dynamic inconsistency – either by foresight (*sophisticated choice*) or by a subsequent adjustment of one's preferences to the chosen plan of action (*resolute choice*). It has been claimed by McClennen and Machina, among others, that these two approaches to dynamic rationality – sophisticated choice and resolute choice – essentially compete with each other.

I am going to argue that the two approaches, if properly understood, may well be reconciled. Wise choice reconciles foresight with a possible

preference adjustment by rejecting two assumptions that create the conflict: Separability of Preferences in the case of sophisticated choice and Reduction to Normal Form in the case of resolute choice.

Sequents for Dependence Logics

Luis Fariñas del Cerro

Avoiding the paradoxes of material implication has been an aim whose pursuit has led to significant progress in the domain of formal reasoning. The standard methodology for addressing this problem is to reduce the multiplicity of manipulations of material implication by restricting its connections with the other connectives (for example with negation by eliminating contraposition). The objective is to obtain a logic whose theorems correspond to natural argumentation. Our hypothesis is that argumentations are syntactical variations of a given discourse in order to adapt it to the locutor. In other words to argue does not mean to introduce new elements of the discourse but only means to display its structure.

Some time ago R. L. Epstein introduced a family of logics called dependence logics in which an implication must contain only arguments referring to the same topic. In other terms the subject matter of atomic elements of premiss and conclusion are the same. One of these implications corresponds to the analytic implication introduced by W. T. Parry in which the constitutive content of the premiss contains that of the conclusion (see also K. Fine). A similar calculus has been introduced by D. Vanderveken based in an implication that allows to formalize speech acts. In the context of deductive data bases S. Cazalens, R. Demolombe and A. Jones introduce a modal implication which expresses the dependency between topics, and which is very useful to represent the notion of cooperation between the data base and the user. E. Orlowska and P. Weingartner define relevant logics based in the same principle.

In the talk we present sequent systems for several dependence logics, and we prove formal relations between classical logic and dependence logics.

Reasoning with Images and Diagrams:

On the combination of propositional and pictorial representations in reasoning processes

Christopher Habel

Investigations on reasoning, memory and language processing give theoretical and empirical evidence for the use of "spatial representations" in reasoning processes.

In the first part I argue - with Gedanken-experiments and results from experimental psychology - for a multi-coding approach, in which propositional (sentence-like) and pictorial (image-like) representations are combined via components of a hybrid architecture. Furthermore, the fundamental concepts of "analog representation" and "intrinsic properties of representations" (in the tradition of Shepard and Palmer) are discussed to characterize the basic notion of "image-like representation".

In the second part reasoning processes on images (and diagrams) are investigated with respect to their "validity": Analog to inferential processes on propositional representations there exist manipulation and inspection processes on pictorial representations. Whether spatial reasoning is valid, depends on the commitment to interpretational constraints. These constraints correspond to formal theories in the sense of propositional approaches.

These ideas are exemplified by two case studies on geometrical reasoning and topological entities natural language processing.

Dialog Partner Modelling and Argumentation

Anthony Jameson

The other talks at the Workshop discuss a great variety of issues concerning reasoning and argumentation from philosophical, logical, psychological, and computational points of view. This talk illustrates how many of these issues can be analyzed within the framework of a natural language dialog system that focuses on pragmatic phenomena. First, an overview is given of the system PRACMA, which currently simulates the seller in a noncooperative sales dialog. Then two components currently being integrated are discussed in more detail:

1. A component for dialog partner modeling forms impressions of the knowledgeability and interests of the dialog partner, using techniques inspired by

both psychological test theory and empirical research on how humans make similar judgments.

2. A component for the pragmatically based selection of utterances determines what the seller should say about the object under consideration by anticipating the impact that possible utterances would have on the buyer's evaluation of the object—and the extent to which they are consistent with the image of herself that the seller is trying to project. Finally, some issues are discussed that arise when these two components are incorporated within a single system, e.g., typical conflicts between the dialog goals of updating the dialog partner model vs. making use of the information it contains. The two components discussed are demonstrated interactively after the talk.

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