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Abstract. A drawback of existing epistemic logics is their inability to deal with entrenchment of beliefs. All beliefs have equal status; none can be held more firmly than others. We present a bimodal logic that generalizes Levesque's reconstruction of autoepistemic logic. In our system standard epistemic concepts can be represented, including the notion of only knowing, but elements of a belief set may be more or less entrenched. This has important implications for the distinction between epistemic defaults and subjunctive (and normative) defaults, both of which are representable in our system.

Abstract. We investigate the complexity of autoepistemic reasoning with parsimonious and moderately grounded expansions. A stable expansion of an autoepistemic set of premises is parsimonious if its objective (i.e. nonmodal) part does not contain the objective part of any other stable expansion. We prove that deciding whether a formula φ belongs to at least one parsimonious stable expansion of a finite base set A is complete for Σ_3^P, while deciding containment in *all* parsimonious stable expansions is complete for Σ_3^P. Similar results are derived for autoepistemic reasoning with moderately grounded expansions. In particular, we show that deciding whether a formula φ belongs to some moderately grounded expansion of a. finite base set A is Σ_3^P-complete, and that deciding whether φ belongs to all moderately grounded expansions is Σ_3^P-complete. These results suggest that reasoning with parsimonious stable expansions and moderately, grounded expansions is strictly harder than reasoning in Moore's standard version of autoepistemic logic. We also address the complexity of reasoning if the set A is in a normalized form, and derive completeness results for this case.

Abstract. Suppose there are several experts, with some dominating others (expert A dominates expert B if B says something is true whenever A says it is). Suppose, further, that each of the experts has his or her own view of what is possible - in other words each of the experts has their own Kripke model in mind (subject, of course, to the dominance relation that may hold between experts). How will they assign truth values to sentences in a common, modal language, and on what sentences will they agree? This problem can be reformulated as one about many-valued Kripke models, allowing many-valued accessibility relations. This is a natural generalization of conventional Kripke models that has only recently been looked at. The equivalence between the many-valued version and the multiple expert one will be formally established. Finally we will axiomatize many-valued modal logics, and sketch a proof of completeness.

ON PERFECT INTROSPECTION WITH QUANTIFYING-IN

Gerhard Lakemeyer *75-98*

Abstract. Agents with perfect introspection may have incomplete beliefs about the world, but they possess complete knowledge about their own beliefs. This fact suggests that the beliefs of introspective agents should be completely determined by their objective beliefs, that is, those beliefs that are only about the domain in question and not about other beliefs. Introspection and logical reasoning alone should suffice to re-construct all other beliefs from the objective ones. While this property has been shown to hold for propositional belief logics, there have so far only been negative results in the case of first-order belief logics with quantifying-in.

In this paper we present a logic of belief with quantifying-in, where the beliefs of a perfectly introspective agent are indeed uniquely determined by the objective beliefs. The result is obtained by weakening the notion of belief of an existing logic that does not have this property.

MORE ON MODAL ASPECTS OF DEFAULT LOGIC

V. Wiktor Marek and Mirosław Truszczyński *99-116*

Abstract. Investigations of default logic have been so far mostly concerned with the notion of an extension of a default' theory. It turns out, however, that default logic is much richer. Namely, there are other natural classes of objects that might be associated with default reasoning. We study two such classes of objects with emphasis on their relations with modal nonmonotonic formalisms.

First, we introduce the concept of a weak extension and Study its properties. It has long been suspected that there are close connections between default and autoepistemic logics. The notion of weak extension allows us to precisely describe the relationship between these two formalisms. In particular, we show that default logic with weak extensions is essentially equivalent to autoepistemic logic, that is, nonmonotonic logic **KD45**.

In the paper we also study the notion of a set of formulas closed under a default theory. These objects are shown to correspond to stable theories and to modal logic **S5**. In particular, we show that skeptical reasoning with sets closed under default theories is closely related With provability in **S5**.

As an application of our results we determine the complexity of reasoning with weak extensions and sets closed under default theories.

ON THE DECIDABILITY AND COMPLEXITY OF AUTOEPISTEMIC REASONING

Ilkka N.F. Niemelä *117-155*

Abstract. The decidability and computational complexity of autoepistemic reasoning is investigated in a general setting where the autoepistemic logic CL_{ae} built on top of a given classical logic CL is studied. Correct autoepistemic conclusions from a set of premises are defined in terms of expansions of the premises. Three classes of expansions are studied: Moore style stable expansions, enumeration based expansions, and L-hierarchic expansions. A simple finitary characterization for each type of expansions in CL_{ae} is developed. Using the characterizations conditions ensuring that a set of premises has at least one or exactly one stable expansion can be stated and an upper bound

for the number of stable expansions of a set of premises can be given. With the aid of the finitary characterizations results on decidability and complexity of autoepistemic reasoning are obtained. E.g., it is shown that autoepistemic reasoning based on each of the three types of expansions is decidable if the monotonic consequence relation given by the underlying classical logic is decidable. In the propositional case decision problems related to the three classes of expansions are shown to be complete problems with respect to the second level of the polynomial time hierarchy. This implies that propositional autoepistemic reasoning is strictly harder than classical propositional reasoning unless the polynomial time hierarchy collapses.

REFLEXIVE AUTOEPISTEMIC LOGIC

Grigori Schwarz *157-173*

Abstract. We propose a new variant of autoepistemic logic which, intuitively, corresponds to understanding a belief operator L as "is known", in contrast to the interpretation of L as "is believed" in Moore's autoepistemic logic. Formal properties of the new logic and relationship to Moore's logic are studied in detail.

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ALGEBRAIC CONSIDERATIONS OF AUTOEPISTEMIC LOGIC

Cecylia M. Rauszer *175-186*

Abstract. Stable autoepistemic sets are treated as S4 maximal theories. This approach allows to use the Lindenbaum algebra of modal logic as a tool in investigations of existence of a special kind of stable sets. Namely, for a given set A, the algebraic constructions of minimal stable sets based on A and moderately grounded expansions of A are shown.

QUALITY CRITERIA FOR PARTIAL ORDER SEMANTICS OF PLACE/TRANSITION-NETS WITH CAPACITIES

Robert Gold, Walter Vogler *187-209*

Abstract. This paper discusses a number of properties that a partial order semantics should have in order to support the modular construction of nets and to deal with finite capacities. Characterizations for these properties are shown, and a new semantics is introduced which seems to be the natural choice if a certain set of properties is required.

ON SOME EQUIVALENCE RELATIONS FOR PROBABILISTIC PROCESSES

Dung T. Huynh and Lu Tian *211-234*

Abstract. In this paper, we investigate several equivalence relations for probabilistic labeled transition systems: bisimulation equivalence, readiness equivalence, failure equivalence, trace equivalence, maximal trace equivalence and finite trace equivalence. We formally prove the inclusions (equalities) among these equivalences. We also show that readiness, failure, trace, maximum trace and finite trace equivalences for finite probabilistic labeled transition systems are decidable in polynomial time. This should be contrasted with the *PSPACE* completeness of the same equivalences for classical labeled transition systems. Moreover, we derive an efficient polynomial time algorithm for deciding bisimulation equivalence for finite probabilistic labeled transition systems. The special case of initiated probabilistic transition systems will be considered. We show that the isomorphism problem for finite initiated labeled probabilistic transition systems is $NC^{(1)}$ equivalent to graph isomorphism.

Keywords. Bisimulation equivalence, readiness equivalence, failure equivalence, trace equivalence, maximal trace equivalence, finite trace equivalence, probabilistic labeled transition system, initiated probabilistic labeled transition system, probabilistic relation, probabilistic automaton, complexity, reducibility.

APPROXIMATE LEARNING WITH MULTIPLE MACHINES

Mahendran Velauthapillai *235-251*

Abstract. In this paper we define two new inference classes *Team Density* and *Team Uniform Density*. The team density class turns out to be the "most powerful" of all the inference classes that have been defined and studied so far. We compare these classes to previously defined classes. We obtain necessary and sufficient conditions for one team density class to be a subset of another team density class. Similar results are obtained for team uniform density class. We also have compare team density and team uniform density classes and obtained necessary and sufficient conditions for one class to be a subset of another. Most importantly we show that team density, the "most powerfull" class, cannot cover the BC class. From this result we obtain several theorems as corollaries that have been proved in earlier papers.

λ-REPRESENTABILITY OF INTEGER, WORD AND TREE FUNCTIONS

Małgorzata Madry *253-270*

Abstract. Six λ-languages over function-types between algebras B, N and Υ are considered. Type $N = (0 \to 0) \to (0 \to 0)$ is called a non-negative integers type; $B = (0 \to 0) \to ((0 \to 0) \to (0 \to 0))$ is called a binary words type; $\Upsilon = (0 \to (0 \to 0)) \to (0 \to 0)$ is called a binary trees type. These associations come from the isomorphism between the types and corresponding algebraic structures. Closed terms whose types are the above mentioned function-types represent unary functions of appropriate types. The problem is: what class of functions is represented by the closed terms of the examined type. It is proved that for $B \to N, N \to B, \Upsilon \to N, \Upsilon \to B$ there exists a finite base of functions such that any λ-definable function is sonic combination of the base functions. The algorithm which, for every closed term, returns the function in the form of a combination of the base functions is given. For two other types, $B \to \Upsilon$ and $N \to \Upsilon$, a method of constructing λ-representable functions using primitive recursion is shown.

AN AUTOMATA-THEORETIC DECISION PROCEDURE FOR PROPOSITIONAL TEMPORAL LOGIC WITH SINCE AND UNTIL

Y.S. Ramakrishna, L.E. Moser, L.K. Dillon, P.M. Melliar-Smith, G. Kutty *271-282*

Abstract. We present an automata-theoretic decision procedure for Since/Until Temporal Logic (SUTL), a linear-time propositional temporal logic with strong non-strict since and until operators. The logic, which is intended for specifying and reasoning about computer systems, employs neither next nor previous operators. Such operators obstruct the use of hierarchical abstraction and refinement and make reasoning about concurrency difficult. A proof of the soundness and completeness of the decision procedure is given, and its complexity is analyzed.

CORRIGENDUM

Erkki Mäkinen *283*

On the Generative Capacity of Context-Free Matrix Grammars over One-Letter Alphabet, Fundamenta Informaticae **16**, 1 (1992), 93-97.
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Abstract. Starting from a general dynamic analysis of reasoning and programming, we develop two main dynamic perspectives upon logic programming. First, the standard fixed point semantics for Horn clause programs naturally supports imperative programming styles. Next, we provide axiomatizations for Prolog-type inference engines using calculi of sequents employing modified versions of standard structural rules such as monotonicity or permutation. Finally, we discuss the implications of all this for a broader enterprise of 'abstract proof theory'.

Abstract. Derivational complexity related to leftmost derivations of context-free grammars is studied by defining a new complexity measure based on characteristic samples of left Szilard languages.

Abstract. The noninterleaving equivalences that have been proposed in the literature may be roughly divided into three classes, depending on the kind of observational scenarios underlying them. Some of them distinguish parallelism from nondeterminism by admitting explicit observations of the causal structure of systems; some others are based on the observation of distribution and still others on the assumption that actions have duration.

In general,. these three observational scenarios give rise to equivalences of incomparable discriminating power. In this paper, we show that three representative equivalences of the aforementioned classes, namely *timed equivalence* [Hen88], *distributed bisimulation* [CH89] and *causal bisimulation* [DD88], coincide over a language for finite parallel processes without communication and restriction. The proof of this result is algebraic in style and relies on a theorem giving a finite, ω-complete axiomatization of causal bisimulation over the language under consideration. We also give a model for our language based upon causal trees and prove that it is fully abstract with respect to the largest congruence contained in strong bisimulation and presetved by a very simple form of action refinement [AH89].