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Forthcoming Papers

S. Kasif, S. Salzberg, D. Waltz, J. Rachlin and D.W. Aha, A probabilistic framework for memory-based reasoning

In this paper, we propose a probabilistic framework for memory-based reasoning (MBR). The framework allows us to clarify the technical merits and limitations of several recently published MBR methods and to design new variants. The proposed computational framework consists of three components: a specification language to define an adaptive notion of relevant context for a query; mechanisms for retrieving this context; and local learning procedures that are used to induce the desired action from this context. We primarily focus on actions in the form of a classification. Based on the framework we derive several analytical and empirical results that shed light on MBR algorithms. We introduce the notion of an MBR transform, and discuss its utility for learning algorithms. We also provide several perspectives on memory-based reasoning from a multi-disciplinary point of view.

A.Y. Levy, and M.-C. Rousset, Combining Horn rules and description logics in CARIN

We describe CARIN, a novel family of representation languages, that combine the expressive power of Horn rules and of description logics. We address the issue of providing sound and complete inference procedures for such languages. We identify *existential entailment* as a core problem in reasoning in CARIN, and describe an existential entailment algorithm for the $\mathcal{ALCNR}$ description logic. As a result, we obtain a sound and complete algorithm for reasoning in non-recursive CARIN-$\mathcal{ALCNR}$ knowledge bases, and an algorithm for rule subsumption over $\mathcal{ALCNR}$. We show that in general, the reasoning problem for recursive CARIN-$\mathcal{ALCNR}$ knowledge bases is undecidable, and identify the constructors of $\mathcal{ALCNR}$ causing the undecidability. We show two ways in which CARIN-$\mathcal{ALCNR}$ knowledge bases can be restricted while obtaining sound and complete reasoning.

T. Costello, The expressive power of circumscription (Research Note)

Circumscription is a form of non-monotonic reasoning, introduced by McCarthy (1997) as a way of characterizing defaults using second order logic. The consequences of circumscription are those formulas true in the minimal models under a pre-order on models. In the case of domain circumscription the pre-order was the sub-model relation. Formula circumscription (McCarthy, 1980, 1986) is characterized by minimizing a set of formulas—one model is preferred to another model when the extensions of the minimized formulas in the first are subsets of the extensions in the second.

We show that the propositional version of formula circumscription can capture all pre-orders on valuations of finite languages. We consider the question of infinite languages, and give the corresponding representation theorems. We further show that there are natural defaults (inertia in temporal projection), captured by inductive definitions, that cannot be captured by circumscription in the first order case.

Finally, contrary to previous claims, we show that propositional formula circumscription can capture all preferential consequence relations over finite propositional languages, as defined by Kraus et al. (1990). Thus, in the finite propositional case, there is no restriction on the kinds of preferential defaults that circumscription can describe.

G. LaForte, P.J. Hayes and K.M. Ford, Why Gödel's theorem cannot refute computationalism

Gödel's theorem is consistent with the computationalist hypothesis. Roger Penrose, however, claims to prove that Gödel's theorem implies that human thought cannot be mechanized. We review his arguments and show how they are flawed. Penrose's arguments depend crucially on ambiguities between precise and imprecise senses of key terms. We show that these ambiguities cause the Gödel/Turing diagonalization argument to lead from apparently intuitive claims about human abilities to paradoxical or highly idiosyncratic conclusions, and conclude that any similar argument will also fail in the same ways.

T.F. Stahovich, R. Davis and H. Shrobe, Generating multiple new designs from a sketch

We describe a program called SKETCHIT that transforms a single sketch of a mechanical device into multiple families of new designs. It represents each of these families with a "BEP-Model", a parametric model augmented with constraints that ensure the device produces the desired behavior. The program is based on qualitative configuration space (qc-space), a novel representation that captures mechanical behavior while abstracting away its implementation. The program employs a paradigm of abstraction and resynthesis: it abstracts the initial sketch into qc-space, then uses a library of primitive mechanical interactions to map from qc-space to new implementations.

J. Kohlas, B. Anrig, R. Haenni and P.A. Monney, Model-based diagnostics and probabilistic assumption-based reasoning

The mathematical foundations of model-based diagnostics or diagnosis from first principles have been laid by Reiter [31]. In this paper we extend Reiter's ideas of model-based diagnostics by introducing probabilities into Reiter's framework. This is done in a mathematically sound and precise way which allows one to compute the posterior probability that a certain component is not working correctly given some observations of the system. A straightforward computation of these probabilities is not efficient and in this paper we propose a new method to solve this problem. Our method is logic-based and borrows ideas from assumption-based reasoning and ATMS. We show how it is possible to determine arguments in favor of the hypothesis that a certain group of components is not working correctly. These arguments represent the symbolic or qualitative aspect of the diagnosis process. Then they are used to derive a quantitative or numerical aspect represented by the posterior probabilities. Using two new theorems about the relation between Reiter's notion of conflict and

our notion of argument, we prove that our so-called degree of support is nothing but the posterior probability that we are looking for. Furthermore, a model where each component may have more than two different operating modes is discussed and a new algorithm to compute posterior probabilities in this case is presented.

C. Baral, A. Gabaldon and A. Provetti, Formalizing narratives using nested circumscription

Representing and reasoning about narratives together with the ability to do hypothetical reasoning is important for agents in a dynamic world. These agents need to record their observations and action executions as a narrative and at the same time, to achieve their goals against a changing environment, they need to make plans (or re-plan) from the *current* situation. The early action formalisms did one or the other. For example, while the original situation calculus was meant for hypothetical reasoning and planning, the event calculus was more appropriate for narratives. Recently, there have been some attempts at developing formalisms that do both. Independently, there has also been a lot of recent research in reasoning about actions using circumscription. Of particular interest to us is the research on using high-level languages and their logical representation using nested abnormality theories (NATs)—a form of circumscription with blocks that make knowledge representation modular. Starting from theories in the high-level language $\mathcal{L}$, which is extended to allow concurrent actions, we define a translation to NATs that preserves both narrative and hypothetical reasoning. We initially use the high level language $\mathcal{L}$, and then extend it to allow concurrent actions. In the process, we study several knowledge representation issues such as filtering, and restricted monotonicity with respect to NATs. Finally, we compare our formalization with other approaches, and discuss how our use of NATs makes it easier to incorporate other features of action theories, such as constraints, to our formalization.

A.M. Abdelbar, An algorithm for finding MAPs for belief networks through cost-based abduction (Research Note)

In cost-based abduction, the objective is to find the least-cost set of hypotheses that are sufficient to explain the observed evidence. In the *maximum a-posteriori* (MAP) assignment problem on Bayesian belief networks, the objective is to find the network assignment $\mathcal{A}$ with highest conditional probability $P(\mathcal{A}|\mathcal{E})$, where $\mathcal{E}$ represents the observed evidence. In this paper, we present a provably-correct linear-time transformation that allows algorithms and heuristic methods for cost-based abduction, such as Charniak and Shimony's best-first search method or Santos' integer linear programming approach, to be used for the MAP problem.

S. Kraus, K. Sycara and A. Evenchik, Reaching agreements through argumentation: a logical model and implementation

In a multi-agent environment, where self-motivated agents try to pursue their own goals, cooperation cannot be taken for granted. Cooperation must be planned for and achieved through communication and *negotiation*. We present a logical model of the mental states of the agents based on a representation of their beliefs, desires, intentions, and goals. We present *argumentation* as an iterative process emerging from exchanges among agents to persuade each other and bring about a change in intentions. We look at argumentation as a mechanism for achieving cooperation and agreements.

Using categories identified from human multi-agent negotiation, we demonstrate how the logic can be used to specify argument formulation and evaluation. We also illustrate how the developed logic can be used to describe different types of agents.

Furthermore, we present a general Automated Negotiation Agent which we implemented, based on the logical model. Using this system, a user can analyze and explore different methods to negotiate and argue in a noncooperative environment where no centralized mechanism for coordination exists. The development of negotiating agents in the framework of the Automated Negotiation Agent is illustrated with an example where the agents plan, act, and resolve conflicts via negotiation in a Blocks World environment.

M. Thielscher, Reasoning about actions: steady versus stabilizing state constraints

In formal approaches to commonsense reasoning about actions, the Ramification Problem denotes the problem of handling indirect effects which implicitly derive from so-called state constraints. We pursue a new distinction between two kinds of state constraints which will be proved crucially important for solving the general Ramification Problem. *Steady* constraints never, not even for an instant, cease being in force. As such they give rise to truly instantaneous indirect effects of actions. *Stabilizing* state constraints, on the other hand, may be suspended for a short period of time after an action has occurred. Indirect effects deriving from these constraints materialize with a short lag. This hitherto neglected distinction is shown to have essential impact on the Ramification Problem: if stabilizing state constraints interact, then approaches not based on so-called causal propagation prove defective. But causal propagation, too, is shown to risk producing anomalous models, in case steady and stabilizing indirect effects are propagated indiscriminately. Motivated by these two observations, we improve the theory of causal relationships and its Fluent Calculus axiomatization, which both are methods of causal propagation, so as to properly handle the distinction between steady and stabilizing constraints.

M. Gaspari, Concurrency and knowledge-level communication in agent languages

P. Lucas, Analysis of notions of diagnosis

T.-Y. Leong, Multiple perspective dynamic decision making

B. Webber, S. Carberry, J.R. Clarke, A. Gertner, T. Harvey, R. Rymon, and R. Washington, Exploiting multiple goals and intentions in decision support for the management of multiple trauma: a review of the TraumAID project

M. Morreau and S. Kraus, Syntactical treatments of propositional attitudes (Research Note)

R.E. Korf, A complete anytime algorithm for number partitioning

S. Kambhampati, On the relations between intelligent backtracking and failure-driven explanation based learning in constraint satisfaction and planning

J.P. Delgrande, On first-order conditional logics