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Forthcoming Papers

K. Kaneiwa, Order-sorted logic programming with predicate hierarchy

Order-sorted logic has been formalized as first-order logic with sorted terms where sorts are ordered to build a hierarchy (called a sort-hierarchy). These sorted logics lead to useful expressions and inference methods for structural knowledge that ordinary first-order logic lacks. Nitta et al. pointed out that for legal reasoning a sort-hierarchy (or a sorted term) is not sufficient to describe structural knowledge for event assertions, which express facts caused at some particular time and place. The event assertions are represented by predicates with n arguments (i.e., n-ary predicates), and then a particular kind of hierarchy (called a predicate hierarchy) is built by a relationship among the predicates. To deal with such a predicate hierarchy, which is more intricate than a sort-hierarchy, Nitta et al. implemented a typed (sorted) logic programming language extended to include a hierarchy of verbal concepts (corresponding to predicates). However, the inference system lacks a theoretical foundation because its hierarchical expressions exceed the formalization of order-sorted logic. In this paper, we formalize a logic programming language with not only a sort-hierarchy but also a predicate hierarchy. This language can derive general and concrete expressions in the two kinds of hierarchies. For the hierarchical reasoning of predicates, we propose a manipulation of arguments in which surplus and missing arguments in derived predicates are eliminated and supplemented. As discussed by Allen, McDermott and Shoham in research on temporal logic and as applied by Nitta et al. to legal reasoning, if each predicate is interpreted as an event or action (not as a static property), then missing arguments should be supplemented by existential terms in the argument manipulation. Based on this, we develop a Horn clause resolution system extended to add inference rules of predicate hierarchies. With a semantic model restricted by interpreting a predicate hierarchy, the soundness and completeness of the Horn-clause resolution is proven. © 2004 Published by Elsevier B.V.

D. Šuc, D. Vladušič and I. Bratko, Qualitatively faithful quantitative prediction

We describe an approach to machine learning from numerical data that combines both qualitative and numerical learning. This approach is carried out in two stages: (1) induction of a qualitative model from numerical examples of the behaviour of a physical system, and (2) induction of a numerical regression function that both respects the qualitative constraints and fits the training data numerically. We call this approach Q^2 learning, which stands for Qualitatively faithful Quantitative learning. Induced numerical models are "qualitatively faithful" in the sense that they respect qualitative trends in the learning data. Advantages of Q^2 learning are that the induced qualitative

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model enables a (possibly causal) explanation of relations among the variables in the modelled system, and that numerical predictions are guaranteed to be qualitatively consistent with the qualitative model which alleviates the interpretation of the predictions. Moreover, as we show experimentally the qualitative model's guidance of the *quantitative* modelling process leads to predictions that may be considerably more accurate than those obtained by state-of-the-art numerical learning methods. The experiments include an application of Q^2 learning to the identification of a car wheel suspension system—a complex, industrially relevant mechanical system. © 2004 Published by Elsevier B.V.

L. Portinale, D. Magro and P. Torasso, Multi-modal diagnosis combining case-based and model-based reasoning: a formal and experimental analysis

Integrating different reasoning modes in the construction of an intelligent system is one of the most interesting and challenging aspects of modern AI. Exploiting the complementarity and the synergy of different approaches is one of the main motivations that led several researchers to investigate the possibilities of building *multi-modal reasoning systems*, where different reasoning modalities and different knowledge representation formalisms are integrated and combined. Case-Based Reasoning (CBR) is often considered a fundamental modality in several multi-modal reasoning systems; CBR integration has been shown very useful and practical in several domains and tasks. The right way of devising a CBR integration is however very complex and a principled way of combining different modalities is needed to gain the maximum effectiveness and efficiency for a particular task. In this paper we present results (both theoretical and experimental) concerning architectures integrating CBR and Model-Based Reasoning (MBR) in the context of diagnostic problem solving. We first show that both the MBR and CBR approaches to diagnosis may suffer from computational intractability, and therefore a careful combination of the two approaches may be useful to reduce the computational cost in the average case. The most important contribution of the paper is the analysis of the different facets that may influence the entire performance of a multi-modal reasoning system, namely computational complexity, system competence in problem solving and the quality of the sets of produced solutions. We show that an opportunistic and flexible architecture able to estimate the right cooperation among modalities can exhibit a satisfactory behavior with respect to every performance aspect. An analysis of different ways of integrating CBR is performed both at the experimental and at the analytical level. On the analytical side, a cost model and a competence model able to analyze a multi-modal architecture through the analysis of its individual components are introduced and discussed. On the experimental side, a very detailed set of experiments has been carried out, showing that a flexible and opportunistic integration can provide significant advantages in the use of a multi-modal architecture. © 2004 Published by Elsevier B.V.

A. Cimatti, M. Roveri and P. Bertoli, Conformant planning via symbolic model checking and heuristic search

J. Larrosa and T. Schiex, Solving weighted CSP by maintaining arc consistency

G. de Cooman and M. Zaffalon, Updating beliefs with incomplete observations

R.I. Brafman and M. Tennenholtz, Efficient learning equilibrium

J.d.R. Millán, F. Renkens, J. Mouriño and W. Gerstner, Brain-actuated interaction

F.C. Chu and J.Y. Halpern, Great expectations. Part II: generalized expected utility as a universal decision rule

H. Liu, H. Motoda and L. Yu, A selective sampling approach to active feature selection