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SCIENCE DIRECT

Artificial Intelligence 166 (2005) 254–255

Artificial Intelligence

www.elsevier.com/locate/artint

Forthcoming Papers

Available online 22 June 2005

D. Berardi, D. Calvanese, G. De Giacomo, Reasoning on UML class diagrams

UML is the de-facto standard formalism for software design and analysis. To support the design of large-scale industrial applications, sophisticated CASE tools are available on the market, that provide a user-friendly environment for editing, storing, and accessing multiple UML diagrams. It would be highly desirable to equip such CASE tools with automated reasoning capabilities, such as those studied in Artificial Intelligence and, in particular, in Knowledge Representation and Reasoning. Such capabilities would allow to automatically detect relevant formal properties of UML diagrams, such as inconsistencies or redundancies. With regard to this issue, we consider UML *class diagrams*, which are one of the most important components of UML, and we address the problem of reasoning on such diagrams. We resort to several results developed in the field of Knowledge Representation and Reasoning, regarding Description Logics (DLs), a family of logics that admit decidable reasoning procedures. Our first contribution is to show that reasoning on UML class diagrams is EXPTIME-hard, even under restrictive assumptions; we prove this result by showing a polynomial reduction from reasoning in DLs. The second contribution consists in establishing EXPTIME-membership of reasoning on UML class diagrams, provided that the use of arbitrary OCL (first-order) constraints is disallowed. We get this result by using $\mathcal{DLR}_{ifd}$, a very expressive EXPTIME-decidable DL that has been developed to capture typical features of conceptual and object-oriented data models. The last contribution has a more practical flavor, and consists in a polynomial encoding of UML class diagrams in the DL $\mathcal{ALCQI}$, which essentially is the most expressive DL supported by current state-of-the-art DL-based reasoning systems. Though less expressive than $\mathcal{DLR}_{ifd}$, the DL $\mathcal{ALCQI}$ preserves enough semantics to keep reasoning about UML class diagrams sound and complete. Exploiting such an encoding, one can use current DL-based reasoning systems as core reasoning engines for a next generation of CASE tools, that are equipped with reasoning capabilities on UML class diagrams.

T. Lukasiewicz, Weak nonmonotonic probabilistic logics

We present an approach where probabilistic logic is combined with default reasoning from conditional knowledge bases in Kraus et al.'s System P, Pearl's System Z, and Lehmann's lexicographic entailment. The resulting probabilistic generalizations of default reasoning from conditional knowledge bases allow for handling in a uniform framework strict logical knowledge, default logical

0004-3702/2005 Published by Elsevier B.V.
doi:10.1016/j.artint.2005.06.001

knowledge, as well as purely probabilistic knowledge. Interestingly, probabilistic entailment in System P coincides with probabilistic entailment under g-coherence from imprecise probability assessments. We then analyze the semantic and nonmonotonic properties of the new formalisms. It turns out that they all are proper generalizations of their classical counterparts and have similar properties as them. In particular, they all satisfy the rationality postulates of System P and some Conditioning property. Moreover, probabilistic entailment in System Z and probabilistic lexicographic entailment both satisfy the property of Rational Monotonicity and some Irrelevance property, while probabilistic entailment in System P does not. We also analyze the relationships between the new formalisms. Here, probabilistic entailment in System P is weaker than probabilistic entailment in System Z, which in turn is weaker than probabilistic lexicographic entailment. Moreover, they all are weaker than entailment in probabilistic logic where default sentences are interpreted as strict sentences. Under natural conditions, probabilistic entailment in System Z and lexicographic entailment even coincide with such entailment in probabilistic logic, while probabilistic entailment in System P does not. Finally, we also present algorithms for reasoning under probabilistic entailment in System Z and probabilistic lexicographic entailment, and we give a precise picture of its complexity.

S. Thiebaux, J. Hoffmann, B. Nebel, In defense of PDDL axioms

There is controversy as to whether explicit support for PDDL-like axioms and derived predicates is needed for planners to handle real-world domains effectively. Many researchers have deplored the lack of precise semantics for such axioms, while others have argued that it might be best to compile them away. We propose an adequate semantics for PDDL axioms and show that they are an essential feature by proving that it is impossible to compile them away if we restrict the growth of plans and domain descriptions to be polynomial. These results suggest that adding a reasonable implementation to handle axioms inside the planner is beneficial for the performance. Our experiments confirm this suggestion.