Updating action domain descriptions*

Thomas Eiter\textsuperscript{a}, Esra Erdem\textsuperscript{b}, Michael Fink\textsuperscript{a,\Ast}, and Ján Senko\textsuperscript{a}

\textsuperscript{a}Institute of Information Systems, Vienna University of Technology, Vienna, Austria
\textsuperscript{b}Faculty of Engineering and Natural Sciences, Sabancı University, Istanbul, Turkey

Abstract

Incorporating new information into a knowledge base is an important problem which has been widely investigated. In this paper, we study this problem in a formal framework for reasoning about actions and change. In this framework, action domains are described in an action language whose semantics is based on the notion of causality. Unlike the formalisms considered in the related work, this language allows straightforward representation of non-deterministic effects and indirect effects of (possibly concurrent) actions, as well as state constraints; therefore, the updates can be more general than elementary statements. The expressivity of this formalism allows us to study the update of an action domain description with a more general approach compared to related work. First of all, we consider the update of an action description with respect to further criteria, for instance, by ensuring that the updated description entails some observations, assertions, or general domain properties that constitute further constraints that are not expressible in an action description in general. Moreover, our framework allows us to discriminate amongst alternative updates of action domain descriptions and to single out a most preferable one, based on a given preference relation possibly dependent on the specified criteria. We study semantic and computational aspects of the update problem, and establish basic properties of updates as well as a decomposition theorem that gives rise to a divide and conquer approach to updating action descriptions under certain conditions. Furthermore, we study the computational complexity of decision problems around computing solutions, both for the generic setting and for two particular preference relations, viz. set-inclusion and weight-based preference. While deciding the existence of solutions and recognizing solutions are PSPACE-complete problems in general, the problems fall back into the polynomial hierarchy under restrictions on the additional constraints. We finally discuss methods to compute solutions and approximate solutions (which disregard preference). Our results provide a semantic and computational basis for developing systems that incorporate new information into action domain descriptions in an action language, in the presence of additional constraints.

Keywords

Knowledge representation; Reasoning about actions and change; Theory change; Action languages; Preference-based semantics

---

\*This paper is a revised and significantly extended version of a preliminary paper that appeared in: Proc. 19th International Joint Conference on Artificial Intelligence (IJCAI 2005), pp. 418–423.

\*Corresponding author. michael@kr.tuwien.ac.at.

This document was posted here by permission of the publisher. At the time of deposit, it included all changes made during peer review, copyediting, and publishing. The U.S. National Library of Medicine is responsible for all links within the document and for incorporating any publisher-supplied amendments or retractions issued subsequently. The published journal article, guaranteed to be such by Elsevier, is available for free, on ScienceDirect.
References

3. Alferes J, Banti F, Brogi A. From logic programs updates to action description updates. Proc. CLIMA V (revised selected and invited papers). Lecture Notes in Computer Science 34872004 Springer 5277
21. Eiter T, Fink M, Senko J. A tool for answering queries on action descriptions. JELIA-06 Lecture Notes in Computer Science 41602006 Springer 473476
24. Eiter T, Lukasiewicz T. Default reasoning from conditional knowledge bases: Complexity and tractable cases. Artificial Intelligence 12422000169241

Published as: Artif Intell. 2010 October ; 174(15): 1172–1221.


45. Liberatore P. The complexity of the language A. Electronic Transactions on Artificial Intelligence, 119971338


