Actions, Processes, and Ontologies

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Abstract

We overview reasoning about actions and processes over ontologies (or knowledge bases) expressed in Description Logics (DLs). This is a critical research challenge that has resisted good, robust solutions for a long time. In particular, while well-developed theories of actions and processes exist in AI, e.g., the ones based on the Situation Calculus, these theories are not well-behaved when applied to DL ontologies, since the latter impose very difficult state constraints. Here we restate this difficulty, by showing that combining even the simplest DLs and the simplest theory of actions in Situation Calculus leads to undecidability of the simplest reasoning task: satisfiability. We then look into a radically different approach, based on so-called Levesques functional view of knowledge bases, that has been proved quite fruitful lately. This approach sees the knowledge base (or ontology) as a system that allows for two kinds of operations: ASK, which returns the (certain) answer to queries, and TELL, which produces a new knowledge base as the result of the application of an atomic action (also related to update). In particular we show that under this view even verification of sophisticated dynamic properties (e.g., formulated in first-order variants of mu-calculus) over ontologies expressed in DLs, ranging from light-weight to very expressive ones, becomes decidable under interesting general conditions.

Short CV. Giuseppe De Giacomo is a professor at Sapienza Università di Roma. He has contributed to diverse areas of AI and CS. In the mid 90's, he explored the correspondence between Description Logics and Logics of Programs, and devised results and reasoning techniques for expressive Description Logics, which contributed to the birth of OWL and OWL2. At the end of the 90', together with his group in Rome, he started the research on conjunctive query answering in Description Logics. He is one of the developers of the DL-Lite family of Description Logics, which have been recently shaping the area of Ontology-Based Data Access. In Databases, he did foundational work on data modeling, data integration, and view based query processing with regular path queries, for both semi-structured and graph data. He has always had a deep interest for Reasoning about Actions and Processes. He profoundly influenced the definition of ConGolog and its successor IndiGolog, which are among the best known formalism for expressing high-level robot programs. He devised one of the best known formal approaches for service composition, the so-called "Roman Model", which has been further developed in AI for behavior compositions synthesis of devices and agents. Recently, he provided foundational results on artifact-based business processes, showing the decidability of verification and synthesis in infinite state data-aware systems.