Reasoning About the Evolution of Graph Structured Data
Using Description Logics

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In this talk, we discuss our work in [Ahmetaj et al., 2017; Ahmetaj et al., 2014; Calvanese et al., 2016], where we advocate using description logics (DLs) to reason about the evolution of graph-structured data (GSD). DLs are, in general, decidable fragments of classical first-order logic (FOL), specially tailored for describing structured knowledge and reasoning with it. Most DLs use only unary and binary predicates, and are closely related to the two-variable fragment of FOL. Some DLs have expressive features beyond FOL, most notably transitive closure to enable graph navigation. In GSD, information is stored as node- and edge-labeled graphs, where labels carry semantic information; such graphs are no different from the relational structures over which DLs are interpreted. This makes DLs obvious candidates for describing properties of GSD. As our work shows, we can leverage DLs to obtain algorithms for challenging data management problems, such as testing whether the satisfaction of integrity constraints is preserved after a sequence of updates.

Plan verification Does a given sequence of actions necessarily/possibly lead to a state where some property (either desired or undesired) holds? We study these problem for a given initial dataset, and also for the case in only a partial description of the initial state is available.

Plan synthesis Is there a sequence of actions chosen from a given set (i.e., a plan), that leads the data to a into a state where some property (either desired or undesired) holds? Again, we study some variations: for a given initial dataset, or for a partial description of it, as well as for plans of bounded length.

We have studied these problems for different DLs, including both lightweight variants based on the well-known DL-Lite family, and very expressive but highly intractable DLs. We will summarize our results, emphasizing the expressive features necessary for the approach, and those that are technically dispensable but desirable for reasoning about GSD. To conclude the talk, we will mention some open challenges that we intend to tackle in our future research.

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References
