Abstracting Temporal ABoxes in TDL-Lite

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The Problem of Reasoning over TDL-Lite KBs

The key idea is to map a TDL-Lite KB into an equisatisable LTL formula by applying the translation described in [5], and then abstracting large temporal ABoxes by adapting the technique presented in [8].

Syntax

We consider here the logic TDL-Lite(N) combining DL-Lite with LTL, but with just future temporal operators and thus interpreted over the natural numbers. TDL-Lite(N) roles R which are either local L or global G, basic concepts B, and (temporal) concepts C are given by the following grammar:

\[ R ::= L \mid L \mid G \mid G, \quad B ::= \bot \mid A \mid qR, \quad C ::= B \mid \neg C \mid C \sqcap C \mid \diamond R C \mid \square R C \]

A TBox T is a set of GCI of the form \[ C_1 \subseteq C_2 \] and an ABox A is a set of concept assertions of the form \[ \ominus^n A(a) \] or \[ \ominus^n \neg A(a) \] or role assertions of the form \[ \ominus^n R(a, b) \] or \[ \ominus^n \neg R(a, b) \]

Reasoner Architecture

ABox Abstraction Approach

1. Shifting all role assertions associated to global roles to time point 0.
2. Mapping the shifted ABox into a first-order temporal formula with unary predicates \[ QTL_1(N) \].
3. Computing the type of each individual.
4. Abstracting individuals according to their types by merging individuals with the same type into a single representative individual \[ v_\tau \].
5. Abstracting the ABox.

Experimental Evaluation

<table>
<thead>
<tr>
<th>TDL-Lite (N) ABox</th>
<th>QTL_1(N)</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Con Assert.</td>
<td>#Role Assert.</td>
<td>Global Roles Gain</td>
</tr>
<tr>
<td>3 675 455 (7 027 000)</td>
<td>23 481</td>
<td>1 346 369</td>
</tr>
<tr>
<td>4 241 783 (10 500 000)</td>
<td>23 617</td>
<td>1 621 779</td>
</tr>
<tr>
<td>4 588 504 (15 500 000)</td>
<td>24 955</td>
<td>1 790 413</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstraction Evaluation</th>
<th>Reasoning over Abstracted ABoxes Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDL-Lite (N) ABox</td>
<td>LTL</td>
</tr>
<tr>
<td>#Abs. Prop.</td>
<td>#Abs. Ind.</td>
</tr>
<tr>
<td>ABox Space</td>
<td>5 025 000</td>
</tr>
<tr>
<td>3 675 455 (7 027 000)</td>
<td>23 481</td>
</tr>
<tr>
<td>4 241 783 (10 500 000)</td>
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</tbody>
</table>

Abstraction results for randomly generated ABoxes with number of individuals, I =100, time span, T = 5 and N = 50.

Each row represents ABox sizes ranging from 70% up to 90% of the whole ABox space (i.e., 5 025 000 distinct possible assertions).

Bibliography

[6] A. Fokoue et al., The summary ABox: Cutting ontologies down to size, ISWC, 2006

Graphical representation of ABox abstraction process.