Exchanging Description Logic Knowledge Bases

Our Framework: Knowledge Base Exchange

given a mapping \( M \) and a source knowledge base (KB) \( K_1 \), compute a target KB \( K_2 \) that is a solution for \( K_1 \) under \( M \).

We consider exchange of Description Logic (DL) KBs: each KB is constituted by a TBox and an ABox, and mapping is a set of DL inclusions.

<table>
<thead>
<tr>
<th>Source KB ( K_1 )</th>
<th>Target KB ( K_2 )</th>
<th>Mapping ( M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Clothing</td>
<td>FootWear</td>
</tr>
<tr>
<td>Drinking</td>
<td>OpenShoes</td>
<td>Strappy</td>
</tr>
<tr>
<td>Shoes</td>
<td>Platform</td>
<td>HighHeel</td>
</tr>
<tr>
<td>Sandals</td>
<td>Summer</td>
<td>Evening</td>
</tr>
<tr>
<td>Classical</td>
<td>Sandals</td>
<td>Plateau</td>
</tr>
<tr>
<td>Heeled</td>
<td>Sandals</td>
<td>HighHeel</td>
</tr>
<tr>
<td>Price</td>
<td>Price</td>
<td>Price</td>
</tr>
<tr>
<td>Size</td>
<td>Size</td>
<td>Size</td>
</tr>
<tr>
<td>Color</td>
<td>Color</td>
<td>Color</td>
</tr>
</tbody>
</table>

Universal and UCQ-Solutions

There are two types of possible solutions to the KB exchange problem: with the empty TBox and with a non-empty TBox.

The universal solution has the empty TBox and it is the ABox \( A^{\emptyset}_{\emptyset} \) of the form:

\[ A^{\emptyset}_{\emptyset} \]

The universal solution has several drawbacks:

- is not representable for DL-Lite;
- is not representable for DL-LiteDWS.

An alternative to the universal solution could be the universal UCQ-solution \( (T_2, A_2) \) depicted below:

\[ T_2 \]

\[ A_2 \]

The universal UCQ-solution has its merits:

- it is polynomial in the size of the mapping and the source KB;
- it is not distinguishable from the universal solution by means of UCQs.

Why Knowledge Base Exchange

Assume we bought shoes and clothes goods described in an ontology. We want to open an online shop selling the goods via a website that will use the information in the ontology for rendering the pages. But first we want to change the ontology vocabulary as it will be displayed to the user.

An ontology over the new vocabulary can be obtained as a solution of the KB exchange problem for \( M \) and \( (T_1, A_1) \).

Why Universal UCQ-Solutions

The website should provide the following functionality:

- browse different categories, e.g., to show all sandals, or all platform on platform;
- filter the listed products according to several criteria, such as color, brand;
- recommend items that fit the currently viewed product.

Such functionality can be implemented querying the target KB with UCQs:

\[ q(x) \leftarrow Sandals(x)^{\emptyset} Sandals(x), \text{hasSize}(x, 37), \text{hasBrand}(x, \text{geox}) \]

\[ \text{Query} \]

\[ q(y) \leftarrow \text{fitsWith}(\text{turq}, \text{green}, y) \]

New Problem: Representability of a TBox

To minimize the exchange of ABBox information, we are interested in solutions that contain as much implicit knowledge as possible:

given a mapping \( M \) and a source TBox \( T_1 \), compute a target TBox \( T_2 \) if it exists, such that for each ABox \( A_1 \), \( (T_2, 
\text{chase}_{M}(\text{A}_1)) \) is a universal UCQ-solution for \( (T_1, A_1) \) under \( M \).

The problem of UCQ-representability for DL-LiteDWS TBoxes can be solved in polynomial time.

\[ \text{Source signature} \]

\[ \text{Target signature} \]