RDF and ontologies

Here are the 8 triples of an RDF graph $G$ about writers and their works: (all identifiers correspond in fact to URIs, $_:b$ is a blank node):

\[
\begin{align*}
(d: Poe, o:wrote, d: TheGoldBug) & \quad (d: Baudelaire, o:translated, d: TheGoldBug) \\
(d: Poe, o:wrote, d: TheRaven) & \quad (d: Mallarmé, o:translated, d: TheRaven) \\
(d: TheRaven, rdf:type, o: Poem) & \quad (d: Mallarmé, o:wrote, _:b) \\
(_:b, rdf:type, o: Poem) & \quad (d: TheGoldBug, rdf:type, o: Novel)
\end{align*}
\]

1. Draw an RDF graph corresponding to these statements
2. Express in English the meaning of these statements.

Consider the RDFS ontology $o$ containing, in addition to those of $G$, the following statements:

\[
\begin{align*}
(o: Novel, rdfs:subClassOf, o: Literature) \\
(o: Poem, rdfs:subClassOf, o: Literature) \\
(o: translated, rdfs:range, o: Literature) \\
(o: wrote, rdfs:domain, o: Writer)
\end{align*}
\]

3. Does this allow to conclude that $d: Poe$, $d: Baudelaire$ or $d: Mallarmé$ is a $o: Writer$? Explain why.
4. Can you express in OWL the statement that “anyone who write Literature is a Writer”?

SPARQL query containment

Consider the following queries $q_1$ and $q_2$ on the RDF graph of the previous exercise:

- $q_1 = \text{SELECT } ?w \text{ FROM } G \text{ WHERE } ((?w o:wrote ?x) \text{ AND } (?x rdf:type o:Poem)) \text{ UNION } (?w o:translated ?x)$;
- $q_2 = \text{SELECT } ?w \text{ FROM } G \text{ WHERE } ((?w o:wrote ?l) \text{ UNION } (?w o:translated ?l)) \text{ AND } (?l rdf:type o:Poem)$.

5. In the course, we defined the distinguished variables $\vec{B}$, the queried graph $G$ and the query pattern $P$. Identify them in $q_1$ and $q_2$.
6. Provide the answers of $q_1$ and $q_2$ with respect to the graph $G$. 


Query containment \( q \sqsubseteq q' \) between two queries \( q = \text{SELECT } \vec{B} \text{ FROM } G \text{ WHERE } P \) and \( q' = \text{SELECT } \vec{B} \text{ FROM } G \text{ WHERE } P' \) is defined by the fact that for any RDF graph, the answers to \( q \) are included in those to \( q' \) \( (\forall G, \mathcal{A}(\vec{B}, G, P) \subseteq \mathcal{A}(\vec{B}, G, P')) \).

7. What does the answer to the previous questions tell you about query containment between \( q_1 \) and \( q_2 \)?

8. Do you think that query containment holds in some direction between \( q_1 \) and \( q_2 \) (either \( q_1 \sqsubseteq q_2 \) or \( q_2 \sqsubseteq q_1 \))?

9. Provide a proof for this. This may be done semantically by using the interpretation of query patterns or syntactically by translating queries into logic and showing that the query containment statement is a theorem.

**Query modulo ontology**

We now consider the ontology \( o \) and the following queries:

- \( q_3 = \text{SELECT } ?y \text{ FROM } o \text{ WHERE } \langle ?x, o:\text{translated}, ?y \rangle \);
- \( q_4 = \text{SELECT } ?y \text{ FROM } o \text{ WHERE } \langle ?y, \text{rdf:type}, o:\text{Literature} \rangle. \)

10. Do you think that query containment holds in some direction between \( q_3 \) and \( q_4 \) (either \( q_3 \sqsubseteq q_4 \) or \( q_4 \sqsubseteq q_3 \))? Tell why.

11. Can you provide a definition for query containment modulo an ontology \( o \) \( (q \sqsubseteq_o q') \)?

12. Does it return different answers for \( q_3 \) and \( q_4 \) (either \( q_3 \sqsubseteq_o q_4 \) or \( q_4 \sqsubseteq_o q_3 \))? Tell why.

**Network of ontologies**

We now consider an ontology \( o' \) which defines the class \( \text{op:Buch} \) and contains the following statements:

\[ \langle d:\text{Baudelaire}, o:\text{translated}, d:\text{Confessions} \rangle \langle d:\text{DeQuincey}, o:\text{wrote}, d:\text{Confessions} \rangle \]

and \( o'' \) which defines the class \( \text{opp:Roman} \) and contain the following statements:

\[ \langle d:\text{Confessions}, \text{rdf:type}, \text{opp:Roman} \rangle \langle d:\text{Musset}, o:\text{translated}, d:\text{Confessions} \rangle \]

They are related together by the following three alignments:

- \( A_{o,o'} = \{ \langle o:\text{Literature}, \equiv, \text{op:Buch} \rangle \} \)
- \( A_{o',o''} = \{ \langle \text{op:Buch}, \subseteq, \text{opp:Roman} \rangle \} \)
- \( A_{o'',o} = \{ \langle \text{opp:Roman}, \equiv, o:\text{Novel} \rangle \} \)

So that we have a network of ontology \( \{ \langle o, o', o'' \rangle, \{ A_{o,o'}, A_{o',o''}, A_{o'',o} \} \} \).

13. Do you think that this network of ontologies is well designed? Why?


15. Provide the constraints that the alignments impose on models.

16. What does this entail for the class \( \text{rdf:type} \) of \( d:\text{Confessions} \) and \( d:\text{TheRaven} \) at \( o \) in this network?