Principles of Knowledge Representation and Reasoning

B. Nebel, S. Wölfl, F. Lindner
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University of Freiburg
Department of Computer Science

Exercise Sheet 6

Due: December 2nd, 2015

Exercise 6.1 (Description Logics Semantics, 2+2)

(a) Condsider the interpretation $\mathcal{I}$ with $\Delta^{\mathcal{I}} = \{a, b, c, d, e, f, g\}$, $A^{\mathcal{I}} = \{a, c, e, g\}$, $B^{\mathcal{I}} = \{a, c, d\}$, $r^{\mathcal{I}} = \{(a, b), (b, c), (e, c), (c, f)\}$, $s^{\mathcal{I}} = \{(a, b), (d, b), (d, c), (d, e), (f, g)\}$, and $t^{\mathcal{I}} = \{(a, b), (d, d), (c, g)\}$. Determine the extensions of the following concept:

- $\exists r \circ s^{-1}.(\geq 2s.(\forall r.((r \circ s \sqsubseteq t) \sqcap (A \sqcup B))))$

(b) Consider the following pairs of TBoxes $\mathcal{T}$ and concept inclusions $C \sqsubseteq D$. For which of the pairs does $\mathcal{T} \models C \sqsubseteq D$ hold? Explain your answers and provide a counterexample in case the concept inclusion does not hold.

- $\mathcal{T} = \{\top \sqsubseteq \exists r.\top \sqcap \exists s.\top\}$ $\quad \top \sqsubseteq \exists r \circ s.\top$
- $\mathcal{T} = \{\top \sqsubseteq \exists r \circ s.\top\}$ $\quad \top \sqsubseteq \exists r.\top \sqcap \exists s.\top$

Exercise 6.2 (Modeling in Description Logics, 3+5)

(a) Extend the family TBox from the lecture (slide 25) by defining the following concepts:

- `Granddaughter`
- `Bachelor` (Unmarried man)
- `Bigamist` (Person married to at least two other persons)

Besides the roles and concepts used in the lecture, you may use the atomic role `married-to`.

(b) Use Protégé (which you can download from `http://protege.stanford.edu/`) to implement your family ontology. Extend the TBox by the basic concept `Patricide`. Next, assert the Oedipus ABox as given below:

```
hasChild(IOCASTE, OEDIPUS) , hasChild(IOCASTE, POLYNICES)
hasChild(OEDIPUS, POLYNICES) , hasChild(POLYNICES, THERSANDROS)
Patricide(OEDIPUS) , not Patricide(THERSANDROS)
```

Use Protégé's reasoner to check whether for the ABox the following holds: Iocaste has a child that is a patricide and that itself has a child that is no patricide. To do so, first define a new class which corresponds to the concept of having a child that is a patricide and that itself has a child that is no patricide. Then start the reasoner and check whether Iocaste is among the inferred instances. Try to explain the result in light of the fact that reasoning in description logics is based on the Open-World Assumption. Please save your ontology as an OWL document and send it to `lindner@informatik.uni-freiburg.de`.