Semantic Web Introduction (WiSe 2012/2013)
Sheet 6

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Next exercise session: 26.11.2012, 11:00-13:00

1. Express the following sentences in terms of the description logic ALC (see slides):
   
   (a) All employees are humans.
   (b) A mother is a female who has a child.
   (c) A parent is a mother or a father.
   (d) A grandmother is a mother who has a child who is a parent.
   (e) Only humans have children that are humans.

2. A knowledge base in description logics consists of a TBox and an ABox, i.e. \( \text{KB} = (\text{TBox}, \text{ABox}) \).
   
   (a) Construct a TBox describing a university. Use concept names such as University, Faculty, Education, Lecturer, Student, and role names such as teaches, works-for and studies-at.
   (b) Extend the TBox from the previous item to a knowledge base by constructing an appropriate ABox.

3. Consider the following ALC knowledge base:

   \[
   \text{TBox} = \{ \text{Female} \sqsubseteq \text{Human}, \text{Child} \sqsubseteq \text{Human}, \text{Works} \sqsubseteq \text{Human}, \\
   \text{StudiesAtUni} \sqsubseteq \text{Human}, \\
   \text{SuccessfulMan} \sqsubseteq \neg \text{Female} \sqcap \text{InBusiness} \sqcap \exists \text{marriedTo.Lawyer} \sqcap \\
   \exists \text{hasChild.}(\text{StudiesAtUni} \sqcup \text{Works}) \} 
   \]
ABox=\{Pedro : \neg Female, Pedro : InBusiness, Mary : Lawyer, John : Works, (Pedro, Mary) : married, (Pedro, John) : hasChild\}

(a) Translate this knowledge base into FOL.
(b) Show by resolution that Pedro is a successful man.

4. Which of the following statements are true? Explain!

(a) \forall R. (A \sqcap B) \subseteq \forall R. A \sqcap \forall R. B
(b) \forall R. A \sqcap \forall R. B \subseteq \forall R. (A \sqcap B)
(c) \forall R. (A \sqcup B) \subseteq \forall R. A \sqcup \forall R. B
(d) \forall R. A \sqcup \forall R. B \subseteq \forall R. (A \sqcup B)

5. Consider the TBox \{\neg (A \sqcup B) \sqsubseteq \bot, A \sqsubseteq \neg B \sqcap \exists R.B, D \sqsubseteq \forall R.A, B \sqsubseteq \neg A \sqcap \exists R.A\} together with the ABox \{(a, b) : R, (a, c) : R, (a, d) : R, (d, c) : R, a : (B \sqcap \forall R.D), b : E, c : \neg A, d : \exists S.\neg D\}.

(a) Is the TBox satisfiable (=does it have a model)?
(b) Is the ABox satisfiable?
(c) Is the whole knowledge base satisfiable?

6. Which constructors from the description logic ALC are redundant? Try to express each constructor by using other constructors.