TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Computer Science Institute of Theoretical Computer Science, Chair of Automata Theory

Logic-Based Ontology Engineering

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Exercise Sheet 2

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Exercise 2.1 Which of the following statements hold:

(a) If $C \sqsubseteq D$ holds, then $\exists r.C \sqsubseteq \exists r.D$ holds.

(b) $\exists r.C$ is equivalent to $(\leq\ 1\, r.\top)$.

(c) $(\leq\ 0\, r.\top)$ is equivalent to $\forall r.\bot$.

(d) $\forall r.(A \sqcup B)$ is equivalent to $(\forall r.A) \sqcup (\forall r.B)$.

(e) $\exists r.(A \sqcup B)$ is equivalent to $(\exists r.A) \sqcup (\exists r.B)$.

Give reasons for your answer.

Exercise 2.2 The description logic $\mathcal{ALC}$ is a fragment of $\mathcal{SROIQ}$ and it is equipped with the concept constructors negation ($\neg$), conjunction ($\sqcap$), disjunction ($\sqcup$), existential restriction ($\exists r.C$), and universal restriction ($\forall r.C$). The Description logic $\mathcal{EL}$ is a fragment of $\mathcal{ALC}$ that is equipped with the concept constructors conjunction ($\sqcap$) and existential restriction ($\exists r.C$), Prove or disprove the following in regard of the logics $\mathcal{EL}$, $\mathcal{ALC}$, $\mathcal{SROIQ}$:

(a) There is an ontology that has no models at all.

(b) There is an ontology that has only finite models.

(c) Every ontology has either no model or infinitely many models.

(d) There is an ontology $\mathcal{O}$ such that all models of $\mathcal{O}$ contain a cycle (when viewed as a graph).

Exercise 2.3 We consider the three RBoxes:

$$\mathcal{R}_1 = \{\, r_1^- \circ r_2 \sqsubseteq r_2,\quad r_3 \circ r_3 \sqsubseteq r_3,\quad r_4 \circ r_3 \sqsubseteq r_4 \,\}$$

$$\mathcal{R}_2 = \{\, r_5 \circ r_5 \sqsubseteq r_5,\quad r_5 \circ r_1 \sqsubseteq r_3,\quad r_5 \sqsubseteq r_3 \,\}$$

$$\mathcal{R}_3 = \mathcal{R}_1 \cup \mathcal{R}_2$$

(a) Which roles are simple?

(b) Which of the RBoxes are regular? Why?

Exercise 2.4 We want to model vehicles in two versions of ontologies. The ontology should capture the following information:

- vehicles have tires, i.e., the number of their tires is not 0.
- If a vehicle has a motor then it also has a car plate
- a car plate has the format: four letters followed by a number between 10 and 20. (Yes, we make simplifying assumptions here.)
- model bikes, unicyles, motorbikes, and cars with the usual number of tires.
- model 5 individuals that are vehicles and have a number of tires each.

(a) Model the ontology (as good as you can) by using only $\mathcal{ALC}$ and
  - either datatypes and datatype properties or
  - nominals and number restrictions.

(b) Can one of the ontologies model Dresden car plates (i.e. the first two letters on the car plate should be "DD")?

(c) Can one retrieve by use of a class expression all the individuals that are vehicles and have an odd number of tires less than 6? If so, how?

Exercise 2.5 In this exercise we want to use the "DL query" tab. You can activate it in Protégé from the menu "Windows" → "Views" → "Query views" → "DL query". Load the pizza ontology and activate the HermiT reasoner.

(a) query for the *direct* subclasses of the concept $\exists$*hasCountryOfOrigin*.*Country*

(b) Query for subclasses of $\exists$*hasOrigin*.{*France*}.

(c) Consider the annotations (using the Annotations view tab). Which annotation property is used to annotate entities with textual descriptions?

(d) Enter the IRI of this annotation property into a web browser to find out in which ontology it is defined. Download this ontology, load it into Protégé and find out who has modelled it, i.e. find out the creators of this ontology. Furthermore, find out (using the Annotation property hierarchy) what the textual description of the property from (c) is.