Exercise sheet 4
Reasoning

This exercise sheet is about reasoning, in specific Description Logic (DL) reasoning. You'll have to answer some questions about the basics of DL and use an integrated development environment (IDE) to create and reason over a DL Knowledge Base (KB).

Exercise 2 and 3 both should be used in the Protégé Ontology Editor[1][2], which can be downloaded at http://protege.stanford.edu/download/protege/4.0/installanywhere/. You can use the vocabulary in exercise 3 to express the knowledge base you'll have to model in exercise 2; you may also define your own vocabulary. Protégé offers a lot of graphical support for creating your knowledge base, if you prefer writing the restrictions by hand, the following table outlines some keywords.

DL Syntax	Protégé Syntax
Class1 ⊓ Class2	Class1 **and** Class2
∃ property.Class	property **some** Class
∀property.Class	property **only** Class
≥ n property.Class	property **min** n Class
= n property.Class	property **exactly** n Class
≤ n property.Class	property **max** n Class

For modeling the ontology, the "Entity" tab of Protégé should be enough, define all properties as "object properties". For querying use the "DL Query" Tab.

Exercise 1 (10 points)

Answer the following questions (Description Logics):

    (a) What are constructors? How do the different description logics differ?
    (b) Provide the constructors for the description logic ALC and explain their meaning.
    (c) In which components is a knowledge base separated to? What does each component contain? Please describe the different types of axioms the components contain.

Exercise 2 (10 points)

Please familiarize yourself with Protégé and represent the following natural language sentences using it. Please use the vocabulary from Exercise 3 to describe it.

    (a) An opera is a musical performance.
    (b) All actors of an opera are singer.
    (c) At least one musical ensemble of an opera is an orchestra.
    (d) A rock concert is another musical performance.

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[1] http://protege.stanford.edu/
[2] tutorial available at http://owl.cs.manchester.ac.uk/tutorials/protegeowltutorial/, the first 50 pages will be sufficient for the exercise

(e) Rock concerts and operas are disjoint to each other.

Exercise 3 (10 points)

Please check all Description Logics statements which are entailed by your statements from Exercise 2. Please answer if the following statements are entailed or not:

(a) Musical Performance $\sqsubseteq$ Opera
(b) Opera $\sqsubseteq$ MusicalPerformance
(c) $\forall$hasActor.Singer $\sqsubseteq$ Opera
(d) Opera $\sqsubseteq$ Musical Performance $\sqcap$ $\forall$hasActor.Singer $\sqcap$ $\exists$hasMusicalEnsemble.Orchestra
(e) Opera $\sqsubseteq$ MusicalPerformance $\sqcap$ $\geq$1 hasMusicalEnsemble $\sqcap$ $\forall$hasActor.Singer
(f) hasMusicalEnsemble $\sqsubseteq$ Opera
(g) Opera $\sqsubseteq$ MusicalPerformance $\sqcap$ $\exists$hasMusicalEnsemble.Orchestra
(h) Opera $\sqsubseteq$ Musical Performance $\sqcap$ =1hasMusicalEnsemble $\sqcap$ $\forall$hasActor.Singer
(i) Opera $\sqsubseteq$ Musical Performance $\sqcap$ $\forall$hasMusicalEnsemble.Orchestra $\sqcap$ $\exists$hasActor.Singer
(j) Opera $\sqsubseteq$ RockConcert
(k) RockConcert $\sqsubseteq$ $\neg$ Opera