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 the description logic SHOIN(D) 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.
(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 ⊑ Opera
(b) Opera ⊑ MusicalPerformance
(c) ∀hasActor.Singer ⊑ Opera
(d) Opera ⊑ MusicalPerformance ∩ ∀hasActor.Singer ∩ ∃hasMusicalEnsemble.Orchestra
(e) Opera ⊑ MusicalPerformance ∩ ≥1 hasMusicalEnsemble ∩ ∀hasActor.Singer
(f) \(\text{hasMusicalEnsemble} \sqsubseteq \text{Opera}\)

(g) \(\text{Opera} \sqsubseteq \text{MusicalPerformance} \sqcap \exists \text{hasMusicalEnsemble.Opera}\)

(h) \(\text{Opera} \sqsubseteq \text{MusicalPerformance} \sqcap =1\text{hasMusicalEnsemble} \sqcap \forall \text{hasActor.Singer}\)

(i) \(\text{Opera} \sqsubseteq \text{MusicalPerformance} \sqcap \forall \text{hasMusicalEnsemble.Opera} \sqcap \exists \text{hasActor.Singer}\)

(j) \(\text{Opera} \sqsubseteq \text{RockConcert}\)

(k) \(\text{RockConcert} \sqsubseteq \neg \text{Opera}\)