

Knowledge Representation and Semantic Technologies

# **Exercises on Knowledge Representation**

Riccardo Rosati

Corso di Laurea Magistrale in Ingegneria Informatica

Sapienza Università di Roma

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# Exercise 1

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We want to formalize knowledge about the domain of students and professors.

In particular, we want to formalize the following statements:

# Exercise 1 (contd.)

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1. Every student is a person
2. Every professor is a person
3. Every student has an ID (matricola)
4. Every student attends at least one course
5. Every course is taught by a professor
6. Every student is not a professor
7. Every exam is constituted of a course, a student, a date and a grade

# Exercise 1 (contd.)

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1) Choose the most appropriate knowledge representation language for expressing the above knowledge among the following:

- ALC
- Datalog
- ASP
- OWL
- DL-Lite
- RDFS

2) Express the above knowledge in the formalism chosen at the previous point.

# Exercise 1 - Solution

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- 1) The formalism chosen is ALC, because:
  - According to statements 3, 4, 5, we need to refer to «existential» individuals (and Datalog and ASP are not suited for this)
  - According to statements 4,5, we need qualified existential restriction (DL-Lite is not suited for this)
  - According to statement 6, we need to express disjointness between concepts (RDFS is not able to express this)
  - ALC seems enough to express the seven statements, so we do not need the extra abilities of OWL

# Exercise 1 - Solution

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2) We choose the following vocabulary (set of predicates and individuals):

Concepts: STUDENT, PERSON, PROFESSOR, COURSE,  
GRADE, DATE

Roles: hasID, attends, isTaughtBy

Moreover, we have to reify the notion of exam at point 7 (that would be naturally encoded by a relation of arity 4) using a concept EXAM and four auxiliary roles examStudent, examCourse, examDate, examGrade

# Exercise 1 - Solution

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2) Here is the formalization of the statements in ALC:

STUDENT  $\sqsubseteq$  PERSON

PROFESSOR  $\sqsubseteq$  PERSON

STUDENT  $\sqsubseteq \exists \text{hasID}.T$

STUDENT  $\sqsubseteq \exists \text{attends}.COURSE$

COURSE  $\sqsubseteq \exists \text{isTaughtBy}.PROFESSOR$

STUDENT  $\sqsubseteq \neg PROFESSOR$

EXAM  $\sqsubseteq \exists \text{examCourse}.COURSE$

EXAM  $\sqsubseteq \exists \text{examStudent}.STUDENT$

EXAM  $\sqsubseteq \exists \text{examGrade}.GRADE$

EXAM  $\sqsubseteq \exists \text{examDate}.DATE$

# Exercise 1 - Comment

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- Notice that statement 7 is problematic for ALC (and Description Logics in general), since DLs do not allow for expressing relations of arity greater than 2.
- However, the reification technique allows for representing (although unnaturally) these kinds of n-ary relations.
- Datalog and ASP allow for directly define a 4-ary exam relation, so, with respect to statement 7 alone, they should be preferred: however, they have more important limitations with respect to the other statements (in particular, both Datalog and ASP are not able to express statements 3,4,5; in addition, Datalog is not able to express statement 6)



# Exercise 2

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We want to formalize knowledge about the domain of students and professors.

In particular, we want to formalize the following statements:

## Exercise 2 (contd.)

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1. Every student is a person
2. Every professor is a person
3. Every student has an ID (matricola)
4. Every course is taught by a professor
5. Every student who attends a course is an active student
6. Every student is not a professor

## Exercise 2 (contd.)

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For each of the following description logics:

- DL-Lite<sub>R</sub>
- EL
- RL

identify which of the above statements can be formalized, and write the corresponding axioms.