Master in Computational Logic & Mestrado Integrado em Engenharia Informática
Universidade Nova de Lisboa

Knowledge Representation and Reasoning Systems

First Test – Closed Book – 2h00m

23rd October 2017

Group 1 [3 val.]

1) Transform the following sentences into clausal form:

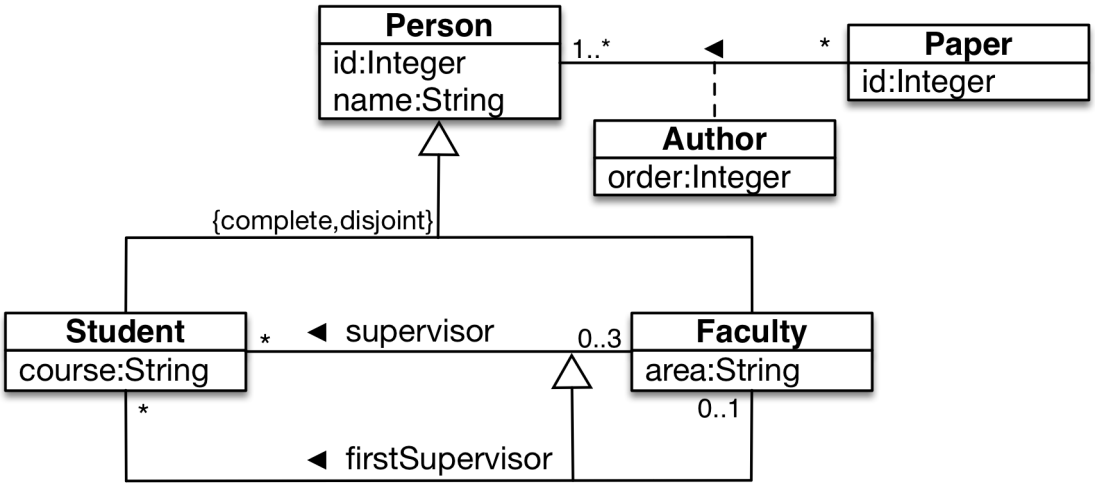
S1 $\exists x \forall y \exists z (R(x,y) \supset P(y,z))$
S2 $\neg \forall x \forall y (Q(x,y) \vee \exists z Q(y,z))$
S3 $\forall x \forall y ((P(x) \vee Q(y)) \supset (P(y) \wedge Q(x)))$

2) Show by resolution that clauses **C1**-**C3** below entail $\neg R(f(1),1)$.

C1 $[R(1, f(1))]$
C2 $[\neg R(y,x), P(f(x))]$
C3 $[\neg P(x), \neg R(y,x)]$

Group 2 [7 val.]

Consider the following UML class diagram representing information about authors of scientific papers in the university:



1) Translate the UML class diagram into an appropriate Description Logic.
2) Express in Description Logic (in the fragment you think is more appropriate) the following concepts:
   i. Faculty members that supervise at least one student
   ii. Unsupervised students
   iii. Faculty members that are not first supervisors
   iv. Students that have co-authored only one paper
   v. Papers whose student co-authors are supervised
   vi. Supervisors whose students have all written more than one paper
3) Indicate which of these concepts can be expressed in $\mathcal{ALC}$.

Group 3 [7 val.]

The tableau algorithm for $\mathcal{ALC}$ shown in the class can be extended to deal with transitive roles by adding the rule: $\rightarrow_{tr} (\forall r.D)(x), r(x,y) \in \mathcal{A}$ and r is transitive, then $\mathcal{A} := \mathcal{A} \cup \{\forall r.D(y)\}$.

1) Using tableau, showing every step, determine the satisfiability of

$$\exists r.A \sqcap \forall r.B \sqcap \neg (\exists s.A \sqcup \forall s.(\forall s.B \sqcap \forall s.\neg A))$$

where s is a transitive role.

2) If the concept is satisfiable, construct a model for it in which $a \in A^I$.

Group 4 [3 val.]

Answer the following questions in a ***short*** and ***concise*** way.

1) What is the point of *Description Logics* and other ontology languages? Why not simply use *First-Order Logic*?

2) What are the benefits of using an ontology at runtime?

3) Description Logics only allow the usage of unary and binary predicates. But sometimes we want to model ternary relationships. How can we overcome this problem?