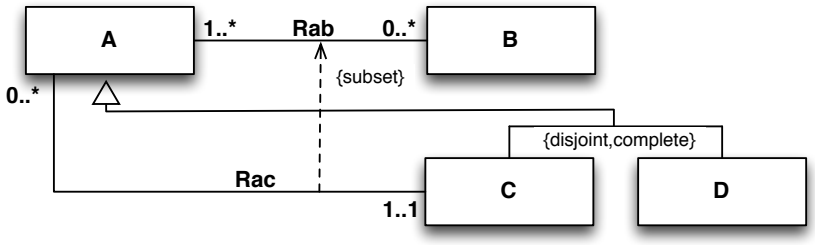
SAPIENZA Università di Roma – MSc. in Engineering in Computer Science

Formal Methods – Jan. 22, 2014

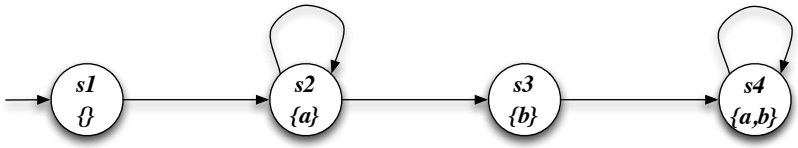
(Time to complete the test: 2 hours)

Exercise 1. Consider the following UML class diagram.



1. Express it in FOL.
2. Express it in *DL-Lite*$_\mathcal{A}$, highlighting parts that are not expressible.
3. Given the ABox $A = \{C(c)\}$ and the boolean conjunctive query $q(x) \leftarrow Rab(x, y), Rab(y, z), A(z)$, return the certain answer by exploiting the *DL-Lite*$_\mathcal{A}$ rewriting algorithm.

Exercise 2. Model check the Mu-Calculus formula $\mu X.\nu Y.(a \vee [next]X) \wedge [next]Y$ and the CTL formula $AFAGa$ against the following transition system:



Exercise 3. Check whether CQ q_1 is contained in CQ q_2, reporting canonical DBs and homomorphism:

$$\begin{array}{lcl} q_1(x_r) & \leftarrow & e(x_r, x_g), e(x_g, x_b), e(x_b, x_r). \\ q_2(x) & \leftarrow & e(x, y), e(y, z), e(z, x), e(z, v)e(v, w), e(w, z). \end{array}$$

Exercise 4. Compute the certain answers to the CQ $q(x) \leftarrow M(x, y), E(y)$ over the incomplete database (naive tables):

$E(mployee)$

$name$
Smith
$null_1$
Brown

$M(anager)$

mgr	mgd
Smith	$null_1$
$null_1$	Brown
Brown	$null_2$

Exercise 5. Compute the weakest precondition for getting $\{x = 100\}$ by executing the following program:

```
x := y + 50;
if (y > 0) then
  x := y + 100
else x := y + 200;
x := x + y;
```