*Sapienza Università di Roma*
*MSc. in Engineering in Computer Science*
***Formal Methods***
*AA 2012/13 – Appello 22/01/13*
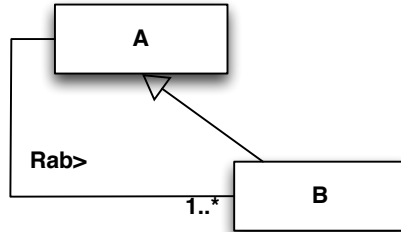*Time to complete the test: 2 hours*

**1.** Consider the following UML class diagram.



    i.   Express it in FOL.
    ii.  Express it in ALCQI or SHIQ.
    iii. Express it in DL-lite$_A$, highlighting parts that are not expressible.
    iv. Conpute the certain answers to the conjunctive query:

$$q(x) \ :- \ Rab(x,y), \ Rab(y,z), \ A(z)$$

over the DL-lite$_A$ TBox obtained in iii and the ABox: `{B(b) }`

**2.** Consider the following transition system:
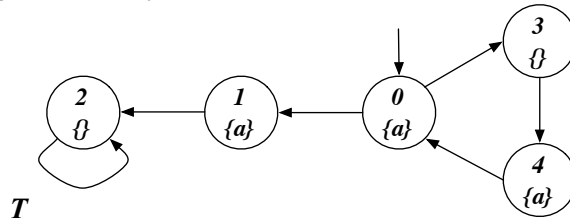


Model check the following formulas:
$$\mu X.\mu Y.((a \vee \langle - \rangle X) \wedge [-](a \vee Y)) \qquad\qquad AF(a \wedge EXa \wedge EX\neg a)$$

**3.** Check using tableaux whether the following ALC subsumption holds, and if not show a counterexample:

$$(\exists R.\neg A \sqcap B) \sqcap (\exists R.A \sqcap \neg B) \sqsubseteq \exists R.(A \sqcap B)$$

**4.** Compute the weakest precondition for getting {x=y} executing the following program:

```
x:=10;
if (y>10) then
    (x=x-y; x = y-5)
else x = x-y
```

**5.** Let `q1` and `q2` be the following two CQs:

`q1(x):-r(x,x),r(x,y),b(x,z),b(y,z)`      `q2(x):-r(x,y),b(y,z),r(x,v),b(v,z)`

Check whether `q1` is contained in `q2`, and write canonical DBs and homomorphism between them.