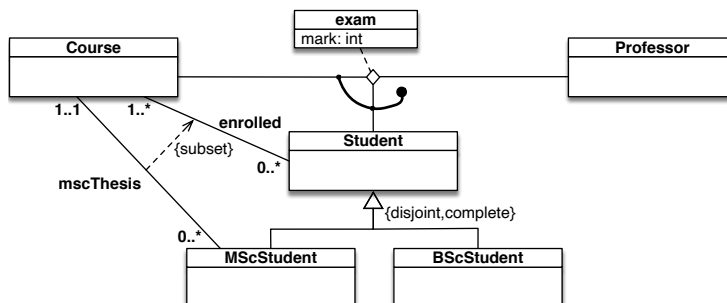


Exercise 1. Express the following UML class diagram in FOL:

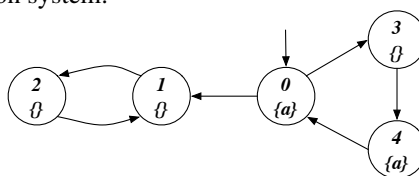


Exercise 2. Consider the above UML class diagram and the following (partial) instantiation:

<i>BScStudent</i>	<i>MScStudent</i>	<i>Professor</i>	<i>Course</i>	<i>enrolled</i>	<i>mscThesis</i>	<i>exam/mark</i>
Barry Bea	Mary Murray Mark	Paul Peter Phoebe	AI SE FM	Barry SE Bea SE Mary AI Mary FM Mary SE	Mary FM Murray AI Mark FM	Barry SE Paul 28 Bea SE Paul 30 Mary AI Peter 30 Mary FM Phoebe 30 Mary SE Paul 27

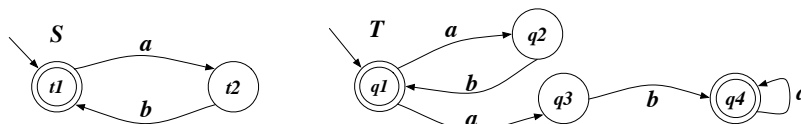
1. Check whether the above instantiation, once completed, is correct, and explain why it is or it is not.
2. Express in FOL the following queries, and evaluate them over the completed instantiation:
 - (a) Return the students who are enrolled in more then one course.
 - (b) Check is there are students who have 30 in all exams they have taken.
 - (c) Return the MSc students who are enrolled in other courses apart those for which do their MSc thesis.
 - (d) Return the MSc students who are enrolled only in the course for which they do their MSc thesis.

Exercise 3. Consider the following transition system:



1. Model check the Mu-Calculus formula: $\nu X. \mu Y. ((a \wedge \langle next \rangle X) \vee \langle next \rangle Y)$
2. Model check (by translating it in Mu-Calculus) the CTL formula: $EF(EXAFa \wedge AXEGa)$

Exercise 4. Write the definition of bisimilarity and compute the bisimilarity relation for the two transition systems below.



Exercise 5. Check whether the following FOL formula is valid, by using tableaux:

$$\forall x. [(\forall y. A(x) \supset B(x, y)) \equiv (A(x) \supset \forall y. B(x, y))]$$