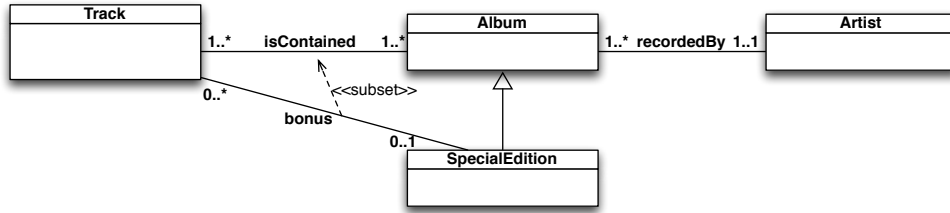
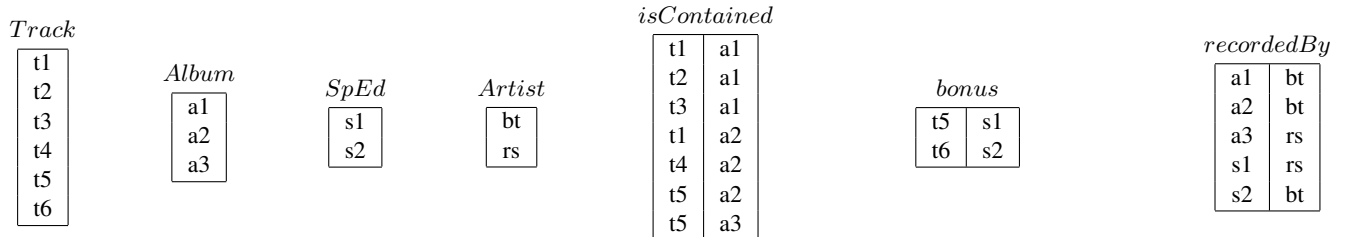


**Exercise 1.** Express the following UML class diagram in *FOL*.

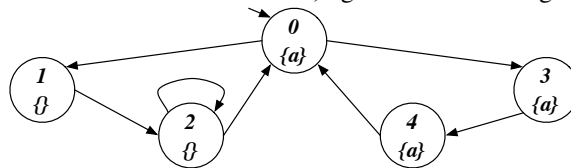


**Exercise 2.** Consider the above UML class diagram and the following (partial) instantiation.



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 artist that recorded an album and a special edition containing the same track.
  - (b) Return those artist that have recorded only special editions.
  - (c) Check if there is a track appearing in all albums that are not special editions.

**Exercise 3.** Model check the Mu-Calculus formula  $\nu X. \mu Y. ((a \wedge \langle next \rangle X) \vee ([next] Y))$  and the CTL formula  $AF(EG(a \supset AXEX \neg a))$  (showing its translation in Mu-Calculus) against the following transition system:



**Exercise 4.** Consider the following two transition systems:



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

**Exercise 5.** Compute the certain answers to the following CQs over the following incomplete database (naive tables), and discuss how you obtained the result:

$$q() \leftarrow \text{contains}(x, y), \text{genre}(y, z) \quad q(x, z) \leftarrow \text{contains}(x, y), \text{genre}(y, z)$$

album	song
wywh	null <sub>1</sub>
null <sub>2</sub>	null <sub>3</sub>
null <sub>4</sub>	null <sub>5</sub>
null <sub>6</sub>	null <sub>3</sub>

song	type
null <sub>1</sub>	progressive
null <sub>3</sub>	blues
null <sub>5</sub>	null <sub>7</sub>