SAPIENZA Università di Roma – MSc. in Engineering in Computer Science
Formal Methods – June 1, 2023
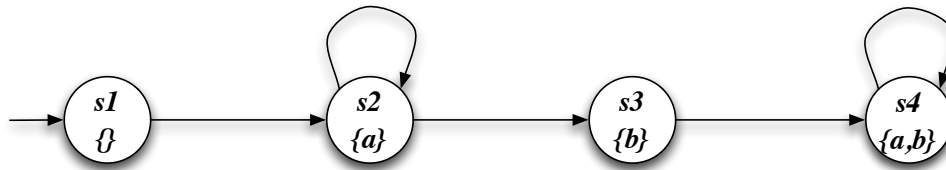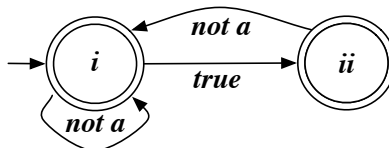*(Time to complete the test: 2 hours)*

Part 1. Consider the following transition system:

- **Exercise 1.1:** Model check the Mu-Calculus formula $\mu X.\nu Y.(a \vee [next]X) \wedge [next]Y$.

- **Exercise 1.2:** Model check the CTL formula $AFAGEXa$ against the following transition system:

- **Exercise 1.3:** Model check the LTL formula $\Diamond(a \wedge \bigcirc a)$, by considering that the Büchi automaton for $\neg\Diamond(a \wedge \bigcirc a)$ is the one below:

Part 2. Consider the following two transition systems:
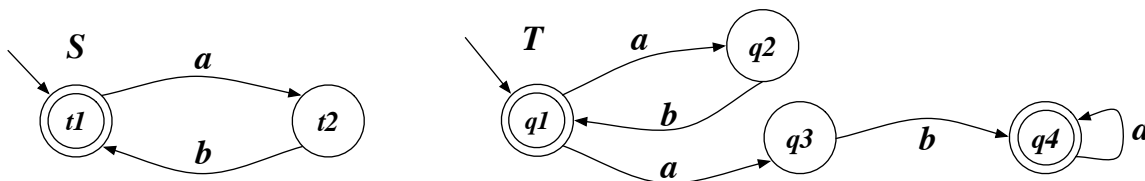
Write the definition of bisimilarity and compute the bisimilarity relation for the two transition systems.

Part 3. Compute the weakest precondition for getting $\{x = 0\}$ by executing the following program:

```
x := 1 - y;
if (x > 1) then
      x := x - y
else x := x + y;
y := y + 1
```