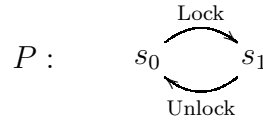


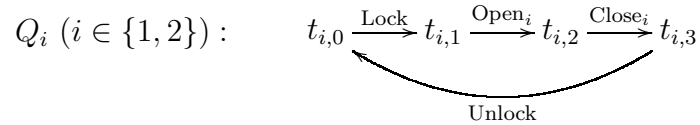
Automata-Based Verification

We consider a system consisting of three concurrent processes P , Q_1 , and Q_2 :

- Process P is a lock, which can be modeled by the following Labelled Transition System, whose initial state is s_0 :



- Processes Q_1 and Q_2 are similar processes, each attempting to execute a sequence of actions “Open₁; Close₁” or “Open₂; Close₂”, respectively. They use the lock in order to guarantee that they execute their sequence of actions atomically, i.e., without interleaving with that of the other process. Q_1 and Q_2 can be modeled as Labelled Transition Systems as follows, where the initial states are respectively $t_{1,0}$ and $t_{2,0}$:



- The whole system is defined as the parallel composition $P \otimes_{\{\text{Lock}, \text{Unlock}\}} (Q_1 \otimes_{\emptyset} Q_2)$.
1. Figure 1 (page 2) contains all states of the product $Q_1 \otimes_{\emptyset} Q_2$. Complete this figure by circling the initial state, and by adding the transitions of $Q_1 \otimes_{\emptyset} Q_2$.
 2. Draw the (reachable part of the) product $P \otimes_{\{\text{Lock}, \text{Unlock}\}} (Q_1 \otimes_{\emptyset} Q_2)$.

$t_{1,0}, t_{2,0}$	$t_{1,1}, t_{2,0}$	$t_{1,2}, t_{2,0}$	$t_{1,3}, t_{2,0}$
$t_{1,0}, t_{2,1}$	$t_{1,1}, t_{2,1}$	$t_{1,2}, t_{2,1}$	$t_{1,3}, t_{2,1}$
$t_{1,0}, t_{2,2}$	$t_{1,1}, t_{2,2}$	$t_{1,2}, t_{2,2}$	$t_{1,3}, t_{2,2}$
$t_{1,0}, t_{2,3}$	$t_{1,1}, t_{2,3}$	$t_{1,2}, t_{2,3}$	$t_{1,3}, t_{2,3}$

Figure 1: Product $Q_1 \otimes_{\emptyset} Q_2$ to be completed