

Model Checking: exercise set 3

Parallel composition and bisimulation

Some of these exercises are from the *Principles of Model Checking* book.

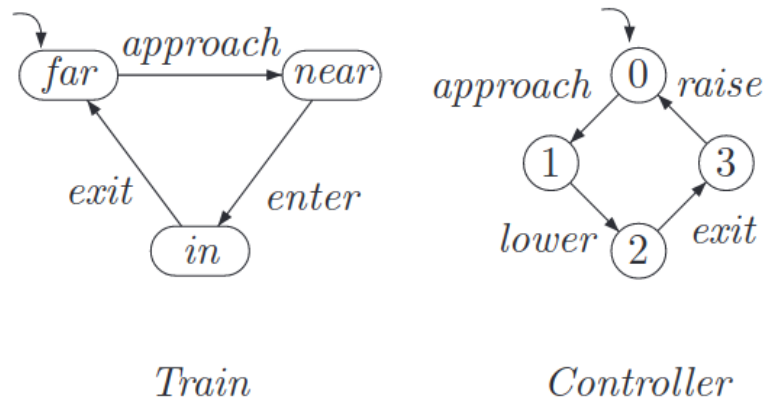
Due date: February 20

- 1 Show that the handshaking operator \parallel that forces two transition systems to synchronize over their common actions (see Definition 2.26 on page 48 of the *Principles of Model Checking* book) is associative. That is, show that:

$$(TS_1 \parallel TS_2) \parallel TS_3 = TS_1 \parallel (TS_2 \parallel TS_3)$$

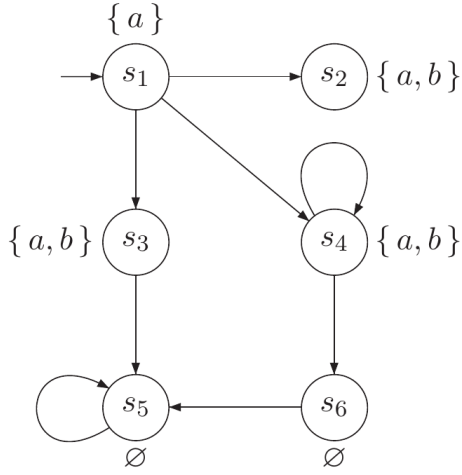
where TS_1, TS_2, TS_3 are arbitrary transition systems.

- 2 Consider the following two transition systems representing a train (TS_1) and the controller for a crossing (TS_2).

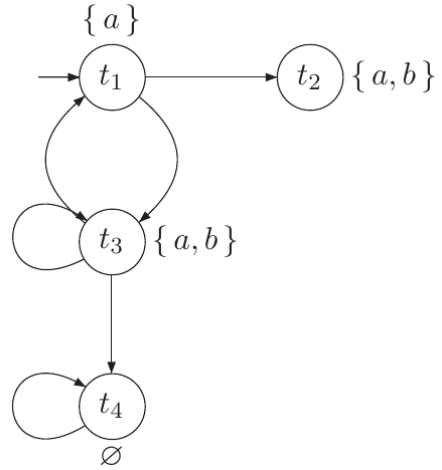


- (a) Determine the set H of handshaking actions.
- (b) Build the parallel composition $TS_1 \parallel_H TS_2$ with your handshaking operator H .

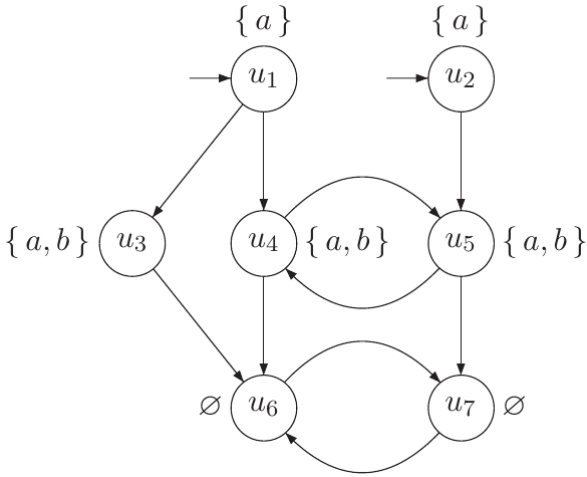
3 Consider the transition systems below:



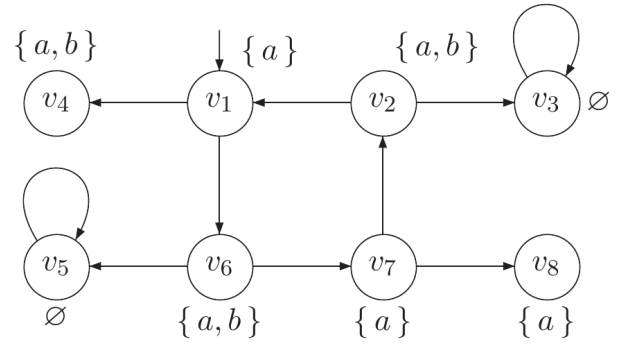
Transition system TS_1



Transition system TS_2



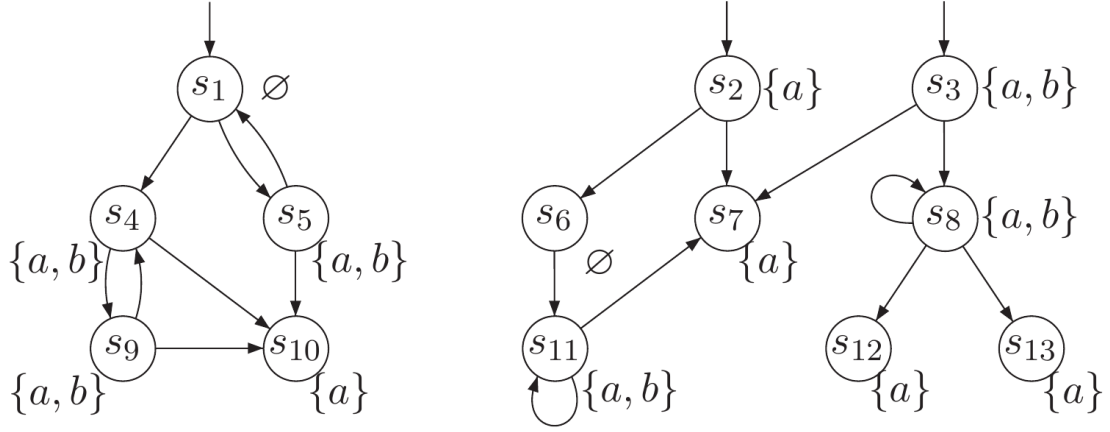
Transition system TS_3



Transition system TS_4

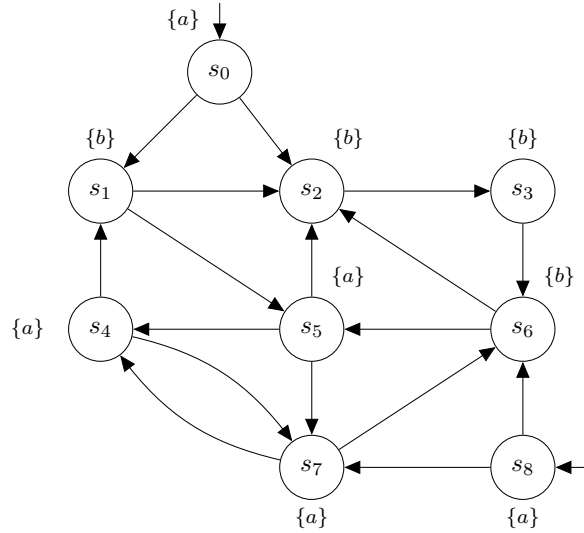
Determine for each pair (TS_i, TS_j) for $0 < i \neq j \leq 4$ of these transition systems whether they are bisimilar. Justify your answer by either providing the bisimulation relation (TS_i, TS_j) or a CTL formula Φ such that $TS_i \models \Phi \wedge TS_j \not\models \Phi$.

4 Consider the following transition system over atomic propositions $\{a, b\}$:



Determine the bisimulation equivalence \sim_{TS} and depict the bisimulation quotient system TS/\sim .

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