Exam Theory of Automata and Processes (2IT15)

25 June 2008, 14.00 –17.00

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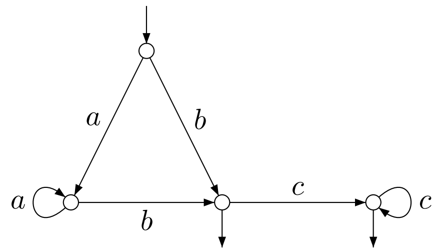
This is a "closed book" exam. The parts add up to 100 points, the grade is obtained by dividing the total number of points by 10. *Motivate your answers!*

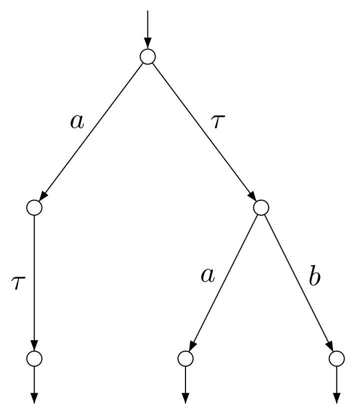
Assignment 1 (10 points) Consider the automaton below.

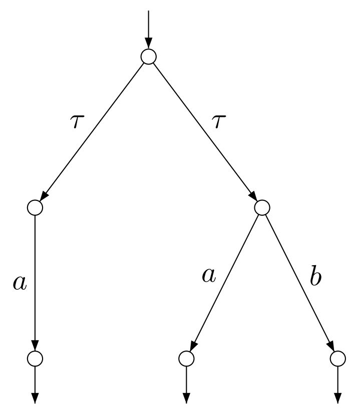


a. Find an automaton with no more than two states which is bisimilar to this automaton.

b. Find an iteration expression of which the automaton generated by the operational rules is bisimilar to this automaton.

Assignment 2 (15 points) Consider the two automata below.





a. Show that the automata are not branching bisimilar.

b. Which of the two automata is branching bisimilar to the automaton of $a.\mathbf{1} + b.\mathbf{1}$? Motivate your answer by exhibiting a branching bisimulation.

Assignment 3 (25 points)

a. Given is the recursive equation $S \leftrightarroweq \mathbf{1} + a.S \cdot b.S$. Using the operational rules, draw the transition system of process S.

b. Given is the recursive equation $B \leftrightarroweq \mathbf{1} + a.(B \parallel b.\mathbf{1})$. Using the operational rules, draw the transition system of process B. You may use the laws of Communication Algebra to simplify the resulting transition system.

c. Show these processes are bisimilar, $S \leftrightarroweq B$. What is the language of these processes?

Assignment 4 (20 points)

a. Given is the recursive specification $\{S \leftrightarroweq \mathbf{1} + S \cdot a.T, T \leftrightarroweq \mathbf{1}\}$. Using the operational rules, determine the transition system of S. Show S is not a context-free process.

b. Given is the recursive specification $\{U \leftrightarroweq \mathbf{1} + U \cdot a.V, V \leftrightarroweq a.V\}$. Using the operational rules, determine the transition system of U. Show U is a regular process.

Assignment 5 (30 points) The lamp on my desk L is only lit if the plug P is in the socket and the switch S is in the correct position. When I enter, the plug is in the socket and the switch is off: this is the initial state. The set of messages D consists of the following:

- *on*: the lamp is switched on;
- *off*: the lamp is switched off;
- *cff*, *cn*: something happens (a 'click'), but the lamp is not switched on or off.

There are the following specifications:

$$
\begin{array}{rcl}
P & \leftrightarroweq & ?off.\overline{P} + ?cff.\overline{P} \\
\overline{P} & \leftrightarroweq & ?on.P + ?cn.P \\
S & \leftrightarroweq & ?on.\overline{S} + ?cn.\overline{S} \\
\overline{S} & \leftrightarroweq & ?off.S + ?cff.S \\
L & \leftrightarroweq & !on.!off.L + !cff.!cn.L
\end{array}
$$

The encapsulation operator ∂_* enforces communication by blocking all $!d, ?d$ for $d \in D$, the abstraction operator τ_c turns *only* the ‽*cff*, ‽*cn* communications into τ's.

a. Using the operational rules, draw a non-deterministic finite automaton for the process $\partial_*(L \parallel P \parallel S)$.

b. In the transition system obtained, rename all ‽cff and ‽cn steps into τ. This is the transition system of $\tau_c(\partial_*(L \parallel P \parallel S))$.

c. Using the operational rules, draw the automaton of iteration expression $\mathbf{1} \cdot (‽on.‽off.\mathbf{1})^*$.

d. Give a branching bisimulation showing $\tau_c(\partial_*(L \parallel P \parallel S)) \underline{\leftrightarrow}_{\mathrm{b}} \mathbf{1} \cdot (‽on.‽off)^*$.