Technische Universiteit
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Faculteit Wiskunde en Informatica

Exam Automata and Process Theory (2IT71 / 2IT17)

23 January 2015, 13.30-16.30u

This is a *closed book* exam. Answers may be given in English or Dutch. For each question the number of points is indicated in the margin. These points add up to 100. Your grade is the sum of the points you scored on all questions divided by 10 (not rounded off).

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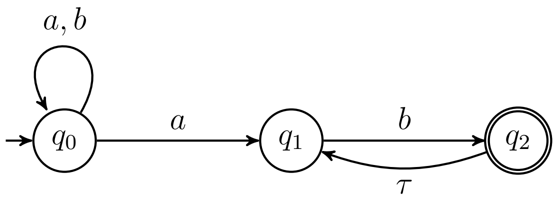
(15) 1. Construct a DFA D with alphabet $\{a, b\}$ and no more than 4 states for the language $L = \{w \in \{a, b\}^* \mid w \text{ has substring } bab\}$. Prove that $\mathcal{L}(D) = L$ by providing the pathsets of the states of D.

2. The transition diagram of NFA N is given by



(10) (a) Derive a DFA D from N that accepts $\mathcal{L}(N)$. Provide both the transition table and the transition diagram of D. [**hint**: the resulting DFA has 3 states]

(10) (b) Construct a regular expression for $\mathcal{L}(N)$ by applying the state elimination method to NFA N.

(10) 3. Given are an alphabet Σ, a symbol $a \in \Sigma$, and a regular language L over Σ. Language L' is defined by

$$L' = \{u \in \Sigma^* \mid ua \in L\}$$

Prove that L' is regular.

(15) 4. Construct a push-down automaton with no more than 5 states accepting language $\{a^k b^\ell c^{2m} \mid k = \ell + m\}$ and give an invariant table for it.

5. The Pumping Lemma for context-free languages states that

> if L is a context-free language then there exists an $m : m > 0$ such that each $w \in L$ with $|w| \geqslant m$ can be written as $w = uvxyz$ with $u, v, x, y, z \in \Sigma^*$, $vy \neq \varepsilon$, $|vxy| \leqslant m$, and for all $i \geqslant 0 : uv^ixy^iz \in L$.

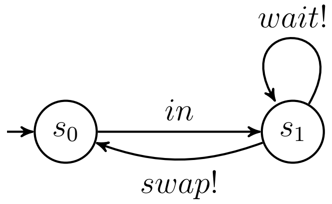
Given is language $L = \{a^k b^p c^\ell \mid k \geqslant p \wedge \ell \geqslant p\}$

(10) (a) Use the lemma to prove that L is not context-free.

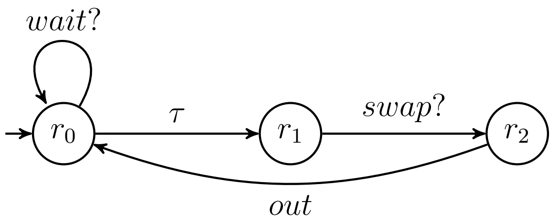
(15) (b) Construct a reactive Turing machine that accepts L and give an accepting computation sequence for string *aabcc*. A proof of correctness is *not* asked for.

(15) 6. Consider LTS S and LTS R given below

S :



R :



For communication function γ we have $\gamma(wait!, wait?) = wait$ and $\gamma(swap!, swap?) = swap$. Let $H = \{wait!, wait?, swap!, swap?\}$ and $I = \{wait, swap\}$. Draw LTS $\partial_H(S \parallel_\gamma R)$ (which has six reachable states) and LTS $\tau_I(\partial_H(S \parallel_\gamma R))$.