

Theoretical Computer Science (2nd Test)  
(Duration: 1h30m + 30m)

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June 5, 2014

1. A palindrome is a possibly empty word that reads the same in both directions. For example, 10101 and 11 are palindromes over the alphabet  $\Sigma = \{0, 1\}$ . Give an inductive definition of the set of all palindromes over  $\Sigma$ .
2. Consider the language defined by the regular expression  $E$  over the alphabet  $\Sigma = \{\text{ping}, \text{pong}\}$ :

$$(\text{ping pong} + \text{ping pong pong})^*(\text{ping} + \text{pong})$$

- (a) Justify if the word `ping pong pong`  $\in L(E)$ .
  - (b) Justify if the word `ping pong ping pong`  $\in L(E)$ .
  - (c) Define a non-deterministic finite automaton (NFA) accepting the language specified by the expression  $E$ . Explain if the NFA you produced is indeed non-deterministic.
  - (d) Based on the NFA you defined in (c), define a deterministic finite automaton (DFA) accepting the same language.
3. Consider the alphabet

$$\Sigma = \{\text{mkdir\_filename}, \text{cd\_filename}, \text{cd...}, \text{not\_found}\}$$

and the grammar  $G = \langle V, \Sigma, S, R \rangle$  where  $V = \{S, T\}$  and  $R$  has the rules:

$$\begin{aligned} S &\rightarrow \text{mkdir\_filename } S \\ S &\rightarrow \text{cd\_filename } T \\ T &\rightarrow \text{not\_found } S \\ T &\rightarrow S \text{ cd...} \\ S &\rightarrow \epsilon \end{aligned}$$

- (a) Check if the next sentence is derivable in  $G$  (write a derivation if it is):

`cd_filename notfound cd_filename mkdir_filename cd...`

- (b) Check if the grammar above is LL(1). If possible, give the transition table for the deterministic syntactic analyser. Otherwise, explain where there might be a parsing conflict.