Languages and Automata (Gyula Katona) December 8., 2016, 18:15-19:15

Neptun code: **Name:**

Midterm 3

1. (a) Define the language class $\mathcal{R}$ (i.e. recursive languages):

(b) Define the language class $TIME(t(n))$ (where $t(n)$ is a function):

(c) Prove that $TIME(t(n)) \subseteq \mathcal{R}$ holds for any function $t(n)$:

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2. Let L be the language of all words $w \in \Sigma^*$ for which M_w (the TM described by w) exists and M_w stops on the empty input in at most 100 steps. Prove that $L \in \mathcal{R}$.

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3. Let w be a Turing Machine description and $s \in \Sigma^*$ any word. Construct a Turing Machine M_{w_s} such that $L(M_{w_s}) = \emptyset$ holds if and only if $s \notin L(M_w)$.

   (Using this construction it is easy to prove that the following problem is undecidable (the corresponding language is $\notin \mathcal{R}$):
   Given a Turing machine, M, is it true that $L(M) = \emptyset$?)

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4. Let $L = \{a^n b a^n \mid n \geq 0\}$.

   Is it true that:

   (a) $L \in \mathcal{R}$?

   (b) $L \in NP$?

   (c) $L \in SPACE(n^{2016})$?

   Prove your claims.