ITU Computer and Informatics Faculty
BLG311E - Formal Languages and Automata

20.03.2014

Duration: 120 minutes

Midterm 1

1. (30p) An experimental monkey is given a series of apples(a) and bananas(b) during an experiment **one by one consecutively**. As the result of the experiments the following outcomes are observed:
   - The monkey eats a banana any time he has a single banana
   - If at any time monkey only has two apples he eats both of them
   - If at any time monkey has two bananas he eats the bananas and throws other fruits away
   - If at any time monkey has two apples and a banana he eats all the fruits
   - If at any time none of the above condition holds, monkey waits for the next fruit

   Assume that the monkey is deterministic and the output given by the monkey is wheteher he eats(1) or not(0). Design a mealy FSM that conforms monkey's behaviour, your **initial design need not to be the optimal solution** with minimal number of states.
   (a) Draw the state transition diagram of your initial design and sketch the state table of the machine
   (b) Apply state reduction to your machine

2. (20p) Consider the following languages A, B and C defined over the alphabet $\Sigma = a, b$.
   - $A = abb^+ba$
   - $B = a(bb)^+ba$
   - $C = a(bbb)^*a$

   Answer each of the following questions considering the definitions above
   i Give an example string that is accepted by the all three languages.
   ii Give an example string that is accepted by only A.
   iii Give an example string that is accepted by only A and B.
   iv Give an example string that is accepted by only A and C.
   v Give an example string that is accepted by only C.
   vi Indicate if there is a subset/superset relation between any pair of the three languages.

3. (20p) Let α be a relation defined over set A. For the relations $\alpha^s = \alpha^t$ where $s < t$ and $p = t - s$, prove the following using induction:
$$\alpha^{s+kp+i} = \alpha^{s+i}; \forall k > 0 \wedge \forall i(0 < i < p)$$

4. (30p) Consider the following grammar
$$\begin{aligned} n_0 &= A \mid n_0 A \\ A &= X \mid Y \mid Z \\ X &= ab \\ Y &= aab \\ Z &= abb \end{aligned}$$
   (a) Which type does this grammar corrrespond to in Chomsky hierarchy? Why?
   (b) Give an equivalent grammar which correspond to a more restrictive Chomsky type.
   (c) Give a regular expression that can be used to represent this language