# CS 722   Fall 2016
Homework Assignment #1
Due: in class on 09/22/16, Thursday

Only hard copies will be accepted. Late submissions and email submissions will not be accepted. If you have not been able to solve a problem completely, you may show the work you have done for partial points. Observe course policies in solving assignment problems.

In all questions "_" is the blank symbol.

1. Consider the DTM to decide { w#w | w ∈ {0, 1}* } in Example 3.9 in the book.
   - a. Give the transition sequence on each of the following inputs:
     - i. 00#00
     - ii. 01#00
   - b. Analyze the worst-case time complexity function of this DTM and express it in $O(g(n))$ asymptotic notation.

2. Consider the NTM in Question 2 here. Give the computation tree of this NTM on each of the following inputs:
   - i. abcab
   - ii. ccc

3. Consider the NTM with $Q = \{q_0, q_{accept}\}$, $\Sigma = \{0\}$, $\Gamma = \{0, \_\}$,

   $\delta(q_0, 0) = \{(q_0, 0, R)\}$
   $\delta(q_0, \_) = \{(q_0, \_, R), (q_{accept}, \_, R)\}$

   - a. Give the computation tree on the input 00. How many accepting branches are in the computation tree?
   - b. Specify the set of all input strings accepted by this NTM.
   - c. Specify the set of all input strings rejected by this NTM.
   - d. Is this NTM a decider? Why or why not?

4. This question is about the simulation of multi-tape DTMs by 1-tape DTMs. Consider the following configuration of a 3-tape DTM with $\Gamma = \{a, b, c, \_\}$:
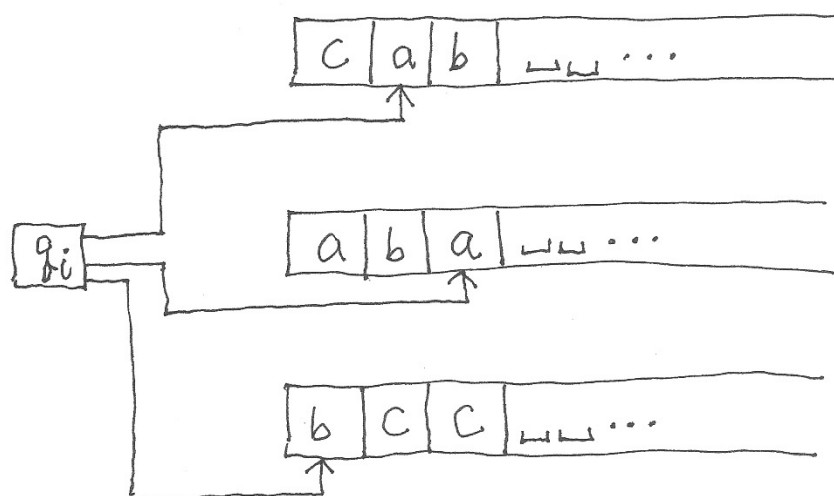
    a. Give the 1-tape DTM configuration simulating the above configuration.
    b. Give the 1-tape DTM configuration simulating the configuration obtained by the 3-tape DTM
       transition $\delta(q_i, a, a, b) = (q_j, b, c, a, R, R, L)$ from the above configuration.

5. Recall the simulation of DTMs by RAMs described in class.

    a. Give the RAM memory configuration simulating $a_5a_4a_1a_3q_3a_4a_2$.
    b. Give the RAM memory configuration simulating the configuration obtained by the transition $\delta(q_3, a_4) = (q_1, a_3, R)$ from the above configuration.

6.
    a. Give a RAM program segment to compute the value of $(r_1-r_2)+(r_3*r_4)$. The result will be placed in the accumulator r_0.
    b. Recall the simulation of RAMs by the 5-tape DTMs described in class. Presuming that, initially, $r_1 = 4, r_2 = 3, r_3 = 1, r_4 = 2$, show the contents of tape 1 (simulating the RAM memory) and tape 2 (simulating the accumulator r_0) after the execution of each instruction in your RAM program. Use a format similar to Question 5 on this page, and abbreviate integers in unary notation to decimal notation.

7. Informally but in sufficient detail, describe how to simulate an arbitrary 1-tape DTM by a 1-tape DTM with $\Sigma = \{0, 1\}$ and $\Gamma = \{0, 1, \_\}$.