CMSC 303 Introduction to Theory of Computation, VCU
Assignment 5

Turned in electronically in PDF, PNG or Word format

Total marks: 45 marks + 3 bonus marks for all the answers typed out.

Unless otherwise noted, the alphabet for all questions below is assumed to be $\Sigma = \{0, 1\}$.

1. [10 marks] This question asks you to examine the formal definitions of a TM and related concepts closely. Based on these definitions, answer the following.
   (a) A *configuration* of a Turing Machine (TM) consists of three things. What are these three things?
   (b) Can input alphabet Σ contain the blank symbol $\sqcup$? Why or why not?
   (c) The tape is infinite. Is the tape alphabet infinite?
   (d) Can a Turing machine's head *ever* be in the same location in two successive steps?
   (e) What is the difference between a decidable language and a Turing-recognizable language?
2. [12 marks] This question requires you to read a Turing Machine and determine if a given string is accepted by the TM. For each string below, show the tape and configuration at each step and state whether the TM accepts the string or not:

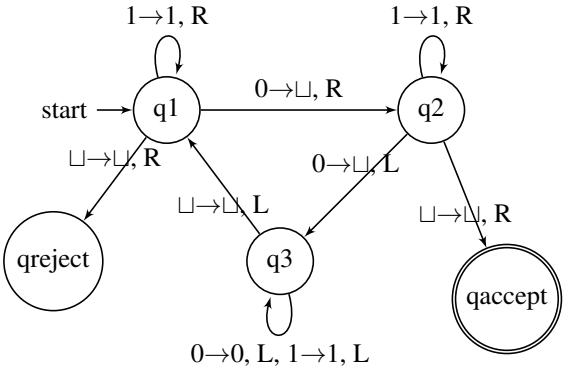

Figure 1: Turing Machine Finite Automata

   (a) [3 marks] 0110
   (b) [3 marks] 010101
   (c) [3 marks] 110
   (d) [3 marks] What language does this Turing Machine describe?
3. [10 marks] This question gets you to practice describing TM's at a semi-low level. Let

$$L = \left\{ ww^R \mid w \in \{0, 1\}^* \right\}$$

Recall that w^R means w written backwards. Give an implementation-level description of a TM that decides L. By *implementation-level description*, we mean a description similar to Example 3.11 in the text (i.e. describe how the machine's head would move around, whether the head might mark certain tape cells, etc.... Please do *not* draw a full state diagram (for your sake and for ours)).

4. [8 marks] This question investigates a variant of our standard TM model from class.

   (a) [6 marks] Consider a TM that, when it moves, left, automatically moves to the leftmost cell. We call this a TM a *Left-Start TM*. Describe how a Left-Start TM can simulate a standard TM. (Hint - Use the fact that you have the ability to mark cells as you move through the tape and change the content of cells.)

   (b) [2 mark] What does this imply about the sets of languages recognized by both models and about the models themselves?

5. [5 marks] This question allows you to explore variants of the computational models we've defined in class. Describe how Turing Machines and PDAs are different. How can you equate a Turing Machine to a PDA? (Hint - What would a PDA need to be equivalent to a Turing Machine)