CS 692 Capstone Exam Theory Spring 2022

Choose any 2 of the 3 problems.

1. Given regular expression (ab)*(a|b) over $\Sigma = \{a, b\}$:

   (a). (6 pts) Draw the equivalent state diagram of an NFA.

   (b). (8 pts) Draw the equivalent state diagram of a DFA.

   (c). (6 pts) Write a corresponding context-free grammar for it.

2. For decidable languages:

   (a). (4 pts) Give a definition of decidable languages.

   (b). (8 pts) Prove that decidable languages are closed under union.

   (c). (8 pts) Prove that decidable languages are closed under intersection.

3. For Turing machines:

   (a). (8 pts) Give the state diagram of a Turing machine that recognizes the following language over $\Sigma = \{a, b\}$:

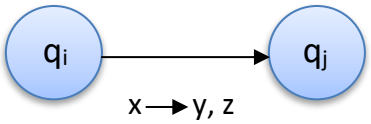
   $$L_1 = \{w : w \text{ contains the substring aab}\}$$

   (b). (12 pts) A Turing machine X with Right Tab T is similar to a normal Turing machine except that its transition function is defined as

   $$\delta: Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R, T\}$$

   where T is an extra tape directive, in addition to Left and Right, that moves the read/write head to the first blank space to the right. Show that X is Turing-complete.

   Note: Please use the following notation to label your Turing machine transitions:



(read symbol x, write symbol y, direction to move is z)