CS 692 Capstone Exam Theory Exam Fall 2023

Choose any 2 of the 3 problems. If all three are answered, only questions 1 and 2 will be graded.

1. Consider language L_1 = { w | w does not contain the substring "00" } over Σ = {0, 1}:

   (a). (5 pts) Write one difference between NFA and DFA in general and explain clearly.

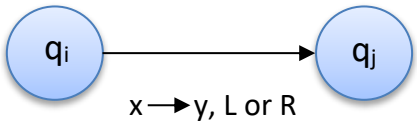
   (b). (10 pts) Draw a state diagram of an NFA for this language L_1.

   (c). (5 pts) Draw a state diagram of a DFA for this language L_1.

2. Consider language L_2 = { w | w begins and ends with the same symbol } over Σ = {0, 1}, for example, string 101 is in L_2, but string 100 is not in L_2.

   (a). (5 pts) Write one difference between Turing machines and Pushdown Automata in general and explain clearly.

   (b). (10 pts) Draw a Turing machine of any type to accept this language L_2. You can use the following notation to label the transitions:



   (read symbol x, write symbol y, direction to move is L or R)

   (c). (5 pts) Explain clearly how your Turing machine works to accept a valid string. You may use any string from L_2 as an example.

3. Consider Σ = {0, 1}:

   (a). (5 pts) Give the Pumping Lemma for regular languages. State clearly and completely.

   (b). (15 pts) Prove whether or not the following language L_3 is a regular language. If it is regular, give a regular expression for L_3. If not, apply the pumping lemma to prove it.

$$L_3 = \{ 0^m 1^n \mid m < n \}.$$