
Submission instructions as in previous homeworks.

4 (100 PTS.) **OLD Homework problem (not for submission):**

Regularize this.

For each of the following languages over the alphabet $\{0, 1\}$, give a regular expression that describes that language, and briefly argue why your expression is correct.

- 4.A. (20 PTS.) All strings that contain the subsequence 101.
- 4.B. (20 PTS.) All strings that do not contain the subsequence 111.
- 4.C. (20 PTS.) All strings that start in 11 and contain 110 as a substring.
- 4.D. (20 PTS.) All strings that do not contain the substring 100.
- 4.E. (20 PTS.) All strings in which every nonempty maximal substring of consecutive 0s is of length 1. For instance 1001 is not in the language while 10111 is.

5 (100 PTS.) **OLD Homework problem (not for submission):**

Then, shalt thou find two runs of three.

Let L be the set of all strings in $\{0, 1\}^*$ that contain the substrings 000 and 111.

- 5.A. (60 PTS.) Describe a DFA that over the alphabet $\Sigma = \{0, 1\}$ that accepts the language L . Argue that your machine accepts every string in L and nothing else, by explaining what each state in your DFA *means*.
You may either draw the DFA or describe it formally, but the states Q , the start state s , the accepting states A , and the transition function δ must be clearly specified.
- 5.B. (40 PTS.) Give a regular expression for L , and briefly argue why the expression is correct.

6 (100 PTS.) **OLD Homework problem (not for submission):**

Construct This

Let L_1 and L_2 be regular languages over Σ accepted by DFAs $M_1 = (Q_1, \Sigma, \delta_1, s_1, A_1)$ and $M_2 = (Q_2, \Sigma, \delta_2, s_2, A_2)$, respectively.

- 6.A. (30 PTS.)
Describe a DFA $M = (Q, \Sigma, \delta, s, A)$ in terms of M_1 and M_2 that accepts $L = L_1 \cup \overline{L_2} \cup \{\epsilon\}$. Formally specify the components Q, δ, s , and A for M in terms of the components of M_1 and M_2 .
- 6.B. (30 PTS.)
Let $H_1 \subseteq Q_1$ be the set of states q such that there exists a string $w \in \Sigma^*$ where $\delta_1^*(q, w) \in A_1$. Consider the DFA $M' = (Q_1, \Sigma, \delta_1, s_1, H_1)$. What is the language $L(M')$? Formally prove your answer!
- 6.C. (40 PTS.) Suppose that for every $q \in A_2$ and $a \in \Sigma$, we have $\delta_2(q, a) = q$. Prove that $\epsilon \in L_2$ if and only if $L_2 = \Sigma^*$.