GROUP HOMEWORK 5, CPSC 421/501, FALL 2020

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Please note:

(1) You must justify all answers; no credit is given for a correct answer without justification.
(2) Proofs should be written out formally.
(3) Homework that is difficult to read may not be graded.
(4) You may work together on homework in groups of up to four, **but you must submit a single homework as a group submission under Gradescope.**

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(1) (a) Let L be a regular language over Σ, and let $w \in \Sigma$. Show that $L \cup \{w\}$ is regular.
    (b) Let L be a regular language over Σ, and let $w \in \Sigma$. Show that $L \setminus \{w\}$ is regular.
    (c) Let L be a nonregular language over Σ, and let $w \in \Sigma$. Show that $L \cup \{w\}$ is nonregular.
    (d) Let L be a nonregular language over Σ, and let $w \in \Sigma$. Show that $L \setminus \{w\}$ is nonregular.

(2) Prove the following statements, or prove that they are false by giving a counterexample.
    (a) The union of two regular languages is regular.
    (b) The union of two nonregular languages is regular.
    (c) The union of a nonregular language and a regular language is nonregular.
    (d) The concatenation of a nonregular language and a regular language is nonregular.

(3) Give a formal description (by a state diagram, or table of δ values, or a list of δ values) of a Turing machine that recognizes the language over $\Sigma = \{0, 1\}$ given by

$$L = \{w \in \{0,1\}^* \mid w \text{ has more 0's than 1's}\}.$$

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Make sure to explain how your machine works, and what each state "means" in terms of your algorithm; make sure that it is clear what are the values of $Q, \Gamma, q_0, q_{\text{accecpt}}, q_{\text{reject}}$.

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