THE PLOT THICKENS

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1. Closed Union

Prove that the class of regular languages is closed under the union ($\cup$) operation. (Hint: Use proof by construction.)

2. If a man attempts to solve a problem using Regular Expressions, they now have two problems

Provide the regular expression that corresponds to each of the following language descriptions. Assume that Σ is $\{0, 1\}$:

(1) $\{w|w$ has exactly a single 1$\}$
$$0^* \cdot \{1\} \cdot 0^*$$
(2) $\{w|w$ contains the string 001 as a substring$\}$
$$\Sigma^* \cdot \{001\} \cdot \Sigma^*$$
(3) $\{w|w$ is a string of even length$\}$
$$(\{0,1\} \cdot 0, 1)^*$$
(4) $\{w|w$ starts and ends with the same symbol$\}$

3. Regex to NFA

Convert the regular expression $(a \cup b)$ to a nondeterministic finite state automaton. Note that you do not have to draw the NFA if you do not wish to do so. You may provide the mathematical specification $M = (Q, \Sigma, \delta, q_0, F)$. For δ you may provide a table of the transitions.

4. Pump it up

Using the pumping lemma prove that $F = \{ww|w \in \{0,1\}\}$ is nonregular.