- 1. Find a regular expression for each of the following languages on $\{0, 1\}$:
 - (a) Words not ending in 11.
 - (b) Words of even length, length at least 3 and with second letter equal to 0.
- 2. Let A be the following DFA:



- (a) Convert A into an NFA having (i) an initial states with no transitions leading into it, and (ii) a single accept state having no transitions of it. The resulting NFA should have five states, including the initial state q_0 and the unique accepting state q_4 .
- (b) Rip out state q_1 , and draw the resulting GNFA. The transitions will be labeled with regular expressions.
- (c) Recall the general prescription for ripping out a state given in the text:



Letting $q_i = q_0$, $q_j = q_3$, and $q_{rip} = q_2$, identify R_1, R_2, R_3 and R_4 . What regular expression labels the transition from q_0 to q_3 after ripping out q_2 ? What obvious simplification can you make involving the empty set?

- (d) Similarly, letting $q_i = q_3$, $q_j = q_3$, and $q_{rip} = q_2$, identify R_1, R_2, R_3 and R_4 . What regular expression labels the transition from q_3 to q_3 after ripping out q_2 ?
- (e) Rip out q_2 and draw the resulting GNFA
- (f) Rip out q_3 to produce a GNFA with two states.
- (g) What is the resulting regular expression for the language accepted by A?
- (h) Give a simple description of L(A) in words.
- 3. Negate the DFA from Problem the previous problem by exchanging accept and reject states to create the DFA A^c .
 - (a) What is $L(A^c)$, in words.

- (b) Convert A^c into an NFA having (i) an initial states with no transitions leading into it, and (ii) a single accept state having no transitions of it. The resulting NFA should have five states, including the initial state q_0 and the unique accepting state q_4 .
- (c) Rip out q_1 .
- (d) The resulting GNFA has states q_0, q_2, q_3, q_4 . Recall the general prescription for ripping out a state given in the text:



Letting $q_i = q_2$, $q_j = q_4$, and $q_{rip} = q_3$, identify R_1, R_2, R_3 and R_4 . What regular expression labels the transition from q_2 to q_4 after ripping out q_3 ? How does that regular expression simplify?

- (e) Rip out q_3 .
- (f) Rip out q_2 .
- (g) What is the resulting regular expression for $L(B) = L(A^c)$.
- 4. (Bonus) The text describes a method for converting an NFA with n states into a DFA with 2^n states. Show that this bound is roughly tight. Specifically, show that for every n there exists a language that can be recognized with an (n+1)-state NFA but cannot be recognized by a DFA with fewer than 2^n states.