Homework 3
CS 321

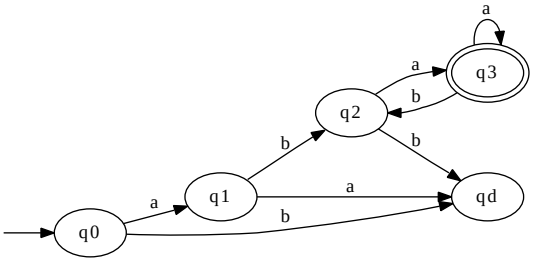
1. Give a regular expression for the following languages.

   (a) $L_2 = \{a^n b^m : n < 4, m \leq 3\}$.
   $(a + aa + aaa + \lambda)(b + bb + bbb + \lambda)$

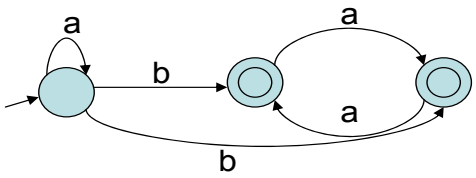
   (b) The complement of L_2.
   $(a + b)^* ba(a + b)^* + (aaaa)a^*b^* + a^*(bbbb)b^*$

   (c) All strings over $\{a, b, c\}$ that contain no runs of a's of length greater than two.
   $(b + c + ab + ac + aab + aac)^*(a + aa + \lambda)$

2. Find a DFA that accepts the language: $L(ab(a + ab)^*(a + aa))$.



3. Find a regular expression for the language accepted by the following NFA.



   Answer: a^*ba^*

4. Find a regular expression that generates the following language on $\{a, b\}$. $L = \{w : (n_a(w)$ and $n_b(w)$ are both even $\}$.

   Answer: $(aa + bb + (ab + ba)(aa + bb)^*(ab + ba))^*$

   Obtained by starting from the DFA and applying the state elimination technique. Since the starting state and the final state are the same, all the other states can be eliminated one by one. The final result is r^* where r is the regular expression on the self-loop around the start/final state.

5. Construct a right linear grammar for the language $L((aab^*ab)^*)$

   $S \to \lambda$
   $S \to aaA$
   $A \to bA$
   $A \to abS$

6. Construct a left linear grammar for the above language. (Hint: construct a right linear language for the reverse of the above language and reverse the right hand sides of all the rules.)

$S \to \lambda$
$S \to Aab$
$A \to Ab$
$A \to Saa$

7. Give a regular grammar for the language $L = \{w : |n_a(w) - n_b(w)| \text{ is odd}\}$

$S \to Aa|Ab$
$A \to Aaa|Abb|Aab|Aba|\lambda$