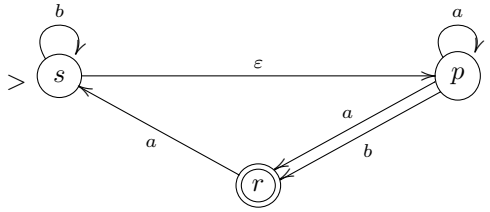
Fundamentals of Computing
Tutorial 4

1. Determine if the nondeterministic automaton



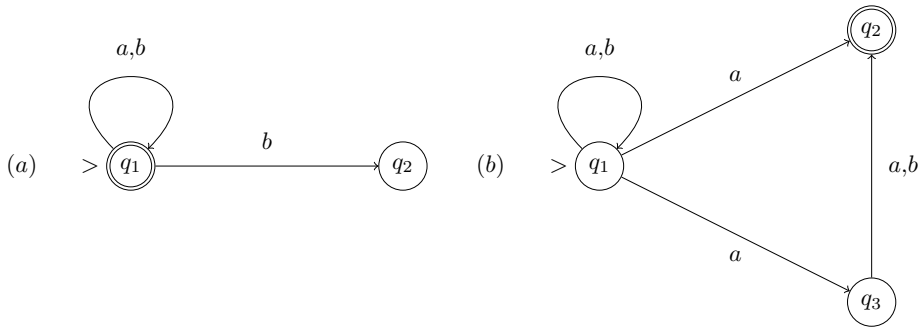
   accepts the strings

   (a) bb
   (b) ab
   (c) aba
   (d) ε

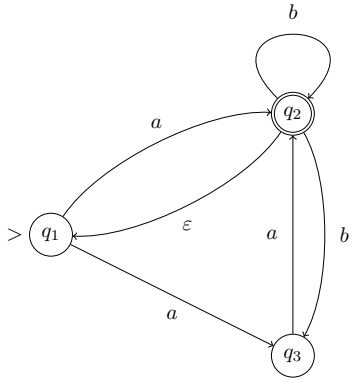
   or not. In each case, give all computations on the string in question.

2. Transform, using the subset construction, the nondeterministic finite automaton in Question 1 above into an equivalent deterministic finite automaton. Then delete the unreachable states. Show your working.

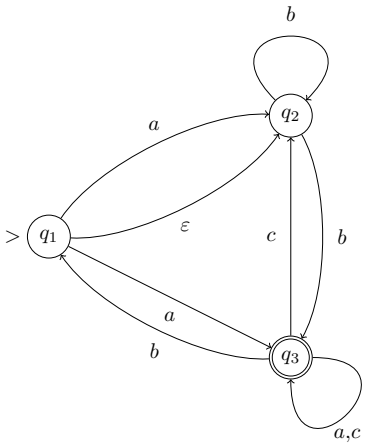
3. Convert each of the following NFAs to DFAs:



4. Convert the following NFA to a DFA:



5. Convert the following NFA to a DFA using the subset construction:



6. Do the regular expressions $(aa \cup ab^*)^*$ and $(aa \cup ab)^*$ define the same language? What about $(ba \cup ab^*)^*$ and $(ba \cup ab)^*$?

7. Describe in English the languages defined by the following regular expressions:
   - $(0 \cup 1)^*01$
   - 1^*01^*
   - $(11)^*$
   - $(0^*10^*10^*)^*$
   - $(0 \cup 1)^*01(0 \cup 1)^*$
   - 1^*0^*
   - $(10 \cup 0)^*(1 \cup 10)^*$
   - $0^*(1 \cup 000^*)^*0^*$

8. Find regular expressions defining the following languages over the alphabet $\Sigma = \{a, b\}$:
   (a) all words ending with ab;
   (b) all words containing the subword aba;
   (c) all words starting with a and containing at least one b;
   (d) all words of even length that do not contain ab as a sub-word;
   (e) all words containing an even number of a's and an even number of b's;
   (f) all words that do not have both of the sub-words bba and abb.

9. Construct DFAs accepting the languages given by the following regular expressions:
   (a) aa^*bb^*;
   (b) $(aa \cup ab^*)^*$.

10. Apply the procedure given in the lectures to convert the regular language
$$L\big[0(0 \cup 11)^*(00 \cup 11)11^*\big]$$
to a finite automaton accepting it.

11. Construct NFAs accepting the languages given by the following regular expressions and convert them into DFAs:
   (a) $(1 \cup 0)^*101^*0$;
   (b) $((10)^*00 \cup (11)^*1)^*$.