

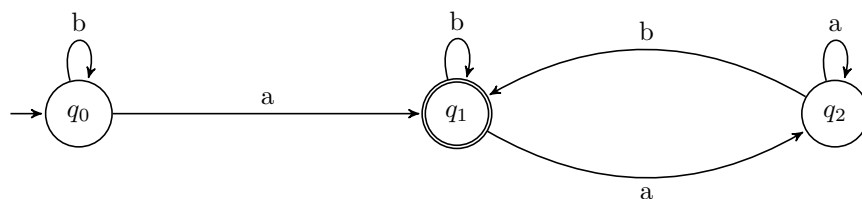
## THE2: Problems for Lectures 1-3

**In class, please start by working on questions 1, 2, 3a,b and 10.** You can then go back to the other questions if there's time in the class, or complete them later, in your own time.

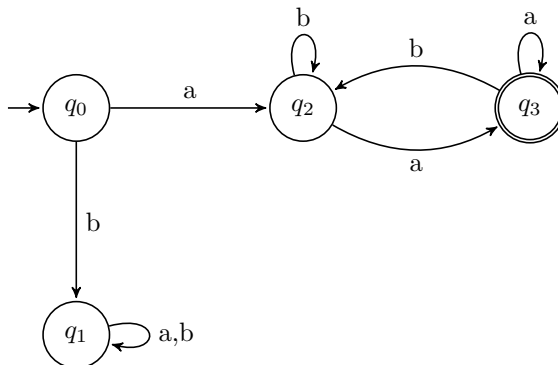
Throughout this sheet, 'FSA' stands for *Finite State Automaton*. This could be either deterministic (DFA) or nondeterministic (NFA). For this sheet, either is acceptable.

### Lectures 1 and 2

- On an alphabet  $\{a, b\}$  give FSAs for the sets consisting of:
  - all strings with exactly one  $a$ ,
  - all strings with at least one  $a$ ,
  - all strings with no more than 3  $a$ s
- Give a FSA that accepts the language  $L = \{ab^5wb^4 \mid w \in \{a, b\}^*\}$
- Consider the sets of strings on  $\{0, 1\}$  defined by the requirements below. For each, construct an accepting FSA:
  - every 00 is followed immediately by a 1. For example, the strings 101, 0010, 0010011001 are in the language, but 0001 and 00100 are not.
  - the leftmost symbol differs from the rightmost one.
  - every substring of 4 symbols has at most two 0's. For example, 001110 and 011001 are in the language, but 10010 is not since one of its substrings, 0010 contains three 0's.
  - the 4th symbol from the right end is different from the leftmost symbol
- For each of the languages given below, write down 10 strings that belong to it.
  - $\{a, b\}^*\{aa, bb\}\{a, b\}^*$
  - $\{b\}^*(\{ab\}\{b\}^*)^*\{\lambda, a\}$
  - $(\{aa, bb\} \cup (\{ab, ba\}\{aa, bb\}^*\{ab, ba\}))^*$
- Show that the language  $L = \{awa \mid w \in \{a, b\}^*\}$  is *regular*.
- Show that the language consisting of strings containing an even number of both a's and b's is regular.
- Give a set description of the language (e.g. as given in question 2) accepted by the following FSA. Describe in words the strings which are in the language.



8. Show that if we make a change in the following figure, making  $q_3$  a nonfinal state and making  $q_0, q_1, q_2$  final states, the resulting FSA accepts  $\bar{L}$  where the original FSA accepts  $L$ .

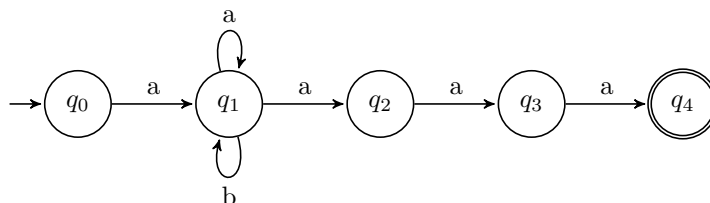


9. Is this true in general?

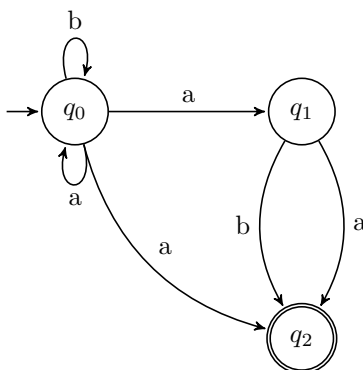
### Lecture 3

10. Convert each of the following NDFAs into equivalent DFAs. Make sure you follow the steps given in lectures, and that these are clearly recorded: inspecting the N DFA and then trying to produce an equivalent DFA may work for simple examples but is unlikely to be successful for larger examples!

(a)



(b)



(c)

