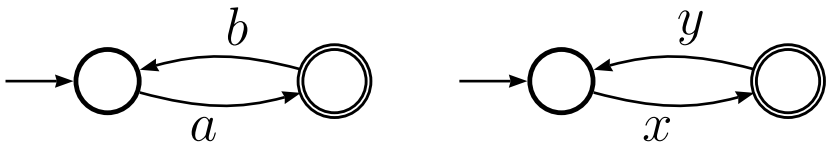
Exercise sheet 1: Grammars and automata

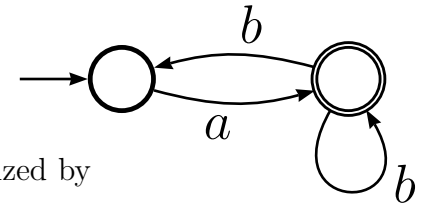
1. Find a finite automaton for each language over the alphabet $\{0, 1\}$
   (a) $\{00\}$
   (b) $\{0, 1010, 110, 001\}$
   (c) {All the strings starting and ending with 1}
   (d) {Strings with at least two consecutive zeros}
   (e) {Strings ending with 00 or 11}
   (f) {Strings with at least two equal consecutive symbols}
   (g) {Strings starting with 1 and ending with 11}
   (h) {Strings not containing the substring 001}
   (i) {Strings with an even number of zeros}
   (j) {Strings with an even number of zeros and an odd number of ones}

2. Draw a diagram of an automaton recognizing the union of the recognized languages of the following automata:

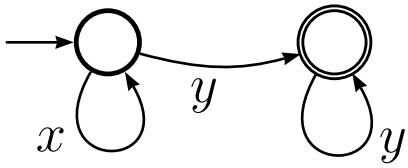


3. String concatenation is the operation of joining two character strings end-to-end. For example, the strings "snow" and "ball" may be concatenated to give "snowball". We write $M \circ N$l to represent the concatenation of the word M with the word N. Language concatenation is the concatenation of all the words in one language with the words in the other. Notice that $L_1 \circ L_2 \neq L_2 \circ L_1$.

   Draw a diagram of an automaton recognizing the concatenation of the language recognized by



   with the language recognized by



4. Given the alphabet $\{a, b, c\}$, find an automaton for each language.
   (a) {Strings with a number of b being a multiple of 3 and no starting with a}
   (b) {Strings having at most two consecutive b and not ending with c}
   (c) {Strings with an even number of a and odd number of b}
   (d) {Strings ending with c}
   (e) {Strings with an even number of a and odd number of b and ending with c}

5. Find a regular grammar for each language of exercises 1 and 4.

6. Find a regular grammar for each automaton of exercises 2 and 3.