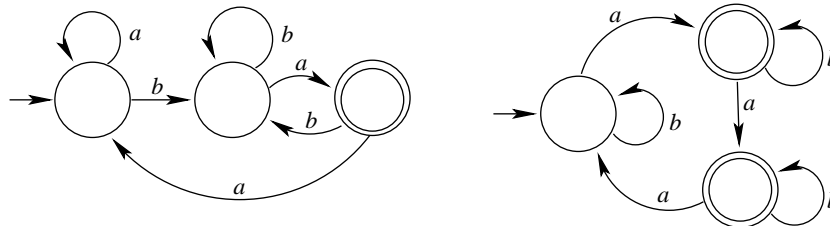


1. Describe the following languages as regular expressions:
 - (a) $\{w \in \{a, b\}^* \mid w \text{ contains exactly two } as\}$,
 - (b) $\{w \in \{a, b\}^* \mid w \text{ contains at least two } as\}$,
 - (c) $\{w \in \{a, b\}^* \mid w \text{ contains an even number of } as\}$.
2. Describe the following languages as regular expressions:
 - (a) $\{w \in \{a, b\}^* \mid w \text{ contains the substring } aa \text{ or } bb\}$,
 - (b) $\{w \in \{a, b\}^* \mid w \text{ does not contain the substring } aa \text{ nor } bb\}$,
 - (c) $\{w \in \{a, b\}^* \mid w \text{ contains the substrings } ab \text{ and } ba \text{ (which can overlap)}\}$,
3. (a) Following the construction of Theorem 1.55, give the NFA corresponding to the expression $(a \cup b)^*a$.
 (b) Following the construction of Theorem 1.39, give the equivalent DFA.
4. (a) Give a DFA for examining whether the input binary string contains at least twice the substring 11; the substrings may overlap.
 (b) Describe language recognized by the DFA as a regular expression.
5. Following the construction of Theorem 1.60, give the regular expressions corresponding to the following automata:



6. Give the regular expressions describing the language of the following automaton:

