Revised on 5/13 to correct a typo in one of the examples in 1.b

Revised on 5/11 as follows: (i) change to problem 1.b; (ii) requirement to submit solutions to part 4 using the online tool; (iii) correction to diagram of DFA in problem 4.b

This homework is due on May 16, by start of class, 12:50pm. Write each solution on a different sheet of paper, and put your name and student ID on each page. You can turn in the homework solutions for part 3 in the CS103 drop box in Gates, by emailing it to `cs103-spr1314-hw@lists.stanford.edu`, or turning it in in class.

Note: Please submit your solutions using the DFA/NFA online tool for parts 1 and 2 and the Regular Expressions online tool at https://www.stanford.edu/class/cs103/cgi-bin/simpleregex/edit.php for part 4. No credit will be given for solutions that do not use the online tool as it allows us to automate our grading. It also lets you easily test your automata against any inputs you can come up with.

1. **Problem 1 (30 points)** Constructing DFAs

   (a) For the alphabet $\Sigma = \{0, 1\}$, construct a DFA for the language
   $L = \{w \in \Sigma^* \mid w \text{ the first and the last symbol are identical}\}$.
   To be clear, the empty string is not in the language, but all length-1 strings are in the language.

   (b) Fix the alphabet $\Sigma = \{a, b\}$. Let L be the collection of all strings which contain the same number of copies of ab and baa. Here are a few examples: the string bb is in L because it contains zero copies of ab and zero copies of baa; The string $baab$ is in L because it contains one copy of ab (ba**ab**) and one copy of baa (**baa**b); The string $abaab$ is is not in L because it contains two copies of ab (**ab**a**ab**) but only one copy of baa (a**baa**b).
   Construct a DFA for L.

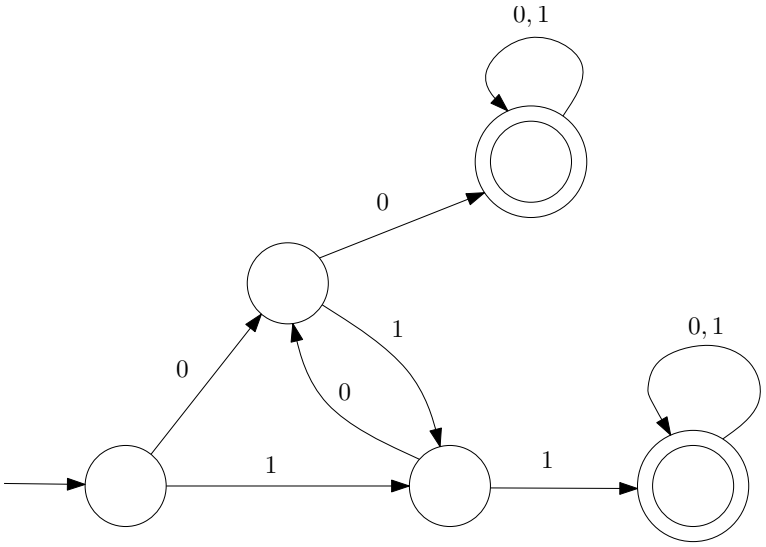
2. **Problem 2 (30 points)** NFA Construction

   (a) For the alphabet $\Sigma = \{0, 1\}$, construct an NFA for the language
   $L = \{w \in \Sigma^* \mid w \text{ contains at least one } \mathbf{0} \text{ and at least one } \mathbf{1} \}$.

(b) For the alphabet $\Sigma = \{a, b, c, d, e\}$, construct an NFA for the language $L = \{w \in \Sigma^* \mid w$ the last character of w appears nowhere else in the string, and $|w| \geq 1\}$.

3. **Problem 3 (15 points)**

Consider the following DFA over the alphabet $\Sigma = \{0, 1\}$

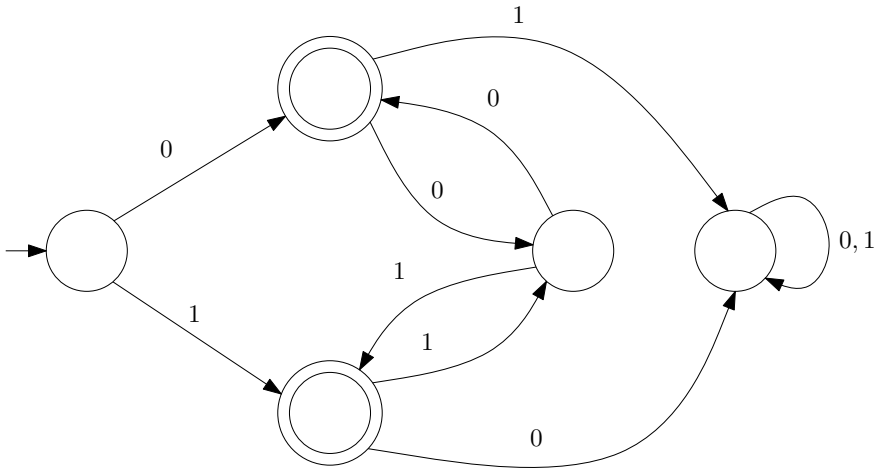


Give a one-sentence description of the language recognized by the DFA.

4. **Problem 4 (25 points)**

(a) Write a regular expression for the DFA in Problem 3.

(b)



Write a regular expression for the DFA above.