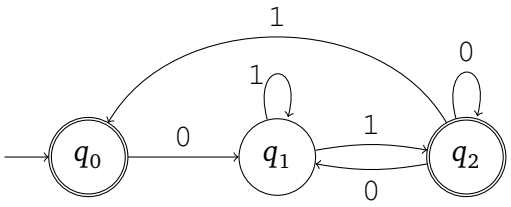
CS345/541 **Practice for Test 2** Fall 2025
MA345

Books, notes, calculators, computers and phones are *not* permitted.

1. (16%) *By using the algorithm we learned in class,* add a new accepting state to the following NFA and then remove state q_1. Draw the resulting automaton. [Exercise 4.5.1(a)]



2. (16%) Use the Pumping Lemma to show that the language $\{0^i1^j \mid i \leq j\}$ is not regular. [Exercise 5.2.1]

3. (16%) Give a CFG for each of the following languages.

   (a) The language of strings that contain the substring `001`. The alphabet is $\{0, 1\}$. [Example 6.9]

   (b) The language $\{1^i\#1^j\#1^{i+j}\}$. The alphabet is $\{1, \#\}$. [Exercise 6.3.2]

4. (8%) Consider the expression `a*a+a`. Give two different parse trees for this string in the following grammar:

$$E \to E{+}E \mid E{*}E \mid (E) \mid \mathtt{a}$$

   [Exercise 6.4.4]

5. (16%) Use the Pumping Lemma to show that the language $\{\mathtt{a}^i\mathtt{b}^j\mathtt{c}^k \mid i \leq j \leq k\}$ is not context-free. The alphabet is $\{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$. [Exercise 6.5.2]

6. (12%) Prove that the class of context-free languages is closed under union. [Exercise 6.7.1]

7. (16%) Give the state diagram of a Turing machine for the language of strings of length at least two that end in `00`. The alphabet is $\{0, 1\}$. [Exercise 7.3.1]