University of Nevada, Las Vegas Computer Science 456/656 Fall 2025
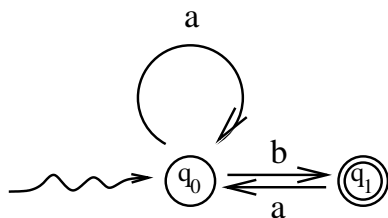## Assignment 7: Due November 18, 2025, 11:59:59 PM

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. You will receive a message from the graduate assistant, Sabrina Wallace, telling you how to turn in the assignment.
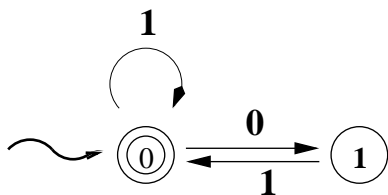
There are problems in this homework that were on the second examination. I have concentrated on problems which many students did badly. They will likely be repeated in the next examination or the final examination.
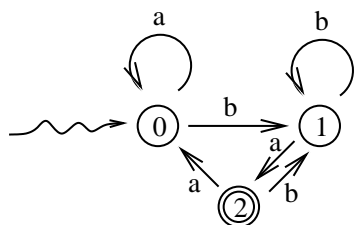
$\mathcal{P}$ means $\mathcal{P}$–TIME.

1. True/False. If the answer is not known to science at this time, enter "O" for Open.

    (a) _____ Every context-sensitive language is decidable.

    (b) _____ If a convergent sequence of rational numbers can be written by some machine, its limit must be a recursive real number.

    (c) _____ If G is a context-free grammar, there must be an LALR parser which constructs a parse tree for any $w \in L(G)$.

2. Give an example of an $\mathcal{NC}$ language which is not context-free.

3. Write a regular expression for each of these regular languages.

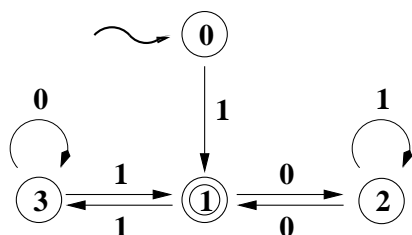   (a) The language accepted by the machine illustrated below.

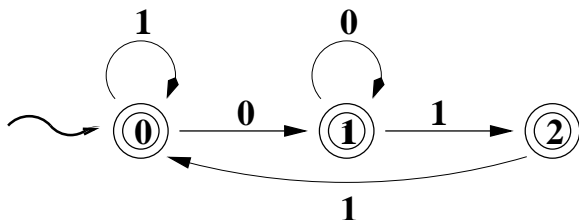   (b) The language accepted by the machine illustrated below.

(c) The language accepted by the machine illustrated below.

(d) The language accepted by the machine illustrated below.

(e) The language accepted by the machine illustrated below. (Harder then the others.)

4. Recall the "pigeonhole" principle: If $f : A \to B$ is a function, where A and B are finite and $|A| > |B|$, there must exist elements $x, y \in A$, such that $x \neq y$ and $f(x) = f(y)$. Prove the pumping lemma for regular languages.

5. State the pumping lemma for context-free languages.

6. Use the pumping lemma for context-free languages to prove that $L = \{a^n b^n c^n : n \geq 0\}$ is not context-free.

7. Give a definition of an *ambiguous* context-free grammar.

8. Give a definition of an *inherently ambiguous* context-free language. Example: $\left\{a^i b^j c^k \ : \ i = j \text{ or } j = k\right\}$ is context-free and inherently ambiguous.

9. What is Russell's paradox?