University of Nevada, Las Vegas Computer Science 456/656 Spring 2023

Assignment 3: Due Saturday February 25, 2023, 11:59 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 graduage assistant, Sandeep Maharjan, telling you how to turn in the assignment.

1. Read the handout `pdaDef.pdf` on my website or on canvas.

   (a) The PDA M_1 given as Example 1 accepts the language. $L = \{a^n b^n : n \geq 0\}$.

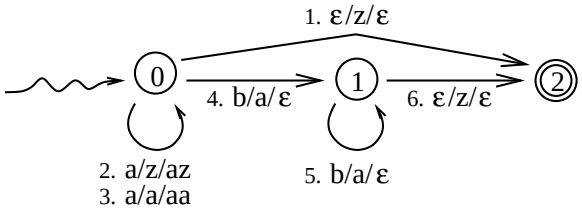


Diagram of M_1.

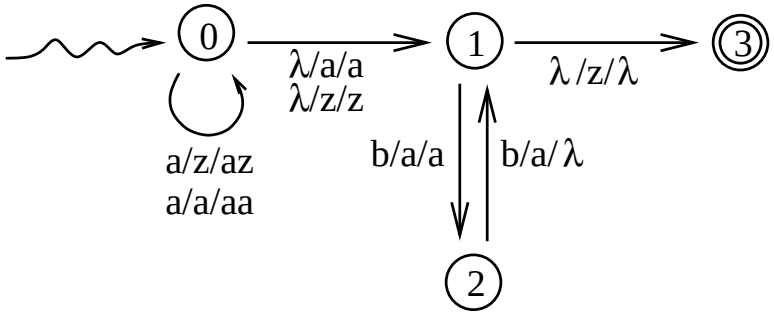
   (b) Is M_1 a DPDA? Explain your answer.

2. The PDA M_2 given as Example 2 in that handout accepts the language L of all palindromes over $\{a, b\}$.

   (a) Using the transitions given, write an accepting computation of M_2 for the input string *abbabba*.

   (b) Draw a diagram of M_2.

3. What language does this PDA accept? Hint: Instead of just staring at it, hoping for inspiration, try some strings; such as *aaaabbbb*.



4. The Dyck language, strings where left and right parentheses match in the usual way. For example, $()(()) \in L_{\text{DYCK}}$.

   Since left and right parentheses look similar, expecially if you write them in a hurry, we substitute a and b for left and right parentheses. Thus, $abaabb \in L_{\text{DYCK}}$. A more formal definition is that L_{DYCK} is the set of all strings over $\{a, b\}$ which have equal numbers of a's and b's, and every prefix of which has at least as many a's as b's.

   Design a DPDA which accepts L_{DYCK}.

5. True or False. T = true, F = false, and O = open, meaning that the answer is not known science at this time. You may need to search the handouts, or even the internet, for answers to some of these questions. Recall that "enumerable" and "countable" have the same meaning.

   (i) _____ The set of integers is countable.

   (ii) _____ The set of prime integers is countable.

   (iii) _____ The set of rational numbers is countable.

   (iv) _____ If a language L is countable, there must be machine which enumerates L.

   (v) _____ The set of real numbers is countable.

   (vi) _____ Every language is countable.

   (vii) _____ The set of all languages over the binary alphabet is countable.

   (viii) _____ The set of all decidable languages over the binary alphabet is countable.

   (ix) _____ The set of recursively enumerable languages over the binary alphabet is countable.

   (x) _____ The intersection of any two decidable languages is decidable.

   (xi) _____ The complement of any undecidable language is undecidable.

   (xii) _____ The complement of any decidable language is decidable.

   (xiii) _____ The halting problem is recursively enumerable.

   (xiv) _____ The context-free grammar equivalence problem is recursively enumerable.

   (xv) _____ Every subset of an enumerable set is enumerable.

   (xvi) _____ Every subset of a recursively enumerable set is recursively enumerable.

   (xvii) _____ There is a mathematical statement which is true but has no logical proof. (This does not mean, "No proof has been found." It means that no proof could **ever** be found.)

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