

University of Nevada, Las Vegas Computer Science 456/656 Spring 2021

Assignment 3: Due Tuesday March 2, 2021

Name: _____

You are permitted to work in groups, get help from others, read books, and use the internet. Post your answers on Canvas as instructed by the graduate assistant, Mr. Singh, by 11:59 PM on the due date.

1. True or False. 5 points each. T = true, F = false, and O = open, meaning that the answer is not known science at this time.

(a) _____ The context-free grammar equivalence problem is decidable.

(b) _____ The context-free grammar equivalence problem is $\text{co-}\mathcal{RE}$.

(c) _____ If L_1 is a regular language and L_2 is a context-free language, then $L_1 \cap L_2$ is context-free.

(d) _____ If there is a recursive reduction of L_1 to L_2 , where L_1 is an undecidable language, then L_2 must be undecidable.

(e) _____ The factoring problem is in \mathcal{P} .

(f) _____ If L is a recursive language, there must be a machine which enumerates L in canonical order.

(g) _____ If there is a machine which enumerates a language L in canonical order, then L must be recursive.

2. State the pumping lemma for regular languages.

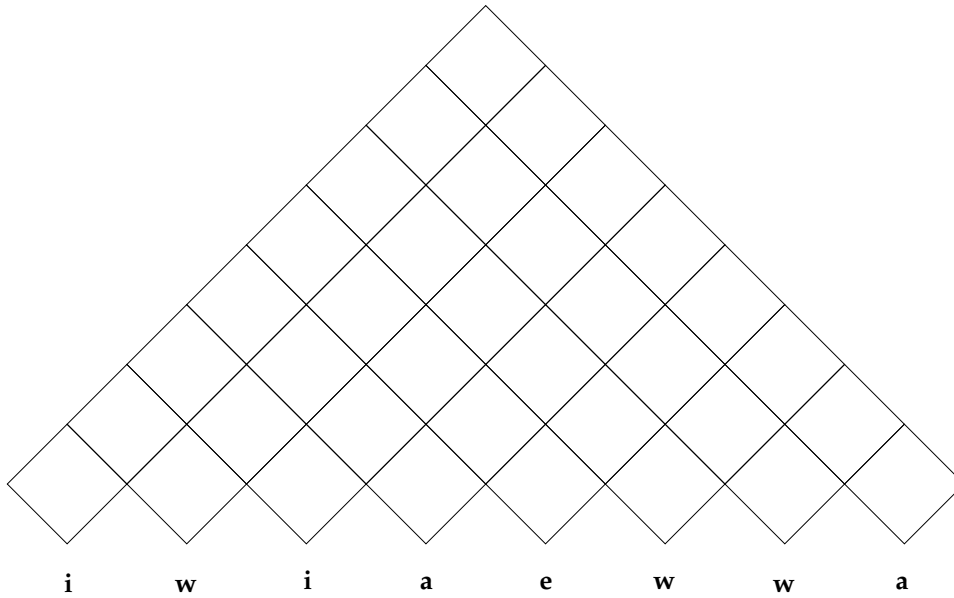
3. Use the pumping lemma to prove that the Dyck language is not regular.

4. Consider the Chomsky Normal Form grammar G given below.

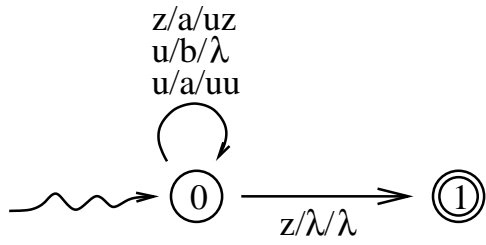
- $S \rightarrow IS$
- $S \rightarrow WS$
- $S \rightarrow XY$
- $X \rightarrow IS$
- $Y \rightarrow ES$
- $S \rightarrow a$
- $I \rightarrow i$
- $W \rightarrow w$
- $E \rightarrow e$

(a) Show that G is ambiguous by giving two different **leftmost** derivations for the string $iaea$.

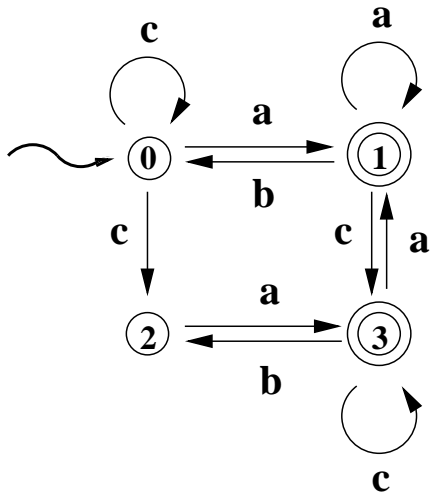
(b) Use the CYK algorithm to prove that $iwiaewwa \in L(G)$.



5. Let L be the language accepted by the PDA diagrammed below. What is L ? You can either describe L in a few words, or give a context-free grammar for L .



6. Find a minimal DFA equivalent to the NFA shown below.



7. Give a context-sensitive grammar for $\{a^n b^n c^n d^n : n \geq 1\}$

8. Fill in the following table, showing which operations are closed for each class of languages. In each box, write **T**, **F**, or **O**.

language class	union	intersection	concatenation	Kleene closure	complementation
\mathcal{NC}					
regular					
context-free					
\mathcal{P}					
\mathcal{NP}					
co- \mathcal{NP}					
recursive					
\mathcal{RE}					
co- \mathcal{RE}					
undecidable					

9. Prove that the halting problem is undecidable.