

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

Assignment 4: Due Friday October 13, 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 graduaage assistant, Sepideh Farivar, telling you how to turn in the assignment.

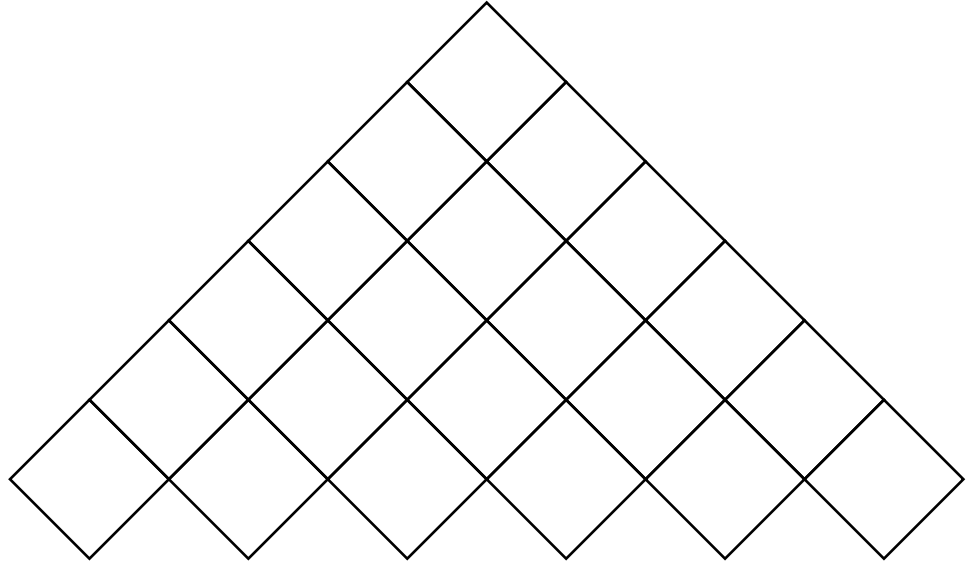
1. True or False. T = true, F = false, and O = open, meaning that the answer is not known science at this time.

I expect every student to score 100% on all these questions. Search the internet if you have to.

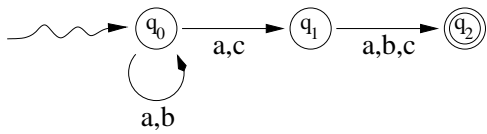
- (a) _____ All sliding block problems are \mathcal{P} -SPACE.
- (b) _____ The game RUSH HOUR is \mathcal{P} -SPACE complete.
- (c) _____ The set of binary numerals for prime numbers is a \mathcal{P} -TIME language.
- (d) _____ The prime factors of an integer can be computed in \mathcal{P} time if the integer is represented as a binary numeral.
- (e) _____ The prime factors of an integer can be computed in \mathcal{P} time if the integer is represented as a unary numeral.
- (f) _____ Every PDA is equivalent to some DPDA.
- (g) _____ Every language is countable.
- (h) _____ The set of binary languages is uncountable.
- (i) _____ If $\mathcal{P} = \mathcal{NP}$, RSA encryption can be broken in polynomial time.
- (j) _____ Any context-free language over the unary alphabet is regular.
- (k) _____ The complement of any decidable language is decidable.
- (l) _____ The complement of any undecidable language is undecidable.
- (m) _____ Boolean satisfiability is \mathcal{NP} -complete.
- (n) _____ If L is any \mathcal{NP} language, there is a \mathcal{P} time reduction of L to Boolean satisfiability.
- (o) _____ The language of all contradictions is $\text{co-}\mathcal{NP}$.
A *contradiction* is a Boolean expression if no assignment to the variables makes it true. For example, “ x and not x ” is a contradiction.
- (p) _____ \mathcal{P} -TIME = \mathcal{P} -SPACE.
- (q) _____ There is a mathematical statement which is true but has no proof.

2. Let G be the CNF grammar given below. Use the CYK algorithm to show that the $iaewia \in L(G)$.

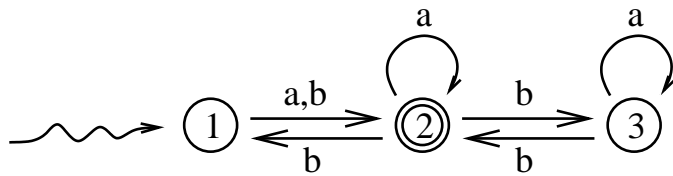
1. $S \rightarrow a$
2. $S \rightarrow WS$
3. $W \rightarrow w$
4. $S \rightarrow IS$
5. $S \rightarrow AB$
6. $A \rightarrow IS$
7. $B \rightarrow ES$
8. $E \rightarrow e$
9. $I \rightarrow i$



3. Give a grammar, with at most 2 variables, for the language accepted by the following NFA.



4. Give a regular expression for the language accepted by the following NFA



Which of the following strings are in the language described by the regular expression

$$(a + bc^*)(de^*(d + \lambda) + fg + h)^*$$

- $abcdefgh$
- $bdh.fghde$
- $deedhh$

5. Let L be the language consisting of all strings over $\{a, b\}$ which have equal numbers of each symbol. Give a CFG for L .

6. Let $L = \{a^n b^n c^n : n \geq 0\}$. As I mentioned in class, L is not context-free. Prove that the complement of L is context-free.

7. We say a set S is *proper* if $S \notin S$. Let P be the set of all proper sets. Is P proper? (Hint: Bertrand Russell.)