

University of Nevada, Las Vegas Computer Science 456/656 Spring 2022

Assignment 3: Due Monday March 7 2022

Name: _____

You are permitted to work in groups, get help from others, read books, and use the internet. You will receive a message from our graduate assistant telling you how to turn in the assignment.

1. Which of the following Boolean expressions are satisfiable? Show the truth tables.

(a) $x + !x$

(b) $x * !x$

(c) $(x + y) * (!x + !y)$

(d) $!(x \Rightarrow y) \Rightarrow !y$

(e) $!(z \Rightarrow (!x * y))$

(f) $((x * !y) * !z) * (x \Rightarrow (y + z))$

2. Draw a diagram for a DPDA which accepts the language over $\{a, b\}$ of all strings with equal numbers of a 's and b 's. Assume that the input string contains the end-of-file symbol \$.

3. Fill in the matrix below. Each answer is T or F, not O.

- A Known to be \mathcal{P} -TIME.
- B Known to be \mathcal{NP} .
- C Known to be \mathcal{NP} -complete.
- D Known to be $co - \mathcal{NP}$.
- E Known to be \mathcal{P} -SPACE.
- F Known to be decidable.
- G Known to be undecidable.

	A	B	C	D	E	F	G
Regular grammar membership	T	T	F	T	T	T	F
CF grammar membership							
CF grammar equivalence							
SAT	F	T	T	F	T	T	F
3-SAT							
2-SAT							
4-SAT							
Independent set							
Partition							
Knapsack							
Rush Hour							
co-Rush Hour							
Polygon placement							
Mover's problem							
Factoring							
Traveling Salesman							
DFA equivalence							
NFA equivalence							
Regular expression equivalence							
Halting problem							
Primality							

Definitions of some problems and languages.

- Polygon placement. A given set of polygons can be placed in a given bigger polygon without overlap.
- Mover's problem. A given set of polygons, starting outside the room, can be moved into a room with a door, such that no overlap is permitted at any time during the move.
- Factoring. Given binary numerals $\langle n \rangle$ and $\langle a \rangle$, n has a prime factor greater than a .
- Rush Hour. Given a configuration of the cars in a parking lot, the red car can be moved out.
- co-Rush Hour. Given a configuration of the cars in a parking lot, the red car cannot be moved out.
- Primality. A given binary numeral represents a prime number.

4. The following CF grammar generates all non-empty strings over $\{a, b\}$ which have equal numbers of a 's and b 's. However, it is not CNF. Give a CNF grammar for the same language.

$$S \rightarrow aSbS$$

$$S \rightarrow abS$$

$$S \rightarrow aSb$$

$$S \rightarrow ab$$

$$S \rightarrow bSaS$$

$$S \rightarrow bSa$$

$$S \rightarrow baS$$

$$S \rightarrow ba$$

5. Use the CYK algorithm to decide whether the string $iwiaewiaea$ is generated by this CNF grammar by filling in the diagram below. Be sure to complete every cell.

1. $S \rightarrow a$

2. $S \rightarrow WS$

3. $S \rightarrow IS$

4. $S \rightarrow XY$

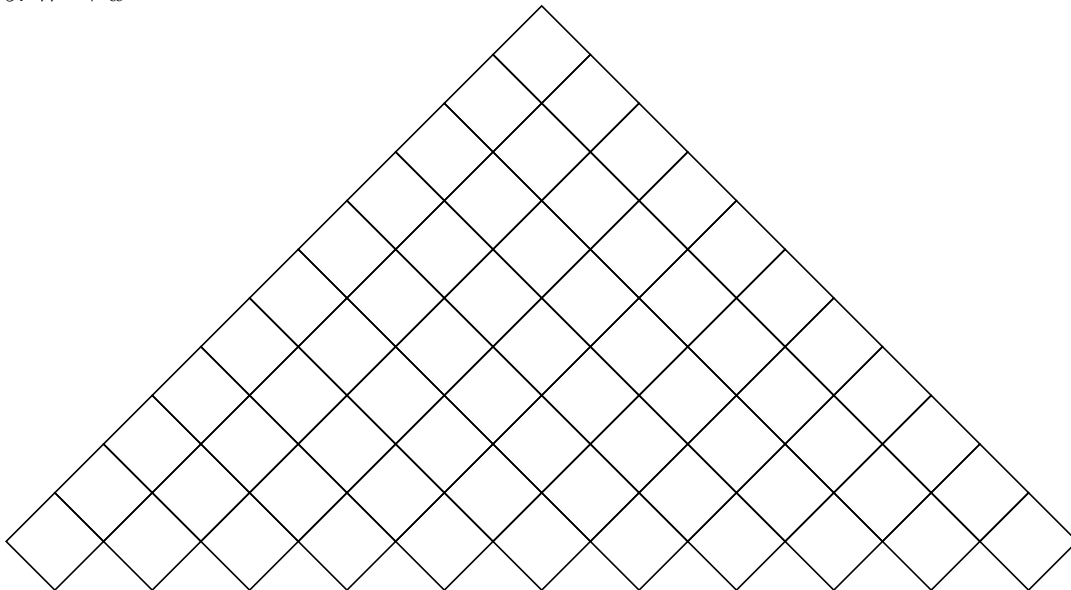
5. $X \rightarrow IS$

6. $Y \rightarrow ES$

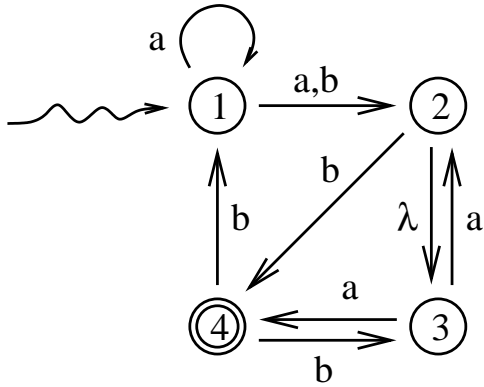
7. $I \rightarrow i$

8. $E \rightarrow e$

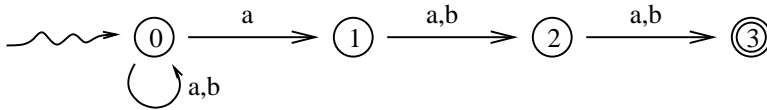
9. $W \rightarrow w$



6. Give a regular grammar for the language accepted by the following NFA.



7. Find a DFA equivalent to the following NFA. I was a mistake to give you problem 7 on the homework, since its solution is too complex. Insead, I am replacing it with a shorter version, below. The DFA should have 2^4 states (instead of 2^5 as before) but only half of those are reachable, so the resuling minimal DFA has 8 states.



8. Give a \mathcal{P} -TIME reduction of the subset sum problem to the partition problem.