

Theory of Computation

Undecidability & Decidability II

DPP 02

[MSQ]

1. Let $L = \{(X) \mid \text{is a DFA and } L(X) \text{ is a infinite language}\}$; where (X) represents the illustration of the deterministic finite automata (DFA).

Then which of the statement is/are correct?

- (a) It is recognizable by Turing.
- (b) Its complement is recognizable by Turing.
- (c) It is Turing decidable (recursive).
- (d) It is context-free but not regular.

[MSQ]

2. Which of the following statement is/are incorrect?
- (a) If L is CFL and A is DCFL then $L-A$ is CFL.
 - (b) The subset of a decidable language is always decidable.
 - (c) If L and A are DCFL then $(\bar{L} \cap \bar{A})$ is CFL.
 - (d) None of the above are incorrect.

[MCQ]

3. Consider some language $P \in \{0,1\}^*$ reduces to another language $Q \in \{0,1\}^*$. Which of the following statement is true?
- (a) P is decidable.
 - (b) A Turing machine that recognizes P can be used to construct a Turing machine that recognizes Q .
 - (c) If Q is decidable then P is decidable.
 - (d) If P is decidable then Q is decidable.

[MCQ]

4. Consider the following statement:
- S₁:** In phrase structured language, membership problem is semi decidable.
- S₂:** In context-free languages, membership problem can be solved in polynomial time.
- (a) Only S_1 is true
 - (b) Only S_2 is true
 - (c) Both S_1 and S_2 are true
 - (d) Neither S_1 nor S_2 is true

[MCQ]

5. Consider the following statements:
- S₁:** For a decidable language X , X^R may or may not be decidable. (X^R represents the reverse of language X).
- S₂:** If X is not recursively enumerable then \bar{X} must be recursively enumerable.
- (a) Only S_1 is true
 - (b) Only S_2 is true
 - (c) Both S_1 & S_2 are false
 - (d) Both S_1 & S_2 are true

[MCQ]

6. Consider the following statements about Turing machine.
- S₁:** If there is some Turing machine that accepts every string in L and rejects every string not in L then L is decidable.
- S₂:** If there is some Turing machine that accepts every string in L and either rejects or loops on every string not in L , then L is semi-decidable or computably enumerable (CE).
- (a) Only S_1 is true
 - (b) Only S_2 is true
 - (c) Both S_1 & S_2 are true
 - (d) Neither S_1 nor S_2 is true

[MSQ]

7. Which of the following is/are decidable properties of context-free?
- (a) for context-free grammar X , find if string $w \in X$.
 - (b) for context-free grammar X , find if $L(X) = \emptyset$.
 - (c) for context-free grammar X , find if $L(X)$ is infinite.
 - (d) none of the above are decidable properties of context free.

[MCQ]

8. Consider the following statements:

S₁: There is language for which no TM available.
Then surely language will be Not RE.

S₂: Language is undecidable if and only there is no
HTM available for language.

Which of the following is incorrect?

- (a) S₁ only.
- (b) S₂ only.
- (c) Both S₁ and S₂.
- (d) Neither S₁ Nor S₂.



Answer Key

- | | |
|--------------|--------------|
| 1. (a, b, c) | 5. (c) |
| 2. (a, b, c) | 6. (c) |
| 3. (c) | 7. (a, b, c) |
| 4. (c) | 8. (d) |



Hint & Solutions

1. (a, b, c)

$L \rightarrow$ regular

- (a) True: $\text{Regular} \subset \text{recursively enumerable}$.
 (b) True: $\overline{\text{regular}} = \text{regular}$ and $\text{regular} \subset \text{RE}$.
 (c) True: $\text{regular} \subset \text{recursive}$.

2. (a, b, c)

- (a) False: CFL is not closed under intersection.
 (b) False: Σ^* is decidable but it has undecidable subsets ($a^p \rightarrow P$ is not prime)
 (c) False: same as option a
 Hence, a, b, c are false

3. (c)

If P is reduced to Q then properties of Q are possessed by P hence, answer is 'C'.

4. (c)

- S₁:** True \rightarrow membership problem in unrestricted (\therefore Phrase is unrestricted) is semi-decidable
S₂: True \rightarrow using CYK algorithm, membership problem in context-free language can be solved in polynomial time.

5. (c)

- S₁:** False \rightarrow On input 'P', the algorithm for X^R , will reverse 'P' and then run the algorithm for X.
S₂: False \rightarrow There are language like REGULAR which are not R.E. and their complement is also not RE.

6. (c)

- If there is some Turing machine that accepts every string in L and rejects every string not in 'L' then 'L' is decidable.
- If there is some Turing machine that accepts every string in L and either rejects or loops on every string not in L then L is semi decidable or computably enumerable(CE).

7. (a, b, c)

- There exists a membership algorithm for CFG so, it is decidable.
- Context-free emptiness problem is decidable.
- The context-free finiteness problem is decidable.

8. (d)

Both statements are correct.
 So, Correct option is (d).



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