Computer Science 456/656 Fall 2018: Assignment 6. Due October 7, 2018

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

2. ______ The regular expression equivalence problem is decidable.

3. ______ The C++ program equivalence problem is decidable.

4. ______ Every language generated by an unambiguous context-free grammar is accepted by some DPDA.

5. ______ The language $\{a^n b^n c^n d^n \mid n \geq 0\}$ is recursive.

6. ______ Let L be the language over $\{a, b, c\}$ consisting of all strings which have more a's than b's and more b's than c's. There is some PDA that accepts L.

7. ______ The context-sensitive membership problem is decidable.

8. ______ The language $\{a^n b^n \mid n \geq 0\}$ is context-free.

9. ______ The language $\{a^n b^n c^n \mid n \geq 0\}$ is context-free.

10. ______ The language $\left\{a^i b^j c^k \mid j = i + k\right\}$ is context-free.

11. ______ The intersection of any three regular languages is context-free.

12. ______ Every problem that can be mathematically defined has an algorithmic solution.

13. ______ The intersection of any two undecidable languages is undecidable.

14. ______ If L is a context-free language over an alphabet with just one symbol, then L is regular.

15. ______ The set of strings that your high school algebra teacher would accept as legitimate expressions is a context-free language.

16. ______ The language consisting of all strings over $\{a, b\}$ which have more a's than b's is context-free.

17. ______ Every language generated by a context-sensitive grammar is recursive.

18. ______ Every language generated by a general grammar is recursive.

19. ______ Every language accepted by a non-deterministic machine is accepted by some deterministic machine.

20. ______ The problem of whether two given context-free grammars generate the same language is decidable.

21. ______ The problem of whether a given string is generated by a given context-free grammar is decidable.

22. ______ If G is a context-free grammar, the question of whether $L(G) = \emptyset$ is decidable.

23. ______ If G is a context-free grammar, with terminal alphabet Σ, the question of whether $L(G) = \Sigma^*$ is decidable.

24. ______ The set of all fractions whose values are less than π is decidable.[1]

[1] A *fraction* is a string, defined to be a non-empty string of decimal digits followed by a slash followed by a non-empty string of decimal digits, such as "3/42"

25. ______ For any two languages L_1 and L_2, if L_1 is undecidable and there is a recursive reduction of L_1 to L_2, then L_2 must be undecidable.

26. ______ For any two languages L_1 and L_2, if L_2 is undecidable and there is a recursive reduction of L_1 to L_2, then L_1 must be undecidable.

27. ______ Every bounded function from integers to integers is computable.[2]

28. ______ Let $\mathcal{RE}$ be the class of all recursively enumerable languages. If L is in $\mathcal{RE}$ and L is also in co-$\mathcal{RE}$, then L must be decidable.

29. ______ Every language is enumerable.

30. ______ If a language L is undecidable, then there can be no machine that enumerates L.

31. ______ If a language L is is enumerated in canonical order by some machine, then L is decidable.

32. ______ There exists a mathematical proposition that can be neither proved nor disproved.

33. ______ There is an uncomputable function which grows faster than any computable function.

34. ______ Let U be a universal Turing machine. Then U cannot be finitely described, that is, $\langle U \rangle$ does not exist.

A real number x is said to be *recursive*, or *computatble*, if there is there is a program that computes the i^{th} decimal digit of x as a function of i.

35. ______ Every algebraic real number is computable. `https://en.wikipedia.org/wiki/Algebraic_number`

36. ______ π is computable.

37. ______ Every real number is computable.

38. ______ Given any two Turing machine descriptions $\langle M_1 \rangle$ and $\langle M_2 \rangle$, it is possible to decide whether M_1 is equivalent to M_2,

39. ______ The context-free grammar equivalence problem is in the class co-$\mathcal{RE}$.

40. ______ The 0/1 factoring problem[3] is decidable.

41. ______ Suppose a machine M can compute something within t steps. Then there must be a Turing machine that can compute the same thing within t steps.

[2] A function f from integers to integers is defined to be *computable* if the corresponding function on numerals is computable.

[3] An instance of that problem is: Given two integers n and a, does there exist a divisor of n which is greater than 1 and less than a?