University of Nevada, Las Vegas Computer Science 456/656 Spring 2024

Assignment 4: Due Saturday March 2, 2024, 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 graduage assistant, Zachary Edwards, telling you how to turn in the assignment.

Recall that there is no such thing as the "set" of regular languges, only the "class" of regular languages. But if we pick an alphabet, we can have sets. For example, we can talk about the set of binary languages, the set of lenguages over the binary alphabet $\{0, 1\}$.

1. True or False, write T or F. If the answer is unknown to science at this time, write O, for Open.

   (a) ________ If L is both $\mathcal{RE}$ and co-$\mathcal{RE}$, then L is decidable.

   (b) ________ SAT is decidable.

   (c) ________ 2-SAT is $\mathcal{P}$–TIME.

   (d) ________ The binary numeral primality problem is $\mathcal{P}$–TIME.

   (e) ________ The binary numeral factorization problem is $\mathcal{P}$–TIME.

   (f) ________ $\mathcal{NP} \subseteq \mathcal{P}$–SPACE.

   (g) ________ Every context-sensitive language is decidable.

   (h) ________ The complement of every undecidable language is undecidable.

   (i) ________ The halting problem is $\mathcal{RE}$.

   (j) ________ The context-free grammar equivalence problem is $\mathcal{RE}$.

   (k) ________ Every undecidable language is either $\mathcal{RE}$ or co-$\mathcal{RE}$.

   (l) ________ There are countably many binary languages.

   (m) ________ Every language has a canonical order enumeration.

   (n) ________ For any real number x, the problem of whether a given rational number is less than x is decidable. (A rational number is a number that can be written as $\frac{p}{q}$, where p and q are integers.)

2. State the pumping lemma for context-free languages correctly.

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

4. Prove that the halting problem is undecidable.

5. Assuming that the subset sum problem is $\mathcal{NP}$–complete, prove that the partition problem is $\mathcal{NP}$–complete.

6. Assuming thqt 3-SAT is $\mathcal{NP}$–complete, prove that the independent set problem is $\mathcal{NP}$–complete.