CSCI 432/532, Spring 2024

Homework 5

Due Tuesday, February 20, 2024 at 9pm Mountain Time

Submission Requirements

- Type or clearly hand-write your solutions into a PDF format so that they are legible and professional. Submit your PDF on Gradescope.
- Do not submit your first draft. Type or clearly re-write your solutions for your final submission.
- You may work with a group of up to three students and submit ***one single document*** for the group. Just be sure to list all group members at the top of the document.
- Each homework will include at least one fully solved problem, similar to that week's assigned problems, together with the rubric we would use to grade this problem if it appeared in an actual homework. These model solutions show our recommendations for structure, presentation, and level of detail in your homework solutions. (Obviously, the actual *content* of your solutions won't match the model solutions, because your problems are different!) Note: this copy currently does not have any solved problems, but will updated with solved problems soon.

Academic Integrity

Remember, you may access ***any*** resource in preparing your solution to the homework. However, you must

- write your solutions in your own words, and
- credit every resource you use (for example: "Bob Smith helped me on problem 2. He took this course at UM in Fall 2020"; "I found a solution to a problem similar to this one in the lecture notes for a different course, found at this link: www.profzeno.com/agreatclass/lecture10"; "I asked ChatGPT how to solve problem 1 part (c); "I put my solution for problem 1 part (c) into ChatGPT to check that it was correct and it caught a missing case and suggested some grammer fixes.") If you use the provided LaTeX template, you can use the `sources` environment for this. Ask if you need help!

Grading Rubrics

For the Turing machine description:

TM rubric. 10 points =

+ 2 for an English description of a Turing machine, regardless of correctness.

+ 6 for correctness.

+ 2 for an appropriate mix of detail and high-level intuition.

For the Turing machine simulation problem:

TM simulation rubric. 10 points =

+ 2 for an English description of how to simulate a standard Turing machine with the new type of Turing machine or how to prove that a standard Turing machine can't be simulated with the new type of Turing machine.

+ 6 for correctness.

+ 2 for an appropriate mix of detail and high-level intuition.

For the undecidability problem:

Undecidability proof rubric. 10 points =

+ 4 for a correct wrapper Turing machine.

+ 6 for a correct proof by contradiction.

1. Describe (as in the problem session solutions—note that you do *not* need to give a full specification of states, transitions, etc.) a Turing machine that decides the following language: $\{ww : w \in \{0, 1\}^*\}$.

2. A ***Turing machine with stay put instead of left*** is similar to an ordinary Turing machine, but the transition function has the form $\delta : Q \times \Gamma \to Q \times \Gamma \times \{R, S\}$. At each point, the machine can move its head right or let it stay put in the same position.

   (a) Show that this Turing machine variant is *not* equivalent to a standard Turing machine.

   (b) What class of languages do these machines recognize?

3. Consider the language $\textsc{NeverReject} = \{\langle M \rangle : \textsc{Reject}(M) = \emptyset$; that is, the set of all (encodings of) Turing machines that do not reject any input. Prove that $\textsc{NeverReject}$ is undecidable.