INSTRUCTIONS

Homework solutions should be neatly written or typed and submitted through Gradescope. No work can be accepted outside of this system, and no late work will be accepted. Please ensure that your submission is legible (neatly written and not too faint) or your homework may not be graded. You may update your submission as many times as you’d like up to the deadline. Only the most recent submission will be graded.

Thirty problems from homework assignments will be graded randomly throughout the quarter. You will not know in advance which problems, if any, will be graded on each assignment.

You may consult your textbook, class notes, lecture slides, instructors, TAs, and tutors for help with homework. You may also discuss homework questions with classmates, but you may not share written work with classmates. You must write up your solutions alone, in your own words. The assignments have been developed to facilitate your learning and to provide a method for fairly evaluating your knowledge and abilities, not the knowledge and abilities of others. To facilitate learning, you are authorized to discuss assignments with others; however, to ensure fair evaluations, you are not authorized to view or share written work with another person, or to write your submission in collaboration with another person. You should not look for answers to homework problems in other texts or sources, including the internet.

Do not post about homework questions on Piazza. For help with homework, please consult the course textbook, lecture slides, class notes, and podcasts, or come visit us in office hours.

READING: Sipser 4.2
1. Suppose you are given a Turing machine \( M \) (not necessarily a decider), a string \( w \), and a magic genie. You can ask the magic genie whether a certain Turing machine halts on a certain input string, and the genie will magically give you the correct yes/no answer. You can ask the genie as many such questions as you like, about any Turing machine and any string.

Describe a strategy you can use to decide whether \( M \) accepts \( w \). Remember to decide means to say with certainty that \( M \) accepts \( w \) or that \( M \) does not accept \( w \).

Note: In class, we showed that \( A_{TM} \) is undecidable, which means it cannot be decided (without magic) whether a Turing machine \( M \) accepts a string \( w \). This means we must use a magic genie in order to be able to answer this question.

2. Suppose you are given a Turing machine \( M \) (not necessarily a decider), a string \( w \), and a (different) magic genie. You can ask the magic genie whether a certain Turing machine accepts a certain input string, and the genie will magically give you the correct yes/no answer. You can ask the genie as many such questions as you like, about any Turing machine and any string.

Describe a strategy you can use to decide whether \( M \) halts on \( w \). Remember to decide means to say with certainty that \( M \) halts on \( w \) or that \( M \) does not halt on \( w \).

Note: Our magic genie decides \( A_{TM} \), an undecidable language. This genie really is magical.