COMP 314 Homework Assignment J

Note: Solutions will not be provided for this assignment.

- **Exercise J** (120 points) Complete only ONE of the following projects. Solutions will be graded generously. Attempts that show clear evidence of 2–3 hours' solid effort will receive a high score. The emphasis of this question is on doing something interesting and creative with the material we have learned this semester. You may complete this project in a team of two or on your own. *You are encouraged to use all appropriate AI tools for completing this project, but your submission should still provide evidence of 2–3 hours' of human work. Your submission should briefly describe which parts of your project were completed by AI and which parts required investment of human time.*
  - Use JFLAP to create a Turing machine that does something interesting. Submit a diagram of your machine and a description of what it does. If you use AI to create the machine itself, spend some time experimenting with it and report on the results. Consider creating some small variants manually and describe those experiments too.
  - Choose one of the problems we have studied this semester that is believed to require super-polynomial time. (Examples include FACTOR and TSP.) Run some practical experiments showing that a simple program for your chosen problem really does require exponential time. Make some concrete estimates of how long it would take your own computer to solve large instances. (e.g. Approximately how long would it take your program, running on your computer, to find the factors of a 1000-digit number in the worst case? Or, how long would it take to find the shortest Hamilton cycle in a 1000-vertex graph?) Submit a 1–2-page description of your experiments.
  - Write a Python program that converts an nfa into a dfa. Submit a printout of your program. Remember that if you use AI write the code, you should spend some human time experimenting with it, creating variants, and reporting on them.
  - Implement a challenging reduction in Python. Choose one of Karp's reductions, or ask the instructor for other suggestions. Remember that if you use AI write the code, you should spend some human time experimenting with it, creating variants, and reporting on them.
  - If you have any other idea for a creative project, feel free to suggest it to me. I will probably say yes.
- (Ungraded) In your own words, describe the difference between *circular* and *circle-free* machines, as defined by Alan Turing in his 1936 paper.
- (Ungraded) Give examples of statements that are (i) true but unprovable and (ii) provable but false. You may use the logical systems described in the textbook but do not copy specific examples directly from the book.
- (Ungraded) Is it possible to write a program that recognizes strings that are provable in Peano arithmetic? In your own words, give reasons for your answer, without necessarily giving a rigorous mathematical proof.
- (Ungraded) In your own words, describe one of the reductions used by Richard Karp in his 1972 paper.

Total points on this assignment: 120