Homework 8

Due midnight, Wednesday, 4/3/2019

You may work on this homework with one or two partners as you like. If you work with partners just turn in a single write-up of the solutions.

Please submit your homework solutions to gradescope as usual.

1. (0) **Academic Honesty Declaration**

2. (5) **Understanding TM's**

   Problem 17.1b from Rich page 407.

3. (10) `Computing with TMs`

   Problem 17.3c from Rich, page 408.

4. (20) **Computation vs. Recognition**

   Problem 17.12 from Rich, page 409. Note that you are not giving formal descriptions of TMs in this problem – instead you are describing informally (but precisely) how they would work.

5. (5 points) **Variants of TM's**

   Another useful variant of a Turing machine has a single tape, but two reading heads. That is, the two reading heads can be looking at two cells of the same tape at any time. Thus one of these turing machines makes a transition based on the current state and the contents under each of the two read heads. It then writes something under each read head and moves each of the heads.

   (a) Give a formal definition of a two head Turing machine, define a configuration of this machine, and give the definition of $\vdash_M$ for this machine.

   (b) Describe informally a two-head Turing machine that decides the language $L = \{ww \mid w \in \{a, b\}^*\}$.

6. (10) **Closure Properties of TMs**

   Show that the decidable languages are closed under intersection and set difference. I.e., if L_1 and L_2 are decidable, then so are $L_1 \cap L_2$ and $L_1 - L_2$. (Recall that if a language is decidable there is a TM that is guaranteed to halt on any input and give an answer of yes or no – determined by whether the final state is y or n – that tells whether the input is in the language or not.)