CS46 Homework 6

This homework is due at 11:59PM on Thursday, April 8. **This homework has three parts; this LaTeXfile is only part 1.**

For this homework, you will work with a partner. It's ok to discuss approaches at a high level with other students, but most of your discussions should just be with your partner. Your partnership's write-up is your own: do not share it, and do not read other teams' write-ups. If you use any out-of-class references (anything except class notes, the textbook, or asking Joshua), then you **must** cite these in your post-homework survey. Please refer to the course webpage or ask me any questions you have about this policy.

The main **learning goals** of this homework is to work with and think about the power of Turing Machines and to connect theory to practice by implementing a CFG recognizer and by designing a CFG-based Twitter bot..

Part 1. Your solutions to this part should be written using LaTeX and submitted using **github** as a file called **hw6.tex**. Write clear and unambiguous Turing machine descriptions. Your explanation of *why* and *how* a Turing machine works should be separate from your description of that Turing machine. Give the Turing machine description first, then explain it separately.

1. **Another Turing machine extension.** Let's consider an extension which gives a Turing machine tape which is infinite in both directions. We keep everything else the same, and specify that the input string is given on a tape which is blank everywhere else, with the read/write head on the first character of the input. So the starting configuration on input w in state q_0 looks like:

   $$\cdots \sqcup \sqcup q_0 w \sqcup \sqcup \cdots$$

   Notice that now the tape head can *always* move left, no matter where it is.

   Prove that Turing machines with doubly infinite tape are no more powerful than usual Turing machines (that is, with singly-infinite tape). Your proof should be formal (so if you are building a Turing machine, you must give a description for how to build all of the transitions.)

2. **Closure properties.** Show that the collection of Turing-recognizable languages is closed under the operations of:

   (a) union

   (b) concatenation

   (c) Kleene star

   (d) intersection

Parts 2 and 3 of this homework go in other files. Make sure you have committed and pushed all your files when you submit.