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 2.2
1. Draw the state diagram for a PDA that recognizes the language

\[ L = \{ w \in \{a, b\}^* \mid w \text{ has an equal number of } a's \text{ and } b's \} \]

based on the informal description given below.

Informal description of PDA:
Push a special symbol to denote an empty stack. The PDA uses its states to keep track of how the number of \( a \)'s compares to the number of \( b \)'s in the portion of the input string that has been read. The number of \( a \)'s can be equal to, less than, or greater than the number of \( b \)'s. When there are an equal number of \( a \)'s and \( b \)'s, the stack is empty. When there are more \( a \)'s than \( b \)'s, the stack contains only \( a \)'s, in a quantity equal to the number of \( a \)'s minus the number of \( b \)'s in the input so far. So the stack keeps track of how many more \( a \)'s than \( b \)'s there are. Similarly, if there are more \( b \)'s than \( a \)'s in the input so far, the stack keeps track of the number of excess \( b \)'s. The PDA should accept when the stack is empty and the entire input string has been read. This means that there are an equal number of \( a \)'s and \( b \)'s in the input string. Otherwise, it should reject.

2. Give an informal description (similar to that given in the previous problem) of a PDA that recognizes the language

\[ L = \{ 0^p1^q2^r \mid p, q, r \geq 0, \ p = q + r \} \]