

There are only three problems on this assignment. You should solve these problems working together with the members of the group of 2 or 3 students to which you have been assigned. On Thursday and Friday 4/9 and 4/10, I will meet with each of these groups in separate online meetings and ask different member of the group to present the solutions to each of these problems. In addition, you are expected to use Glow to submit a PDF file including your group's solution to each problem by noon on the day **preceding** your group meeting. You will then have the option of updating and resubmitting your work by noon on the following Monday.

In future weeks, the weekly assignment will include one or more additional problems that you will each be expected to solve independently and each submit in PDF form through Glow. To let you ease back into things, there will be no such problem this week.

1. Show that

$$(a^*b^*c^* - \{a^n b^n c^n \mid n \geq 0\}) = \{a^l b^m c^n \mid l, m, n \geq 0 \text{ and } l \neq m \text{ or } m \neq n\}$$

is a context-free language by constructing a context-free grammar that describes the language. In addition to listing the rules of the grammar, provide a clear, concise description of how it functions. In particular, it will probably be helpful to give an informal description of the set of strings that are generated by each non-terminal.

Note that this language is in some sense the complement of the language shown to not be context-free in Example 2.36 in the text.

Hints: 1) This problem involves a language that is very similar to the language for which you are asked to describe a PDA in the next problem. The differences are intended to make your work easier. That is, it is slightly harder to describe a grammar for the very similar language included in the next problem and slightly harder to design a PDA for the language in this question. So, note the differences carefully.

2. Show that

$$(a^+b^+c^+ - \{a^n b^n c^n \mid n \geq 1\}) = \{a^l b^m c^n \mid l, m, n \geq 1 \text{ and } l \neq m \text{ or } l \neq n\}$$

is a context-free language by describing a PDA that recognizes the language. Provide a diagram for the PDA and a clear, concise description of how it functions. To facilitate giving a good description you should give the states in your diagram clear labels, give an intuition for the overall functioning and finally briefly describe each state's role.

Note that this language is in some sense the complement of the language shown to not be context-free in Example 2.36 in the text.

Hints: 1) By default, when we say PDA we mean non-deterministic PDA. 2) This problem can be solved using a PDA of 10 or fewer states. 3) Remember that a PDA accepts a string if and only if it can reach a final state at a point where its input has all been consumed.

3. Prove that the intersection of a context-free language and a regular language must be context-free.