Department of Computer Science, University of Houston
COSC 3340 - Exercise Set 3

Remember the academic honesty policy for this course. Internet use is prohibited for the homework exercise, but you may discuss the problem with someone in the class this semester, provided you **write** the answer in your own words and list the name(s) of the student(s) you discussed it with.

1. Design PDAs for the following languages:

   (i) $\{w \in \{a, b, c\}^* \mid$ the middle symbol of w is either c or $b\}$.

   (ii) $\{w \in \{0, 1\}^* \mid w$ starts and ends with the same symbol$\}$.

   Run the PDA for part (i) above on JFLAP with at least 3 strings in the language and at least 3 strings not in the language. List the test strings and the verdicts of JFLAP with your solutions.

2. Convert the grammar $S \rightarrow SS \mid aSb \mid \epsilon$ to Chomsky Normal Form (CNF) and show all steps. Draw parse trees for the sting abab using the original grammar and the equivalent grammar in CNF.

3. Give a CFG for the language which is the complement of $\{a^n b^n \mid n \geq 0\}$. Give also two different PDA's for this language, where one is obtained by applying the construction to the grammar and the other directly. Run one of the PDA's on JFLAP with at least 3 strings in the language and at least 3 strings not in the language. List the test strings and the verdicts of JFLAP with your solutions.

4. Although CFLs are not closed under intersection, they are closed under intersection with regular languages, i.e., if L is any CFL and R is any regular language then $L \cap R$ is a CFL. Can you give an intuitive reason for this in 2-3 sentences? Use this fact to give a proof that the following language is a CFL $\{w \in \{0, 1\}^* \mid w$ has 010 as a substring and w has equal 0's and 1's $\}$. Whichever language you use to show this, prove it is a CFL or regular by giving a CFG or regular expression.

5. Prove or disprove the following statements:

   (a) there are context-free languages L_1 and L_2 such that: both L_1 and L_2 are not regular, but $L_1 L_2$ is regular.

   (b) there is a CFL L that is not regular, but L^* is regular.