Homework 5

CptS 317, Spring 2021

Due Date: March 19th, 2021 by 11:59pm Pacific.

To be submitted on Canvas.

1. Let $G = (V, \Sigma, R, \langle\text{STMT}\rangle)$ be the following grammar:

   $\langle\text{STMT}\rangle \rightarrow \langle\text{ASSIGN}\rangle|\langle\text{IF}\rangle|\langle\text{IF-ELSE}\rangle$

   $\langle\text{IF}\rangle \rightarrow$ `if condition` $\langle\text{STMT}\rangle$

   $\langle\text{IF-ELSE}\rangle$ `if condition` $\langle\text{STMT}\rangle$ `else` $\langle\text{STMT}\rangle$

   $\langle\text{ASSIGN}\rangle$ `a:=1`

   $\Sigma = \{$`if`,`condition`,`else`,`a:=1`$\}$

   $V = \{\langle\text{STMT}\rangle, \langle\text{IF}\rangle, \langle\text{IF-ELSE}\rangle, \langle\text{ASSIGN}\rangle\}$

   G is a natural-looking grammar for a fragment of a programming language, but G is ambiguous.

   a) Show that G is ambiguous.

   b) Give a new unambiguous grammar for the same language.

2. Consider the following language: $A = \{a^i b^j c^k | i = j \text{ or } j = k \text{ where } i, j, k \geq 0\}$.

   a) Give a context-free grammar that generates this language.

   b) Give an informal description of a pushdown automaton that recognizes this language.

3. Let CFG G be the following grammar:

$S \rightarrow aSb|bY|Ya$

$Y \rightarrow bY|aY|\epsilon$

Give a simple description of $L(G)$ in English. Use this description to give a CFG for $\overline{L(G)}$, the complement of $L(G)$

4. Convert the following grammars into Chomsky Normal Form:

   a) $S \rightarrow 0|1|00S|01S|10S|11S$

   b) $S \rightarrow 0S0|1S1|0|1|\epsilon$

5. Convert the following CFG into an equivalent PDA (note that in this problem, the start symbol is X):

$X \rightarrow X - Y|Y$

$Y \rightarrow Y/Z|Z$

$Z \rightarrow (X)|q$

6. The following is a context-free grammar for JH-Lisp2, which you have previously encountered in Homework 4:

$S \rightarrow [O\_E\_E]$

$E \rightarrow [O\_E\_E]|N$

$N \rightarrow 0|1|2|3|4|5|6|7|8|9|NN$

$O \rightarrow add|sub|mul|div|mod$

Convert this grammar into Chomsky Normal Form.