CYK Algorithm HW #2

creating grammars:

1. $L = \{ a^n b^n \mid n \geq 0 \}$

$L = \{ \varepsilon, ab, aabb, aaabbb \ldots \}$

$G = (V, \Sigma, R, S)$

$= (\{S\}, \{a, b\}, R, S)$ where

$R = \{ S \rightarrow aSb \mid \varepsilon \}$

2. $L = \{ a^i b^j c^k \mid i = j \text{ or } j = k \}$

$G = \{\{S A B C\}, \{a, b, c\}, R, S\}$ where

$R = \quad S \rightarrow AB \mid BC$

$A \rightarrow aA \mid a$

$B \rightarrow bBc \mid bc$

$C \rightarrow cC \mid c$

3. $L = \{ x_1 \# x_2 \# \ldots \# x_k \mid k \geq 1$, each $x_i \in \{a, b\}^*$ and for some i and j, $x_i = x_j^R \}$

$R = \quad S \rightarrow X \mid X \# S$

$X \rightarrow A \mid B \mid AX \mid BX$

$A \rightarrow a \mid aA$

$B \rightarrow b \mid bB$

4. The rules of the grammar are already listed:

$S \rightarrow TT \mid U$

$T \rightarrow 0T \mid T0 \mid \#$

$U \rightarrow 0U00 \mid \#$

CFG to CNF

1. $S \rightarrow aSb \mid \varepsilon$

$S_0 \rightarrow S$
$S \rightarrow aSb \mid \varepsilon$

$S_0 \rightarrow S \mid \varepsilon$
$S \rightarrow aSb \mid ab$

$S_0 \rightarrow aSb \mid ab \mid \varepsilon$
$S \rightarrow aSb \mid ab$

$S_0 \rightarrow aSb \mid ab \mid \varepsilon$
$S \rightarrow aZ_1 \mid ab$
$Z_1 \rightarrow Sb$

$S_0 \rightarrow ab \mid aZ_1 \mid \varepsilon$
$S \rightarrow ab \mid aZ_1$
$Z_1 \rightarrow Sb$

$A \rightarrow CD \mid CB \mid \varepsilon$
$S \rightarrow CD \mid CB$
$B \rightarrow SD$
$C \rightarrow a$
$D \rightarrow b$

Note: ending all CNF in single terminal symbols makes it easier for our program to read

2.

$S \rightarrow AB \mid BC$
$A \rightarrow aA \mid a$
$B \rightarrow bBc \mid bc$
$C \rightarrow cC \mid c$

$S_0 \rightarrow S$
$S \rightarrow AB \mid BC$
$A \rightarrow aA \mid a$
$B \rightarrow bBc \mid bc$
$C \rightarrow cC \mid c$

$S_0 \rightarrow S$
$S \rightarrow AB \mid BC$
$A \rightarrow aA \mid a$
$B \rightarrow bBc \mid bc$
$C \rightarrow cC \mid c$

$S_0 \rightarrow AB \mid BC$
$S \rightarrow AB \mid BC$
$A \rightarrow aA \mid a$
$B \rightarrow bc \mid bD$
$C \rightarrow cC \mid c$
$D \rightarrow Bc$

$S_0 \rightarrow AB \mid BC$
$S \rightarrow AB \mid BC$
$A \rightarrow XA \mid X$
$B \rightarrow YZ \mid YD$
$C \rightarrow ZC \mid Z$
$D \rightarrow BZ$
$X \rightarrow a$
$Y \rightarrow b$
$Z \rightarrow c$

#3.

$S \longrightarrow X \mid X\#S$

$X \longrightarrow A \mid B \mid AX \mid BX$

$A \longrightarrow a \mid aA$

$B \longrightarrow b \mid bB$

$S_0 \longrightarrow S$

$S \longrightarrow X \mid X\#S$

$X \longrightarrow A \mid B \mid AX \mid BX$

$A \longrightarrow a \mid aA$

$B \longrightarrow b \mid bB$

$S_0 \longrightarrow X\#S \mid AX \mid BX \mid a \mid aA \mid b \mid bB$

$S \longrightarrow X\#S \mid AX \mid BX \mid a \mid aA \mid b \mid bB$

$X \longrightarrow AX \mid BX \mid a \mid aA \mid b \mid bB$

$A \longrightarrow a \mid aA$

$B \longrightarrow b \mid bB$

$S_0 \longrightarrow AX \mid BX \mid a \mid aA \mid b \mid bB \mid XC$

$S \longrightarrow AX \mid BX \mid a \mid aA \mid b \mid bB \mid XC$

$X \longrightarrow AX \mid BX \mid a \mid aA \mid b \mid bB$

$A \longrightarrow a \mid aA$

$B \longrightarrow b \mid bB$

$C \longrightarrow \#S$

$S_0 \longrightarrow AX \mid BX \mid XC \mid D \mid DA \mid E \mid EB$

$S \longrightarrow AX \mid BX \mid XC \mid D \mid DA \mid E \mid EB$

$X \longrightarrow AX \mid BX \mid D \mid DA \mid E \mid EB$

$A \longrightarrow D \mid DA$

$B \longrightarrow E \mid EB$

$C \longrightarrow FS$

$D \longrightarrow a$

$E \longrightarrow b$

$F \longrightarrow \#$

#4. $S \rightarrow TT \mid U$

$T \rightarrow 0T \mid T0 \mid \#$

$U \rightarrow 0U00 \mid \#$

$S_0 \rightarrow S$

$S \rightarrow TT \mid U$

$T \rightarrow 0T \mid T0 \mid \#$

$U \rightarrow 0U00 \mid \#$

$S_0 \rightarrow TT \mid 0U00 \mid \#$

$S \rightarrow TT \mid 0U00 \mid \#$

$T \rightarrow 0T \mid T0 \mid \#$

$U \rightarrow 0U00 \mid \#$

$S_0 \rightarrow TT \mid 0U00 \mid \#$

$S \rightarrow TT \mid 0U00 \mid \#$

$T \rightarrow 0T \mid T0 \mid \#$

$U \rightarrow 0U00 \mid \#$

$Y_1 \rightarrow 00$

$Z_1 \rightarrow UY_1$

Note:

$a = 0$

$b = \#$

inputs changed to less error prone symbols for the program

$A \rightarrow TT \mid D \mid EC$

$S \rightarrow TT \mid D \mid EC$

$T \rightarrow ET \mid TE \mid D$

$U \rightarrow D \mid EC$

$B \rightarrow EE$

$C \rightarrow UB$

$D \rightarrow b$

$E \rightarrow a$

Group 3 CFG Questions in CNF

$S_0 \rightarrow AB \mid BC$
$S \rightarrow AB \mid BC$
$A \rightarrow XA \mid a$
$B \rightarrow YZ \mid YD$
$C \rightarrow ZC \mid c$
$D \rightarrow BZ$
$X \rightarrow a$
$Y \rightarrow b$
$Z \rightarrow c$

Group 3 CFG Questions in CNF

$S_0 \rightarrow AB \mid BC$
$S \rightarrow AB \mid BC$
$A \rightarrow XA \mid a$
$B \rightarrow YZ \mid YD$
$C \rightarrow ZC \mid c$
$D \rightarrow BZ$
$X \rightarrow a$
$Y \rightarrow b$
$Z \rightarrow c$