

Parsing

Homework 1 (CFG, PDA), due 26 April 2021

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Question 1 (CFG)

1. Consider the CFG G_1 with non-terminals $\{S, A, B\}$, terminals $\{a, b\}$, start symbol S and productions

$$S \rightarrow AB \quad A \rightarrow aA \quad A \rightarrow Aa \quad A \rightarrow a \quad B \rightarrow BB \quad B \rightarrow b$$

Is G_1 in Chomsky Normal Form? Explain your answer

2. Consider the CFG G_2 with non-terminals $\{S, A, B, C\}$, terminals $\{a, b, c\}$, start symbol S and productions

$$S \rightarrow ABC \quad A \rightarrow ABa \quad A \rightarrow a \quad B \rightarrow BBC \quad B \rightarrow BC \quad B \rightarrow b \quad C \rightarrow cc$$

Transform G_2 into an equivalent CFG G'_2 in Chomsky Normal Form.

3. Consider the CFG G_3 with non-terminals $\{S, A, C\}$, terminals $\{a, c\}$, start symbol S and productions

$$S \rightarrow AC \quad A \rightarrow a \quad C \rightarrow Ca \quad C \rightarrow ac \quad C \rightarrow c$$

Transform G_3 into an equivalent CFG G'_3 without left recursion.

Solution

1. No, because there are productions with both nonterminal and terminal symbols in the righthand side.
2. $S \rightarrow AX, X \rightarrow BC, A \rightarrow AY, Y \rightarrow BT_a, T_a \rightarrow a, A \rightarrow a, B \rightarrow BZ, Z \rightarrow BC, B \rightarrow BC, B \rightarrow b, C \rightarrow T_cT_c, T_c \rightarrow c$
3. We put indices on our non-terminals: S has index 1, A index 2, C index 3:

$$S_1 \rightarrow A_2C_3 \quad A_2 \rightarrow a \quad C_3 \rightarrow C_3a \quad C_3 \rightarrow ac \quad C_3 \rightarrow c$$

I Take a new non-terminal X and replace the C_3 -productions with

$$C_3 \rightarrow ac \quad C_3 \rightarrow c \quad C_3 \rightarrow acX \quad C_3 \rightarrow cX$$

$$X \rightarrow aX \quad X \rightarrow a$$

\rightsquigarrow new set of productions:

$$S_1 \rightarrow A_2C_3$$

$$A_2 \rightarrow a$$

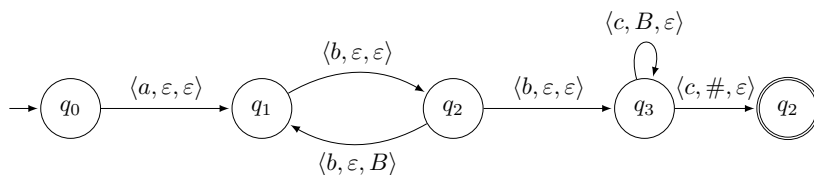
$$C_3 \rightarrow ac \quad C_3 \rightarrow c \quad C_3 \rightarrow acX \quad C_3 \rightarrow cX$$

$$X \rightarrow aX \quad X \rightarrow a$$

Question 2 (PDA)

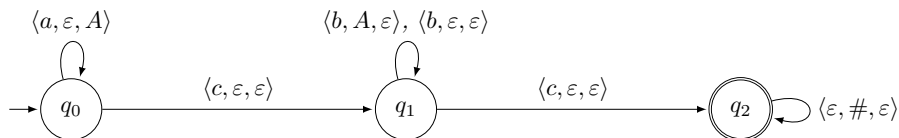
Give a PDA that recognizes the following language, acceptance with final state: $\{a(bb)^{(n+1)}cc^n \mid n \geq 0\}$.

Solution:



Question 3 (PDA)

Consider the following PDA M , initial stack symbol is $\#$.



Give $L(M)$ and $N(M)$.

Solution:

$$L(M) = \{a^n cb^m c \mid m \geq 0, n \geq 0\}$$

$$N(M) = \{a^n cb^m c \mid m \geq n \geq 0\}$$

Question 4 (PDA)

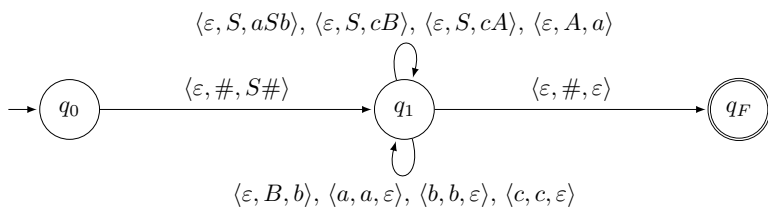
Consider the CFG G with non-terminals $\{S, A, B\}$, terminals $\{a, b, c\}$, start symbol S and productions

$$S \rightarrow aSb \quad S \rightarrow cA \quad S \rightarrow cB \quad A \rightarrow a \quad B \rightarrow b$$

Give an LL-PDA and an LR-PDA for this CFG.

Solution:

LL-PDA ($\#$ initial stack symbol):



LR-PDA ($\#$ initial stack symbol):

