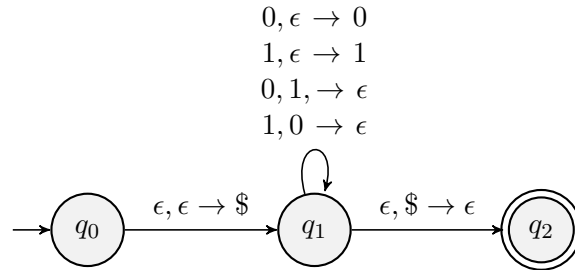


CS F351 Theory of Computation

Tutorial-7

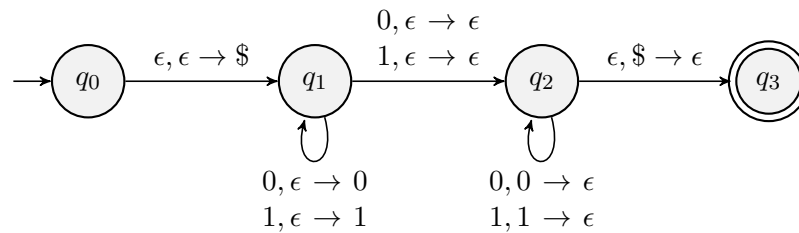
Problem 1 Find an equivalent CFG for the following PDAs :

(a)



Solution: See <https://www.cse.cuhk.edu.hk/~siuon/csci3130-f18/slides/lec11.pdf>

(b) *



Problem 2 Simplify the following CFG by removing useless symbols if any:

$$\begin{aligned}
 S &\rightarrow aSa \mid bB \mid bAA \\
 A &\rightarrow abb \mid SbA \mid aB \\
 B &\rightarrow AB \mid CaB \\
 C &\rightarrow cC \mid Sa \mid bD \\
 D &\rightarrow dD \mid \epsilon
 \end{aligned}$$

Solution: $S \rightarrow aSa \mid bAA, A \rightarrow abb \mid SbA$

(see full solution at https://www.cs.scranton.edu/~mccloske/courses/cmcs260/cfg_remove_useless.html.)

Problem 3

Convert the following CFGs into chomsky normal form.

1. $S \rightarrow aXbX, X \rightarrow aY \mid bY \mid \epsilon, Y \rightarrow X \mid c$

Solution: Remove ϵ production:

$$S \rightarrow aXbX \mid abX \mid aXb \mid ab, X \rightarrow aY \mid bY \mid a \mid b, Y \rightarrow X \mid c$$

Remove unit production:

$$S \rightarrow aXbX \mid abX \mid aXb \mid ab, X \rightarrow aY \mid bY \mid a \mid b, Y \rightarrow aY \mid bY \mid a \mid b \mid c$$

Remove useless symbol:

$$S \rightarrow aXbX \mid abX \mid aXb \mid ab, X \rightarrow aY \mid bY \mid a \mid b, Y \rightarrow aY \mid bY \mid a \mid b \mid c$$

CNF:

$$S \rightarrow EF \mid AF \mid EB \mid AB$$

$$X \rightarrow AY \mid BY \mid a \mid b$$

$$Y \rightarrow AY \mid BY \mid a \mid b \mid c$$

$$E \rightarrow AX$$

$$F \rightarrow BX$$

$$A \rightarrow a$$

$$B \rightarrow b$$

$$C \rightarrow c$$

2. $S \rightarrow aTb \mid bTa, T \rightarrow XTX \mid X \mid \epsilon, X \rightarrow a \mid b$
