

CENG491 Homework

1. Eliminate all useless, unit and ε -productions form the following grammar:

$$S \rightarrow aAa \mid bBC$$

$$A \rightarrow B \mid \varepsilon$$

$$B \rightarrow b$$

$$C \rightarrow S \mid c \mid \varepsilon$$

2. Eliminate all useless, unit and ε -productions form the following grammar:

$$S \rightarrow 0A0 \mid 01B$$

$$A \rightarrow 0D \mid 1D$$

$$B \rightarrow 10A \mid \varepsilon$$

$$C \rightarrow A00 \mid 0B0$$

$$D \rightarrow 0 \mid \varepsilon$$

3. Construct a PDA recognizing $L = \{0^k 1^l 2^m \mid l = k + m \text{ and } k, l, m \geq 0\}$.
4. Construct a PDA and a CFG recognizing $L = \{a^m b^{2n} c^n d^{2m} \mid m, n \geq 0\}$.

Deliver your answers on a handwritten A4 paper by hand until Dec 20, 2023 at 4:30pm. No teamworking is permitted.

$$\begin{aligned}
 1- \quad S &\rightarrow aAa \mid bBC \\
 A &\rightarrow B \mid \epsilon \\
 B &\rightarrow b \\
 C &\rightarrow S \mid c \mid \epsilon
 \end{aligned}$$

Eliminate ϵ production:

$$\begin{aligned}
 S &\rightarrow aAa \mid aa \mid bBC \mid bB \\
 A &\rightarrow B \\
 B &\rightarrow b \\
 C &\rightarrow S \mid c
 \end{aligned}$$

Eliminate unit production:

$$\begin{aligned}
 S &\rightarrow aAa \mid aa \mid bBC \mid bB \\
 A &\rightarrow b \\
 B &\rightarrow b \\
 C &\rightarrow aAa \mid aa \mid bBC \mid bB \mid c
 \end{aligned}$$

$$\begin{aligned}
 S &\rightarrow abaa \mid eoa \mid bba \mid bba \\
 C &\rightarrow abaa \mid eoa \mid bba \mid bba \mid c
 \end{aligned}$$

$$\begin{aligned}
 2- \quad S &\rightarrow oAol \mid o1B \\
 A &\rightarrow oDl \mid 1D \\
 B &\rightarrow 1oAl \mid \epsilon \\
 C &\rightarrow Aoool \mid oBo \\
 D &\rightarrow o \mid \epsilon
 \end{aligned}$$

Eliminate
Epsilon
production:

$S \rightarrow 0A0 \mid 01B \mid 01$
 $A \rightarrow 0D \mid 0 \mid 1D \mid 1$
 $B \rightarrow 10A$
 $C \rightarrow A00 \mid 0B0 \mid 00$
 $D \rightarrow 0$

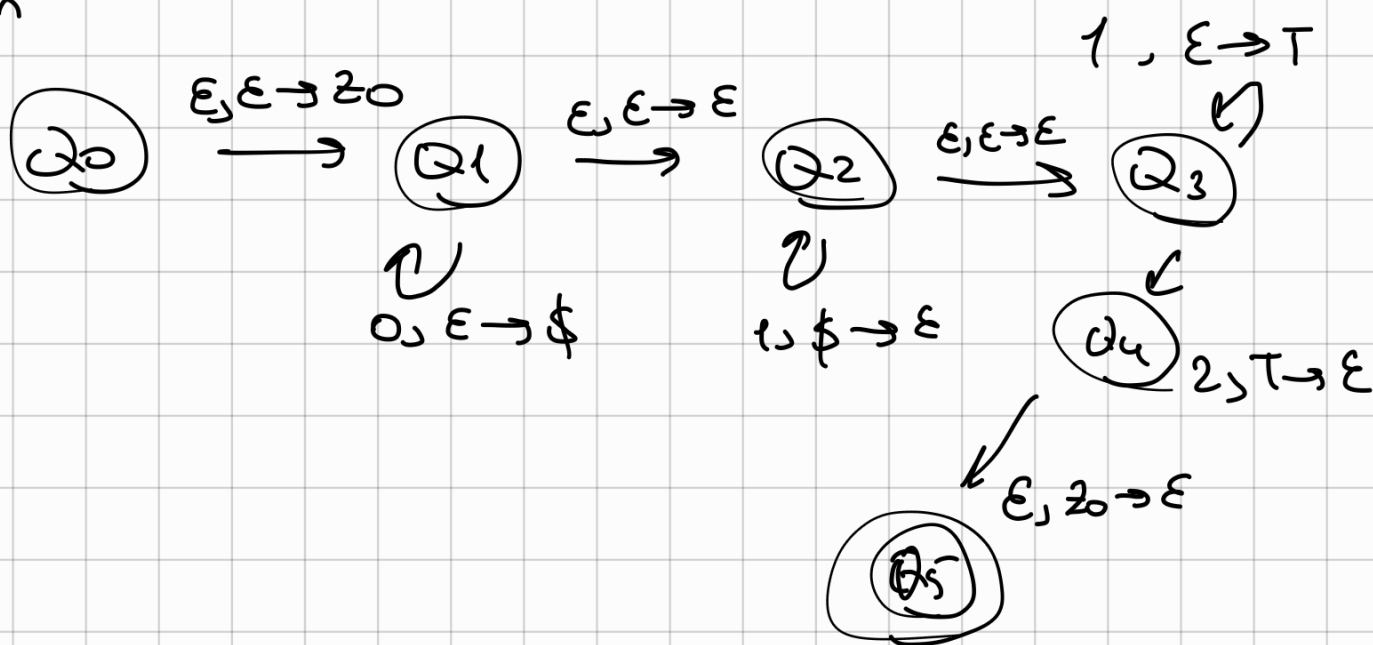
Eliminate
non
reachable:

$S \rightarrow 0A0 \mid 01B \mid 01$
 $A \rightarrow 0D \mid 0 \mid 1D \mid 1$
 $B \rightarrow 10A$
 $D \rightarrow 0$

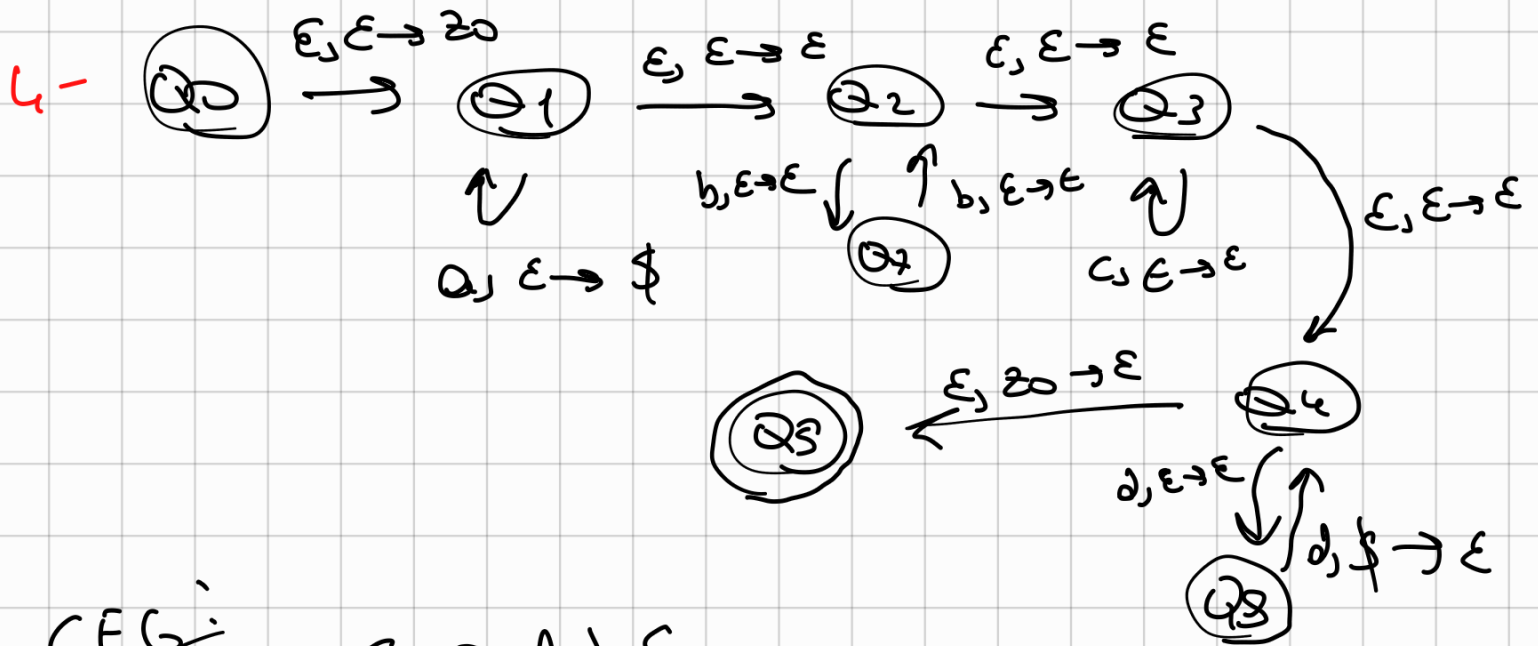
$\begin{matrix} & K & L & M \\ 0 & 1 & 2 & \end{matrix}$

$L = K + M$

3 -



$$a^n b^{2n} c^n \mid n, m \geq 0$$



CFG:

$$\begin{aligned}
 S &\rightarrow A \mid \epsilon \\
 A &\rightarrow aAB \mid \epsilon \\
 B &\rightarrow bbBc \mid \epsilon
 \end{aligned}$$