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TACD
Tutorial 7

1). Convert the following CFG to PDA,
$S \longrightarrow 0S1 \mid A \quad A \longrightarrow 1A0 \mid S \mid \varepsilon$.

Step 1: For each variable $A \in V$, include a transition $\delta(q, \varepsilon, A)$
$\rightarrow \{(q, \alpha) \mid A \rightarrow \alpha$ is a production in $\}$

$\delta(q, \varepsilon, S) \Rightarrow \{(q, 0S1), (q, A)\}$

$\delta(q, \varepsilon, A) \Rightarrow \{(q, 1A0), (q, S), (q, \varepsilon)\}$

Step 2: For each terminal $a \in$, include a transition,
$\delta(q, a, a) \Rightarrow (q, \varepsilon)$

$\therefore \delta(q, 0, 0) = \{(q, \varepsilon)\}$
$\delta(q, 1, 1) = \{(q, \varepsilon)\}$

Therefore, the PDA is given by:

$$M = (\{q\}, \{0,1\}, \{S, A, 0, 1\}, \delta, q, S, \emptyset)$$

where δ is: $\delta(q, \varepsilon, S) = \{(q, 0S1), (q, A)\}$

$\delta(q, \varepsilon, A) = \{(q, 1A0), (q, S), (q, \varepsilon)\}$
$\delta(q, 0, 0) = \{(q, \varepsilon)\}$
$\delta(q, 1, 1) = \{(q, \varepsilon)\}$

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2). Convert following PDA to CFG.

$T = \{0,1\}$ same as sigma from PDA.
We will start symbol "S".

$V = (S, [q_0, X, q_0], [q_0, X, q_1],$
$[q_1, X, q_0], [q_1, X, q_1],$
$[q_0, Z_0, q_0], [q_0, Z_0, q_1],$
$[q_1, Z_0, q_0], [q_1, Z_0, q_1])$.

$1 \rightarrow$ First generate productions from S:
$S \rightarrow [q_0, Z_0, q_0]$
$S \rightarrow [q_0, Z_0, q_1]$

The first 2 components of RHS are fixed, the last piece is every possible state from machine.

We will derive forward.
$[q_0, Z_0, q_1] \rightarrow 0\,[q_0, X, q_0][q_0, Z_0, q_0]$ (1a')
$\rightarrow 0\,[q_0, X, q_1][q_1, Z_0, q_0]$ (1a'')

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Next come the matching production from second variable:

$$[q_0, Z_0, q_1] \rightarrow 0[q_0, X, q_0][q_0, Z_0, q_1] \quad (1a''')$$
$$\rightarrow 0[q_0, X, q_1][q_1, Z_0, q_1] \quad (1a'''')$$

Working from last two variables that mention X, & matching rule 1b,

$$[q_0, X, q_0] \rightarrow 0[q_0, X, q_0][q_1, X, q_0] \quad (1b')$$
$$\rightarrow 0[q_0, X, q_1][q_1, X, q_0] \quad (1b'')$$

$$[q_0, X, q_1] \rightarrow 0[q_0, X, q_0][q_0, X, q_1] \quad (1b''')$$
$$0[q_0, X, q_1][q_1, X, q_1] \quad (1b'''')$$

Then for the other delta moves,
$[q_0, X, q_1] \rightarrow 1$ (2a')
$[q_1, Z_0, q_1] \rightarrow e$ (2b')

Then, working from the 2 variables,

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$[q0, X, q0] \rightarrow 0[q0, X, q0][q0, X, q0]$ (1b')

$\rightarrow 0[q0, X, q1][q1, X, q0]$ (1b'')

$[q0, X, q1] \rightarrow 0[q0, X, q0][q0, X, q1]$ (1b''')

$\rightarrow 0[q0, X, q1][q1, X, q1]$ (1b'''')

Then for the other 4 delta moves,

$[q0, X, q1] \rightarrow 1$ (2a')

$[q1, Z0, q1] \rightarrow e$ (2b')

$[q1, X, q1] \rightarrow e$ (2c')

$[q1, X, q1] \rightarrow 1$ (2d')

The variables $[q1, X, q0]$ & $[q1, Z0, q0]$ never appear in LHS so we can drop 1a'' & 1b''.

Similarly $[q0, X, q0]$ & $[q0, Z0, q0]$ appears on LHS, so we can drop them, 1.

$\therefore$ This leaves,

$S \rightarrow [q0, Z0, q1]$

$[q0, Z0, q1] \rightarrow 0[q0, X, q1][q1, Z0, q1]$

$[q0, X, q1] \rightarrow 0[q0, X, q1][q1, X, q1]$

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∴ All that can be renamed to:

$S \rightarrow A$

$A \rightarrow 0BC$

$B \rightarrow 0BD \mid 1$

$C \rightarrow \varepsilon$

$D \rightarrow 1 \mid \varepsilon$.