27/10

:- Experiment 4 :-

Q1) Explain DPDA & NPDA with help of example

Ans :- Push Down Automata :- PDA is a way to implement a context free grammer (CFG) in a similar way to DFA (Deterministic Finite Automata) for a regular grammer.

A DFA can remember a finite amount of information but a PDA can remember an infinite. Basically, a PDA is finite state machine + a stack.

PDA has three components.

A i/p tape.
A control unit.
A stack with infinite size.
A PDA is further divided into DPDA &

NPDA:

i) DPDA (Deterministic Pushdown Automata):

In a DPDA, for each combination of current state & input symbol, there is at most one possible action that the automata can take. This means the DPDA.

ii) NPDA (Non - Deterministic Pushdown Automata)
In an NPDA, there can be multiple possible actions for the same combination of current state & i/p symbole. This means that the atomata can chose any of several transition to make based on the same i/p symbol & state this non determinism allows for greater flexibility in the recognition of lang. but this require exploration of mult paths during computation

Definition of DPDA & NPDA with example.
let $M = (Q, \Sigma, N, q_0, Z, F, \delta)$ be a PDA The PDA is deterministic if & only if
i) $\delta(q, a, z_0)$ has one element.
ii) If $\delta(q, \epsilon, z_0)$ is non - empty $c \in \Sigma$
both condition should be satified for the PDA the PDA is non deterministic.

eg:
Is the PDA corresponding to lang $L = \{a^n b^n \mid n >= 1\}$ by the finite state is deterministic?

Sol^n:
$$\delta(q_0, a, z_0) = \delta(q_0, az_0)$$
$$\delta(q_0, a, a) = \delta(q_0, aa)$$
$$\delta(q_0, b, a) = \delta(q_1, \epsilon)$$
$$\delta(q_1, b, a) = \delta(q_1, \epsilon)$$
$$\delta(q_1, \epsilon, z_0) = \delta(q_f, \epsilon)$$

The PDA should satify the two condition.

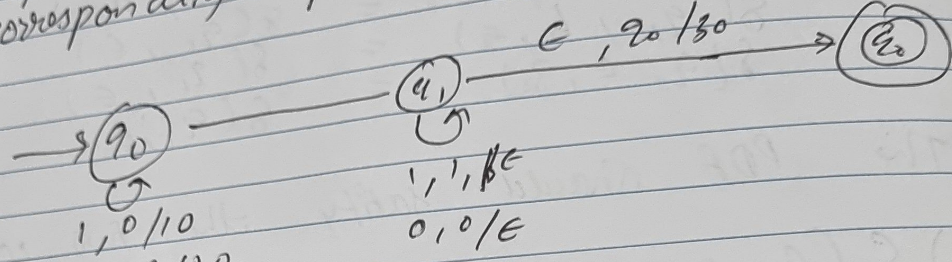
i) $\delta(q_0, a, z_0)$ has only one elemet, In this case for each $q \in Q$, $a \in \Sigma$, & $Z \in N$, there exist only one definition. so the first condition is satified.

ii) To satisfy the second condition is satified the transition $\delta(q_1, \epsilon, z_0) = (q_f, \epsilon)$ Since the transition is defined the Transition $\delta(q, a, z_0)$ where $a \in \Sigma$ should not be defined which is tre ∴ PDA is determistic.

Q2) Construct PDA accepting language of palidrome $L = \{ww' / wcw', w = \{0,1\}^*\}$ where w^r is reverse of w.
This is the lang. of all palindrome both odd & even over alphabet 0, 1.

<u>logic</u>:

We keep pushing the first part of the string to the stak & then as we move to the next part, we then keep poping as we find out the corresponding pairs.



1,0/10
0,0/00
1,1/11
0,1/01
1,z_0/1z_0
0,z_0/0z_0.

PDA can be defined as:
$M = (\{q_0, q_1, q_2\}, \{0,1\}, \{0,1,z_0\}, \delta, z_0, \{q_2\})$.

Transition function.

$(q_0, 0, 0) = (q_0, 00)$
$(q_0, 1, 0) = (q_0, 10)$
$(q_0, 1, 1) = (q_0, 11)$
$(q_0, 0, 1) = (q_0, 01)$
$(q_0, 1, z_0) = (q_0, 1z_0)$.
$(q_0, 0, z_0) = (q_0, 0z_0)$
$(q_0, c, \epsilon) = (q_1, \epsilon)$

$(q_0, c, \epsilon) = (q_1, \epsilon)$
$(q_1, 1, 1) = (q_1, \epsilon)$
$(q_1, 0, 0) = (q_1, \epsilon)$
$(q_1, \epsilon, z_0) = (q_2, z_0)$

<u>Simulation:</u>

$q_0(010\Delta) \vdash 010\Delta$
with q under the first 0, labelled q_0; stack: 0, z_0

$\vdash 010\Delta$
with q under the 1, labelled q_0

$\vdash 010\Delta$.
with q under the last 0, labelled q_1; stack: q_0

⊢ 0 1 0 Δ
↑
q_2

Accepted.

q_0 (011)

⊢ 0 1 1 Δ
↑
q_0

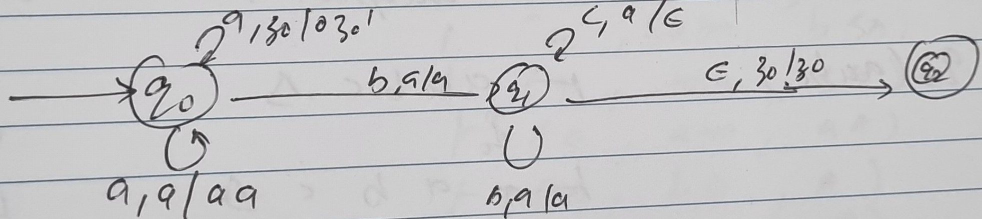
⊢ 0 1 1 Δ
↑
q_0

⊢ 0 1 1 Δ
↑
q_1

∴ not accepted

Q3) Construct PDA for accepting the following language.

$L = \{ a^m b^m c^m \mid m, n >= 1 \}$.



Transition function.

$(q_0, z_0) = (q_0, a z_0)$
$(q_0, a, a) = (q_0, aa)$
$(q_0, b, a) = (q_1, a)$
$(q_1, c, a) = (q_1, \epsilon)$
$(q_1, \epsilon, z_0) = (q_2, z_0)$.

PDA can be defined as:

$M = (\{q_0, q_1, q_2\}, \{a, b\}, \{a, \epsilon, z_0\},$
$q_0, z_0, \{q_2\}, \delta)$

<u>Simulation:-</u>

$q_0(a, bc) \vdash \underset{\underset{q_0}{\uparrow}}{a}\ b\ c\ \Delta$ $\quad \boxed{\begin{matrix} a \\ z_0 \end{matrix}}$

$\vdash a\ \underset{\underset{q_1}{\uparrow}}{b}\ c\ \Delta$

$\vdash a\ b\ \underset{\underset{q_1}{\uparrow}}{c}\ \Delta$ $\quad \boxed{z_0}$

$\vdash a\ b\ c\ \underset{\underset{q_2}{\uparrow}}{\Delta}$ $\quad \boxed{\ }$

$\therefore$ accepted.

$q_0(aabc)$ $\vdash \underset{\underset{q_0}{\uparrow}}{a}\ a\ b\ c\ \Delta$ $\quad \boxed{\begin{matrix} a \\ z_0 \end{matrix}}$

$\vdash a\ \underset{\underset{q_0}{\uparrow}}{a}\ b\ c\ \Delta$ $\quad \boxed{\begin{matrix} a \\ a \\ z_0 \end{matrix}}$

$\vdash a\ a\ \underset{\underset{q_1}{\uparrow}}{b}\ c\ \Delta$ $\quad \boxed{\begin{matrix} a \\ z_0 \end{matrix}}$

$\vdash a\ a\ b\ \underset{\underset{q_1}{\uparrow}}{c}\ \Delta$ $\quad \boxed{\begin{matrix} a \\ z_0 \end{matrix}}$

$\vdash a\ a\ b\ \underset{\underset{q_1}{\uparrow}}{c}\ \Delta$ $\quad \boxed{\begin{matrix} a \\ z_0 \end{matrix}}$

$\therefore$ Not accepted.

1) Design PDA for following CFG show acceptance of one valid string.

$S \rightarrow aAA \mid a$.

$A \rightarrow bS \mid aS$.

Let PDA be P.

$P = (\{q\}, \{a, b\}, \{S, A, a, b\}, \delta, q, S, \phi)$

R1 : $\delta(q, \epsilon, S) \rightarrow \{(q, aAA) ; (q, a)\}$

R2 : $\delta(q, \epsilon, A) \rightarrow \{(q, bS), (q, aS)\}$

R3 : $\delta(q, a, a) \rightarrow (q, \epsilon)$

R4 : $\delta(q, b, b) \rightarrow (q, \epsilon)$

Simulation :

$\delta(q, ababa, S) \vdash (q, ababa, aAA)$ R1

$\vdash (q, baba, AA)$ R3

$\vdash (q, baba, bSA)$ R2

$\vdash (q, aba, SA)$ R4

$\vdash (q, aba, aA)$ R1

$\vdash (q, ba, A)$ R3

$\vdash (q, ba, bS)$ R2

$\vdash (q, a, S)$ R4

$\vdash (q, a, a)$ R1

$\vdash (q, \epsilon)$

$\therefore$ Accepted.