* Non-deterministic PDA (NPDA)

2 types of PDA.

1) DPDA (Deterministic PDA)

2) NPDA (Non-deterministic PDA)

NPDA → provides non-determinism to PDA.

- ~~In a DPDA th~~

DPDA	NPDA
1) Less powerful	1) More powerful
2) only one move in every situation	2) Multiple moves under a situation
3) Class of lang. lies in bet^n a reg. lang & CFL.	3) Lang. is CFL.
4) Palindrome can not be accepted by NPDA.	4) Palindrome can be accepted by NPDA.

Eg-1 Design a PDA for detection of odd palindrome over $\{a, b\}$.

→ odd palindrome will be of the form

1. $W a W^R$ — ab a ba, ab b ba (W, W^R, W, W^R)
2. $W b W^R$.

→ Thus, by simple PDA can not find middle position or a string so the middle position is fixed non-deterministically.

* Let w is of n char. So push n char. on to stack & then match in reverse with last / 2nd half n char.

Every char out of first 'n' char. is should be considered for two cases.

a) It is not the middle character. - push curr. char. using the trans?.

$$\delta(q_0, a, \epsilon) = (q_0, a)$$
$$\delta(q_0, b, \epsilon) = (q_0, b)$$

b) It is a middle chara. - go for matching of 2nd half with first half.

$$\delta(q_0, a, \epsilon) \rightarrow (q_1, \epsilon)$$
$$\delta(q_0, b, \epsilon) \rightarrow (q_1, \epsilon)$$

eg. Let ababa is a string.

Here, string w of length 2. So 3rd char. a is middle char. & 2nd half is w^R.

a)

a	b	a	b	a

↑

middle Char. → NOP, & transit from q_0 to q_1

Char. from 1st half. → Push a into stack

$$\delta(q_0, a, \epsilon) = (q_0, a)$$

eg. 3 consider PDA with following moves.

$\delta(q_0, a, z_0) = \{q_0, az_0\}$

$\delta(q_0, a, a) = \{q_0, aa\}$

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

$\delta(q_1, b, a) = \{q_1, \epsilon\}$

$\delta(q_0, \epsilon, z_0) = \{q_1, \epsilon\}$

obtain CFG equi. to PDA.

$\{q_0, q_1\}$

→ Step-I variables for CFG G.

a) Start symbol S

$S \rightarrow [q_0^{z_0} q_0] \mid [q_0^{z_0} q_1]$

b) variables from $\{q_0, q_1\}$ $\{a, b, z_0\}$

$[q_0^a q_0]$ $[q_0^a q_1]$ $[q_1^a q_0]$ $[q_1^a q_1]$

$[q_0^b q_0]$ $[q_0^b q_1]$ $[q_1^b q_0]$ $[q_1^b q_1]$

$[q_0^{z_0} q_0]$ $[q_0^{z_0} q_1]$ $[q_1^{z_0} q_0]$ $[q_1^{z_0} q_1]$

Step-II Prod^n for CFG.

a) Prod^n for start symbol.

$S \rightarrow [q_0^{z_0} q_0] \mid [q_0^{z_0} q_1]$

b) Prod^n for trans^n $\delta(q_0, a, z_0) = \{q_0, az_0\}$

$q_0^{z_0}$ tran^n Prod^n of type.

$\delta(q_i, a, B) = (q_j, C_1 C_2)$

$\{q_i^B p_1\} \rightarrow a [q_j^{C_1} p_2] [p_2^{C_2} p_1]$

① $\delta(q_0, a, z_0) = (q_0, az_0)$

$[q_0^{z_0} q_0] \to a[q_0^{a} q_0][q_0^{z_0} q_0]$ $P_1 = q_0$ $P_2 = q_0$

$[q_0^{z_0} q_0] \to a[q_0^{a} q_1][q_1^{z_0} q_0]$ $P_1 = q_0$ $P_2 = q_1$

$[q_0^{z_0} q_1] \to a[q_0^{a} q_1][q_1^{z_0} q_1]$ $P_1 = q_1$, $P_2 = q_1$

$[q_0^{z_0} q_1] \to a[q_0^{a} q_0][q_0^{z_0} q_1]$ $P_1 = q_1$ $P_2 = q_0$

② $\delta(q_0, a, a) = (q_0, aa)$

$[q_0^{a} q_0] \Rightarrow a[q_0^{a} q_0][q_0^{a} q_0]$

$[q_0^{a} q_0] \Rightarrow a[q_0^{a} q_1][q_1^{a} q_0]$

$[q_0^{a} q_1] \to a[q_0^{a} q_1][q_1^{a} q_1]$

$[q_0^{a} q_1] \to a[q_0^{a} q_0][q_0^{a} q_1]$

③ $\delta(q_0, b, a) = (q_1, \epsilon)$

$[q_0^{a} q_1] \to b$

④ $\delta(q_1, b, a) = (q_1, \epsilon)$

$[q_1^{a} q_1] \to b$

⑤ $\delta(q_0, \epsilon, z_0) = (q_1, \epsilon)$

$[q_0^{z_0} q_1] \to \epsilon$.