Variants of Turing Machine

1) Multitape Turing Machine (MTTM)

MTTM has multiple tapes where each tape is accessed by seperate head. Each head can move independently of the other head.

A multitape TM has a finite set Q of states, an initial state q_0, a subset F of Q called the final states, a set P of tape symbols. a b (blank)
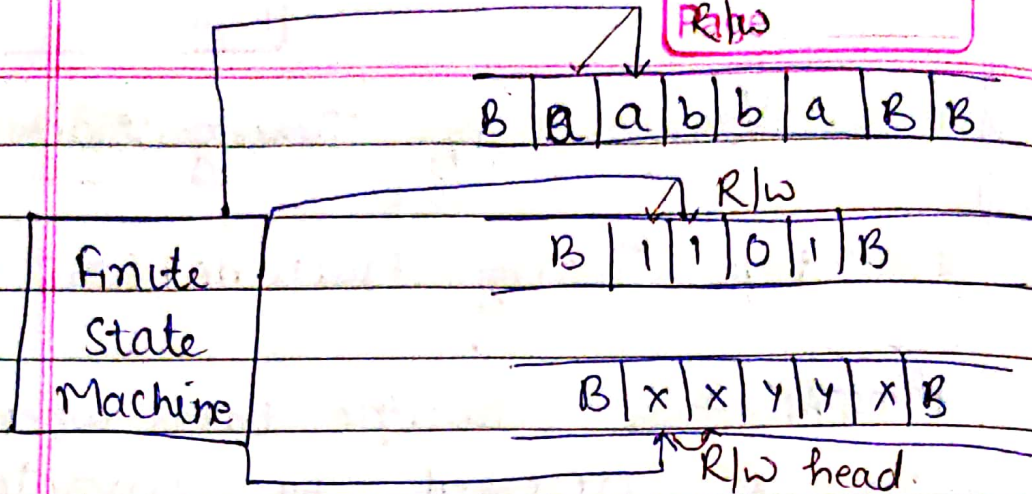
These are k tapes, each divided into cells. The first tape holds the input string w. Initially, all the other tapes hold the blank symbol.

Initially the head of the first tape (input) is at the left end of the input w. All the other heads can be placed at any cell initially.
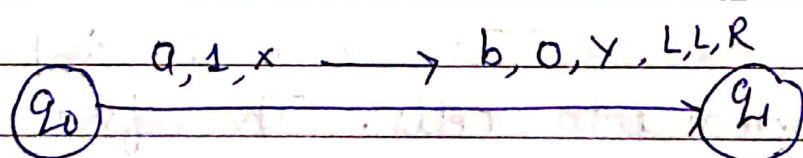
δ (transition)

Multitape :	$Q \times \Gamma^R = Q \times \Gamma^R \times \{L/R\}^K$
Singletape	$Q \times \Gamma = Q \times \Gamma \times (R/L)$

R/w

| B | a | a | b | b | a | B | B |

R/w

| B | 1 | 1 | 0 | 1 | B |

| Finite |
| State |
| Machine |

| B | x | x | Y | Y | X | B |

R/w head.

Several tapes, Each has its own
tape head
eg. of Multitape Turing machine
with R = 3 (tapes)

$$q_0 \xrightarrow{a,1,x \longrightarrow b,0,Y,L,L,R} q_1$$

$$S(q_0, a, 1, x) \longrightarrow (q_1, b, 0, Y, L, L, R)$$

Power (MTTM) — Pow(STTM)

(Single tape TM simulating MTTM)

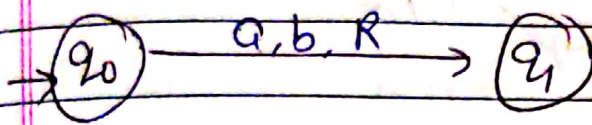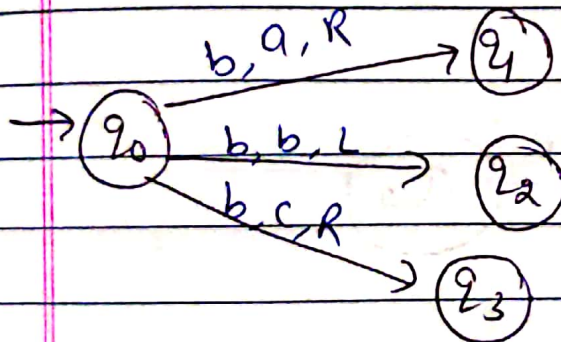		tape 1					tape 2				tape 3				
\$	a	a	b	b	a	\$	1	1	0	1	\$	X	X	Y	Y	X	\$	B
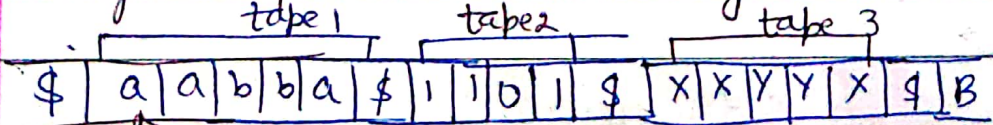
FSM

Non- Deterministic Turing Machine

In non-deterministic TM, for every state and symbol there are group of actions that T.M can have, so transitions are not deterministic.
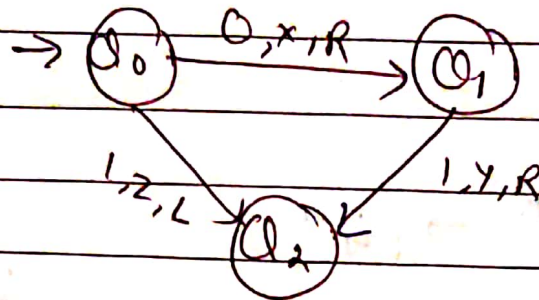
$$q_0 \xrightarrow{\quad a,b,R \quad} q_1$$

Deterministic TM

$$q_0 \xrightarrow{\quad b,a,R \quad} q_1$$
$$q_0 \xrightarrow{\quad b,b,L \quad} q_2$$
$$q_0 \xrightarrow{\quad b,c,R \quad} q_3$$

Non-Deterministic TM.

$$\delta \, (Q \times \Gamma \longrightarrow \underset{\text{Powerset of}}{P} (Q \times \Gamma \times (R/L)))$$

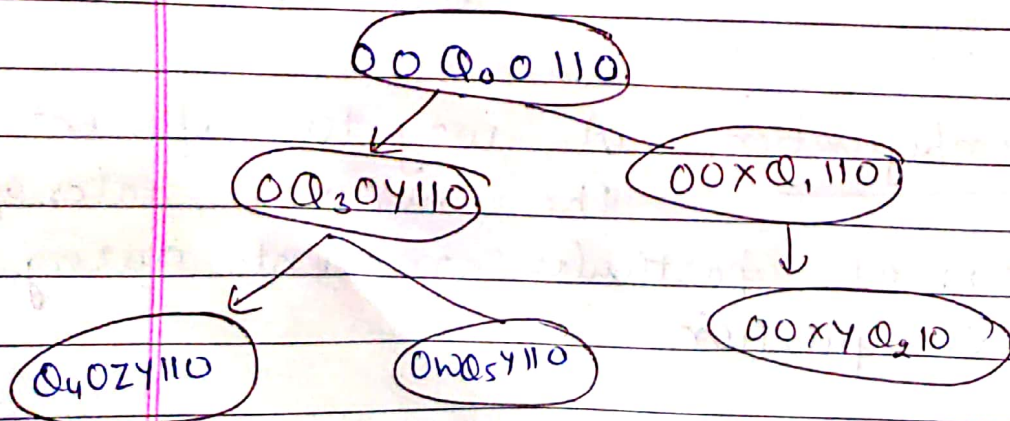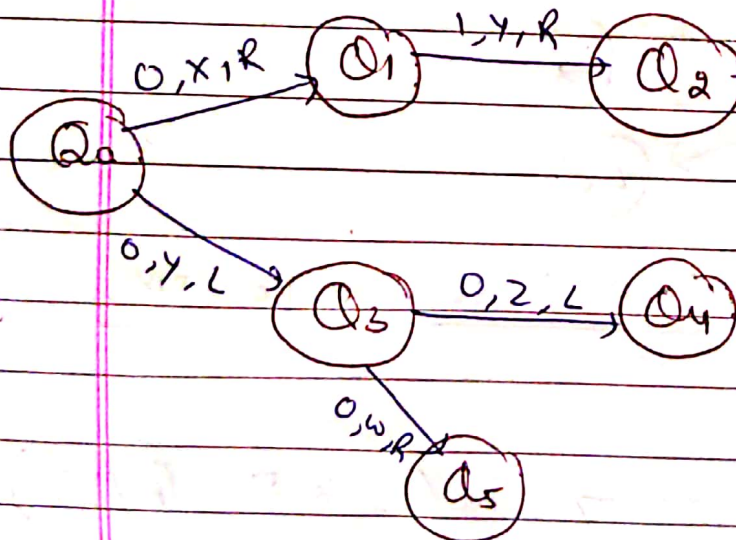Configuration: A way to represent the various states of TM at particular moment during computation.

1) Current state
11) Current position of head
(iii) the entire tape content

$$\boxed{0\ 1\ 0\ Q_0\ 1\ 0\ 0}$$

$$\rightarrow Q_0 \xrightarrow{0,x,R} Q_1$$

$Q_0 \xrightarrow{1,z,L} Q_2$

$Q_1 \xrightarrow{1,y,R} Q_2$

Deterministic

Non-Deterministic

$Q_a \xrightarrow{0,x,R} Q_1 \xrightarrow{1,y,R} Q_2$

$Q_a \xrightarrow{0,y,L} Q_3 \xrightarrow{0,z,L} Q_4$

$Q_3 \xrightarrow{0,w,R} Q_5$

$$\boxed{0\ 0\ Q_0\ 0\ 1\ 1\ 0}$$

$$\boxed{0\ Q_3\ 0\ y\ 1\ 1\ 0} \qquad \boxed{0\ 0\ x\ Q_1\ 1\ 1\ 0}$$

$$\boxed{Q_4\ 0\ z\ y\ 1\ 1\ 0} \qquad \boxed{0\ w\ Q_5\ y\ 1\ 1\ 0} \qquad \boxed{0\ 0\ x\ y\ Q_2\ 1\ 0}$$

Outcome of N.D TM

Accept: If any branch of the computation accept then NDTM accept.

Reject: If all branches of the computation Halt and Reject (ie no branch in the graph accept) then NDTM Rejects.

Multitape Turing Machine is used for constructing NDTM.

TM	I/p tape (never modified)
FS	Simulation tape (used like tape of DTM)
	Address tape: used to Control the BES tells which choice to perform.