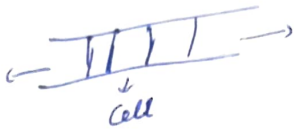
Turing Machine

$M = (Q, \Sigma, \delta, q_0, \Gamma, B, F)$ — Blank or Δ or $\square$

$\delta \quad Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$ — Left, right or stationary

Tape

Language accepted by TM is said recursively enumerable language.

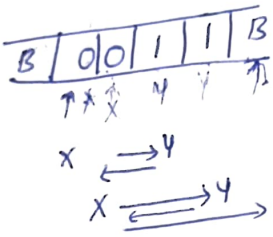


① TM for $0^n 1^n \quad n \geq 0$

Steps: Scan 0, replace with X

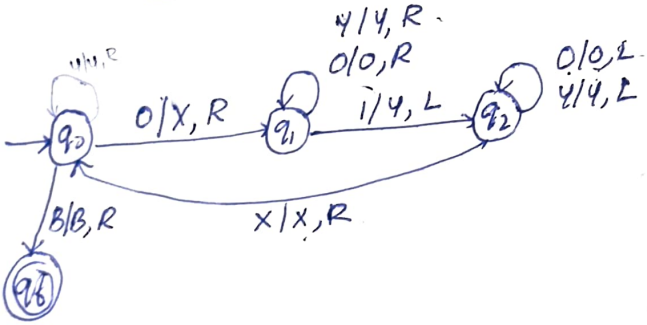
Find first 1 replace by Y

Come back to last X, move to next char if '0' go to step 1

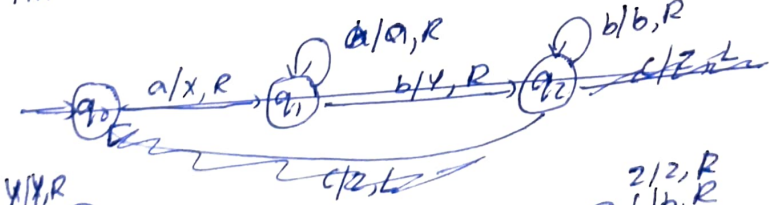


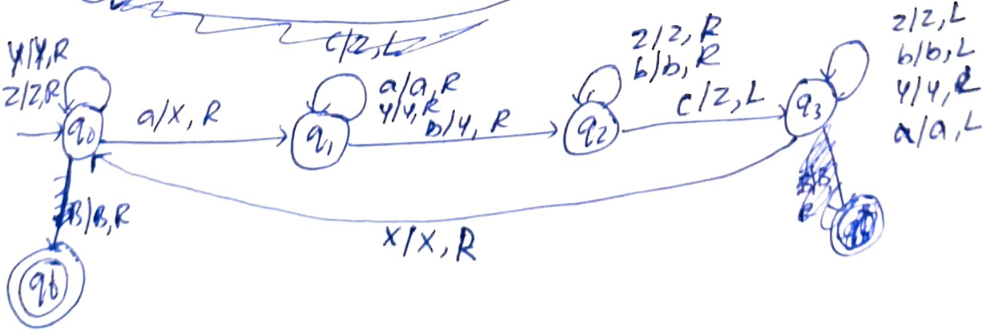
$X \rightleftarrows Y$

$X \rightleftarrows Y$



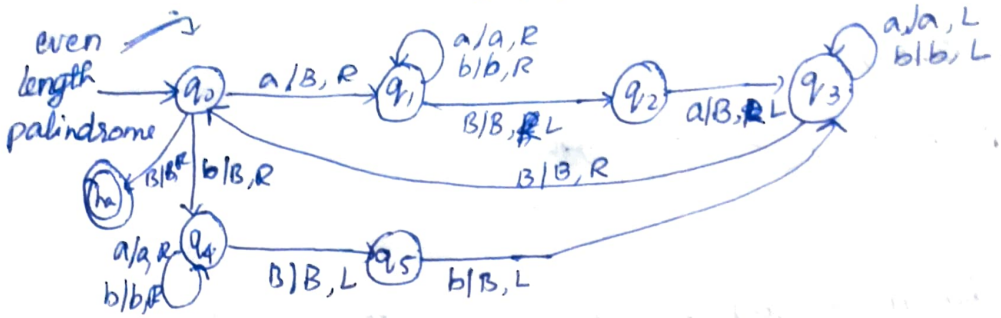
② TM $L = \{a^n b^n c^n \mid n \geq 0\}$



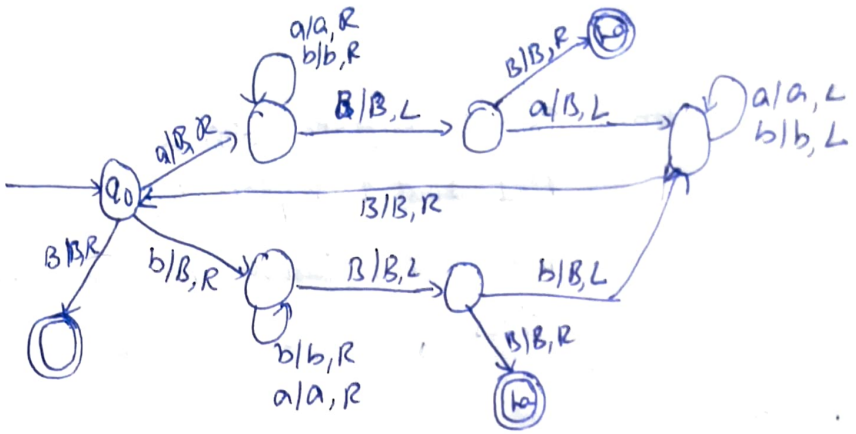


③ TM $L = \{ww^r \mid w \in (a,b)^*\}$ aa abba abaaba bbaab

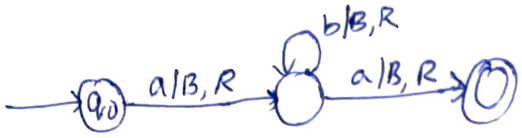
even length palindrome



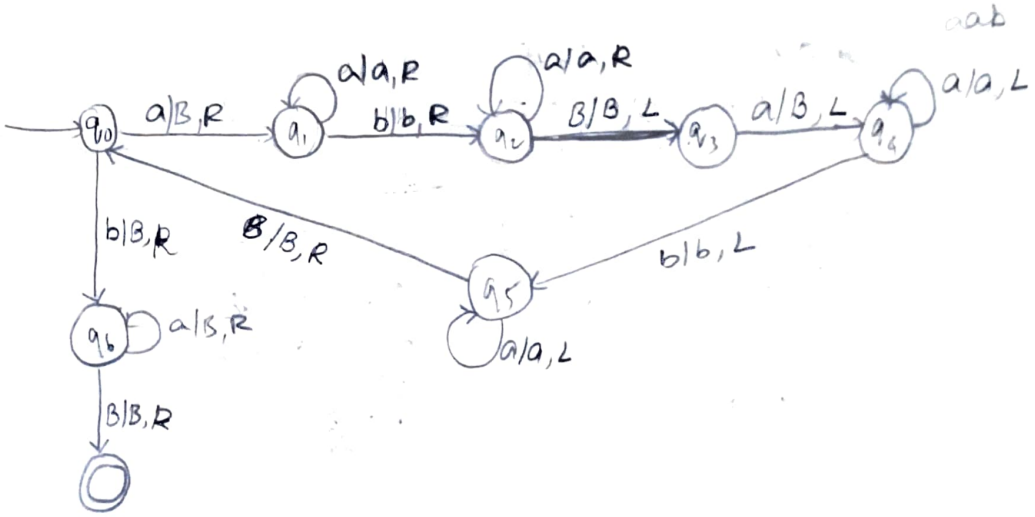
odd length palindrome aba baaab baaab



④ TM for $L = \{ab^n a \mid n \geq 0\}$



⑤ TM for $L = \{a^i b a^j \mid 0 \leq i \leq j\}$ i=2 j=2 aabaa i=2 j=3 aabaaa



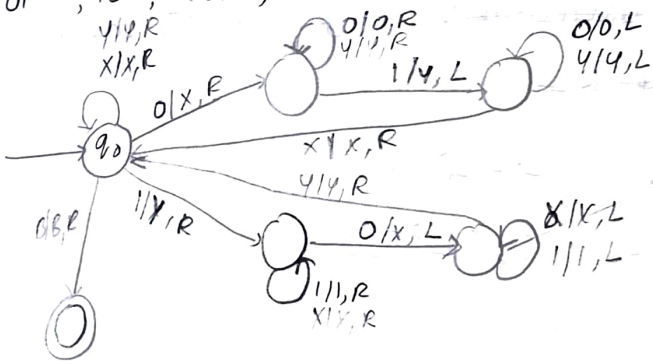
Check if abaa is accepted or not by ID of TM

q_0 Babaa
$\vdash B q_0 baa$
$\vdash Bb q_2 aa$
$\vdash Bba q_3 a$
$\vdash Bbaa q_2$
$\vdash Bba q_4 B$
$\vdash Bb q_A aB$
$\vdash B q_5 baB$
$\vdash B B q_6 aB$
$\vdash BBB q_f B$ → Accepted

q_0 abaab
$\vdash B q_1 baab$
$\vdash Bb q_2 aab$
$\vdash Bba q_3 ab$
$\vdash Bbaa q_2 b$
↓ Rejected

⑥ Set of Strings with an equal no. of 0's and 1's

01 , 10 , 1010 , 0101 , 0011 , 11000110



Turing Machine

① Construct TM for $L = \{ss \mid s \in \{a,b\}^*\}$

aaaa aa abab babbab

Idea: Seperate whole string into two parts (bab|bab)

Steps: Change all characters to its uppercase characters & any other cha

b a b b a b
↓ ↓
X a b b a X
↓
X A b b A X ....

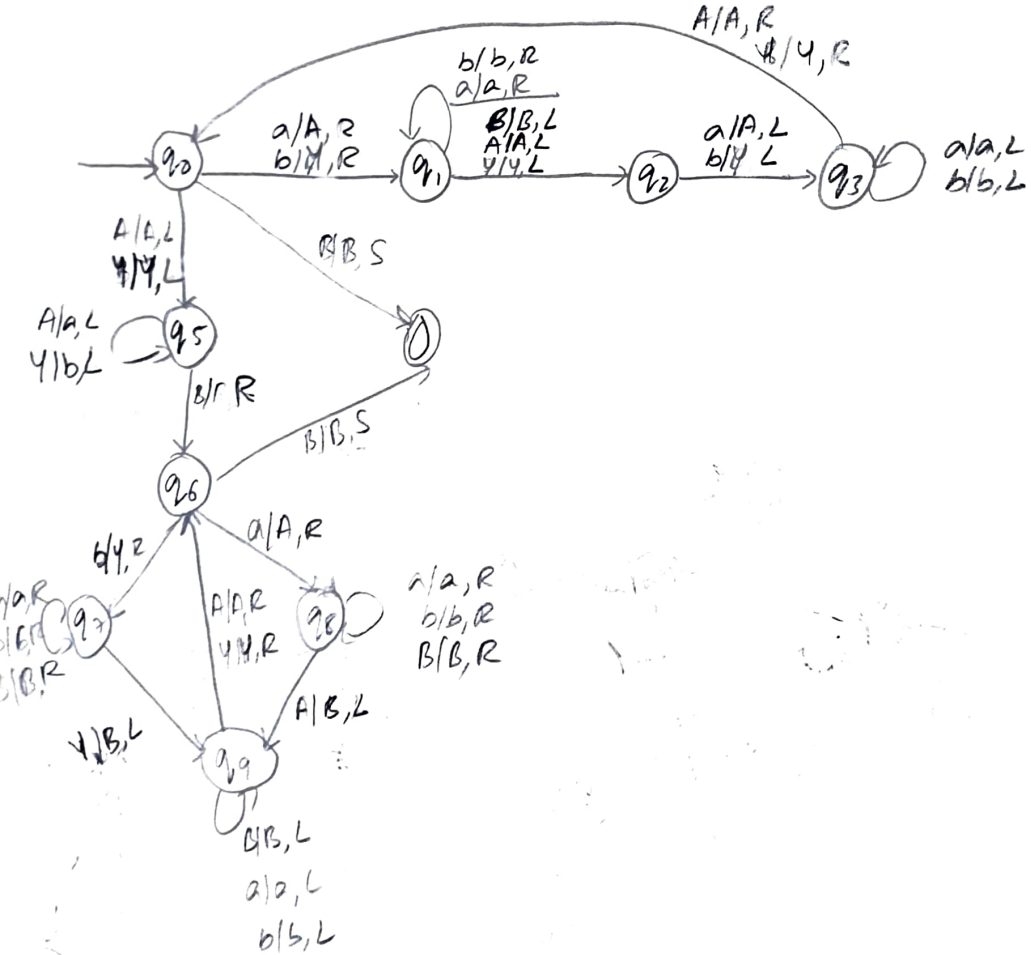
A → A
b → Y

~~a a b a b a b~~

While changing is done, you will ~~at~~ be at mid of string

Replace left part to its original character.

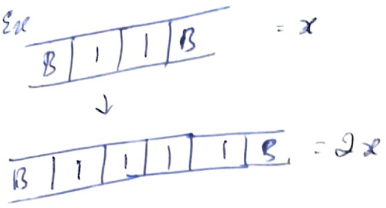
Then cancel-out the same original characters with its uppercase.



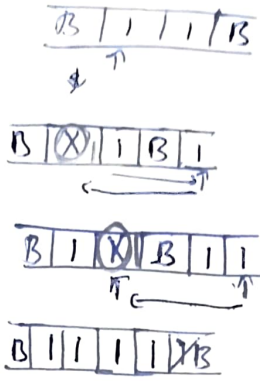
Computing a partial function with a TM

① $x = 2x$

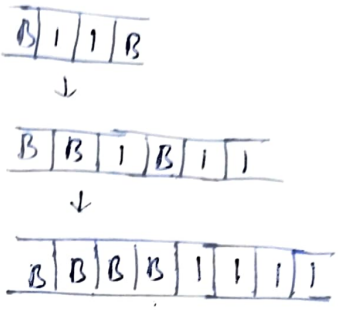
Ex

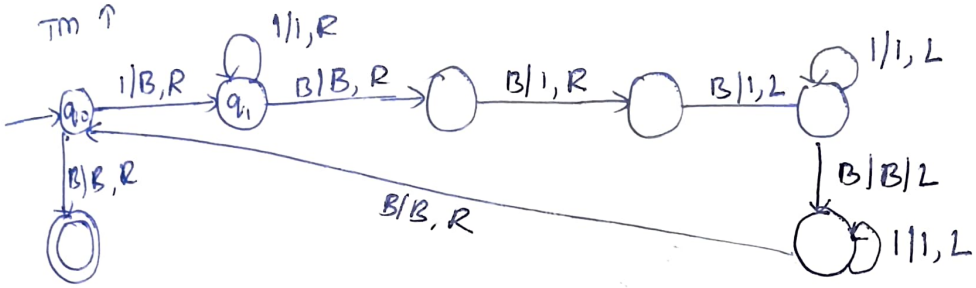


1st approach



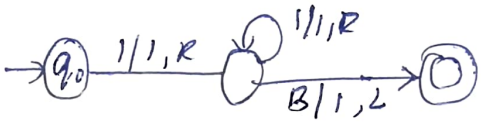
2nd





① $f(x) = x+1$, $x \in 1^*$

② $f(x) = x+1$, $x \in 1^+$

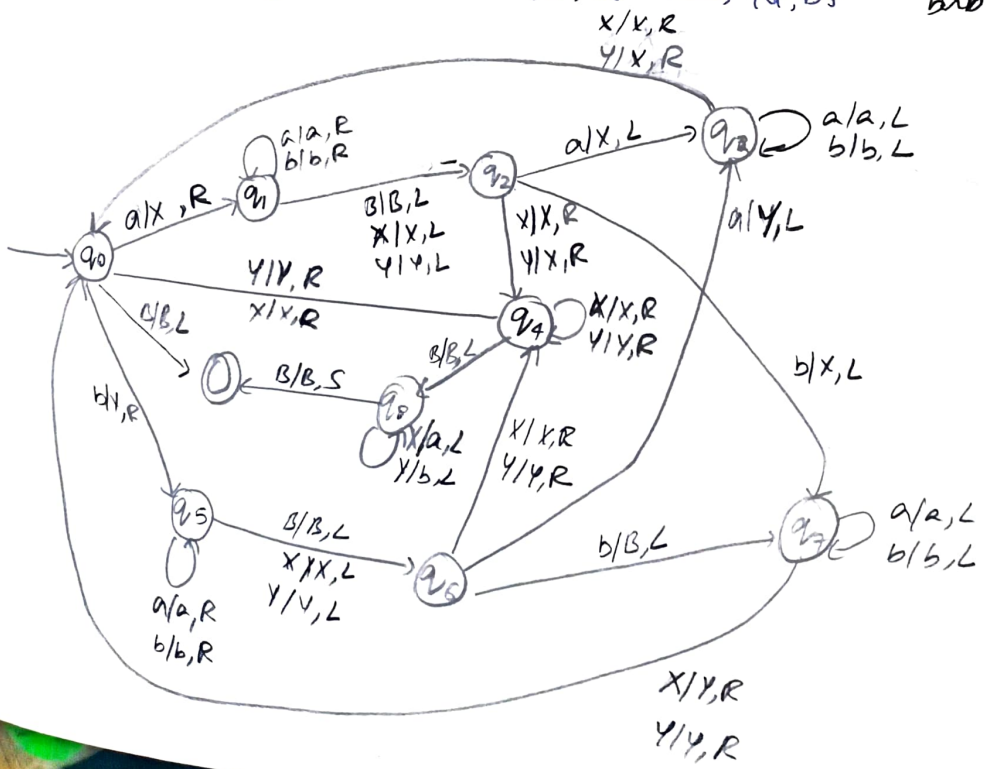


③ Reverse a string

$rev: \{a,b\}^* \longrightarrow \{a,b\}^*$

abb → bba a → a

baba → abab

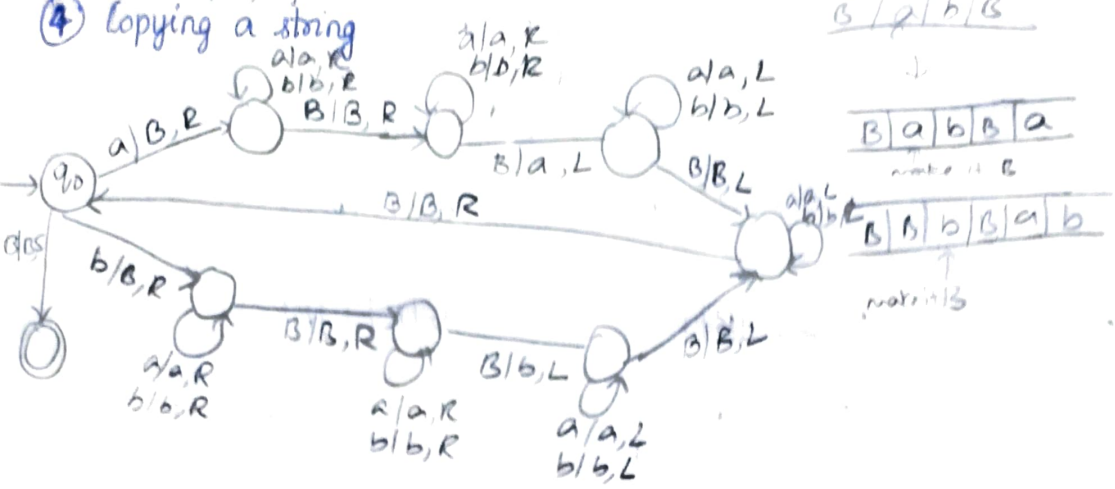


Idea:

abb	a	baba
Xbb	X	Yaba
Xbx	a	YabY
Ybx		XabY
YYX		XXbY
bba		XXXY
		XYXY
		abab

$x \in \{a,b\}^*$

④ Copying a string



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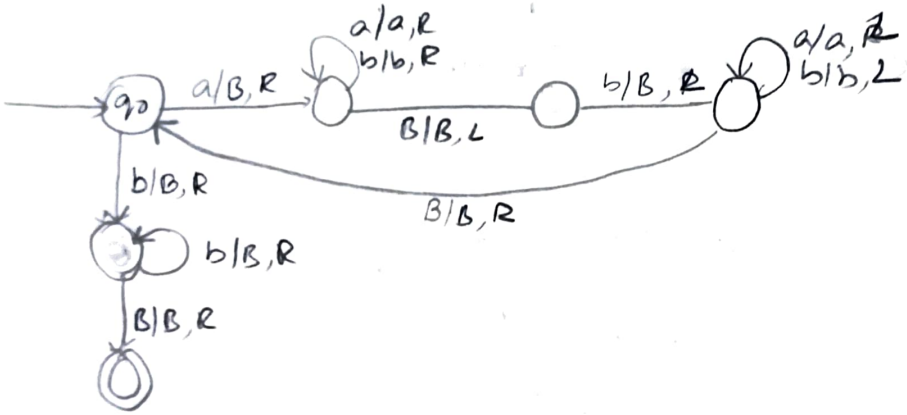
① Draw transition diagram for TM

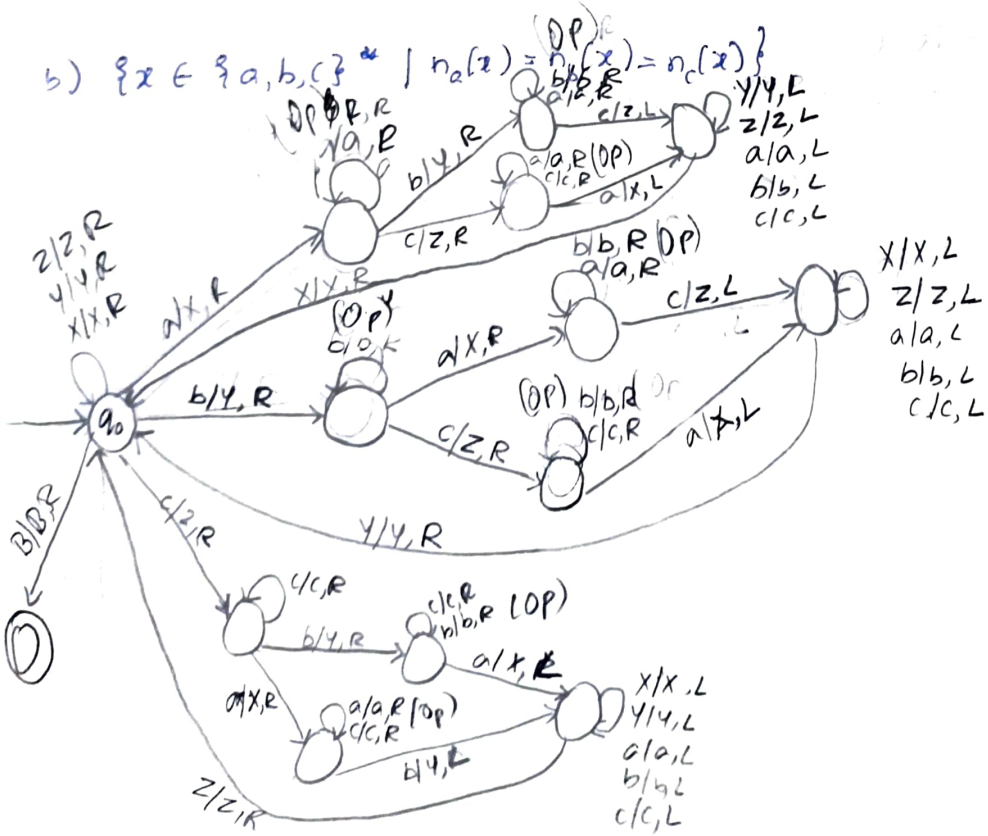
a) $\{a^i b^j \mid i<j\}$ aabbb ✓ aabb ✗



b) $\{x \in \{a,b,c\}^* \mid n_a(x) = n_b(x) = n_c(x)\}$

aibacbccba

X Y X Z Y Z Z



OP
X/X,L
Y/Y,L
Z/Z,L

~~abb~~