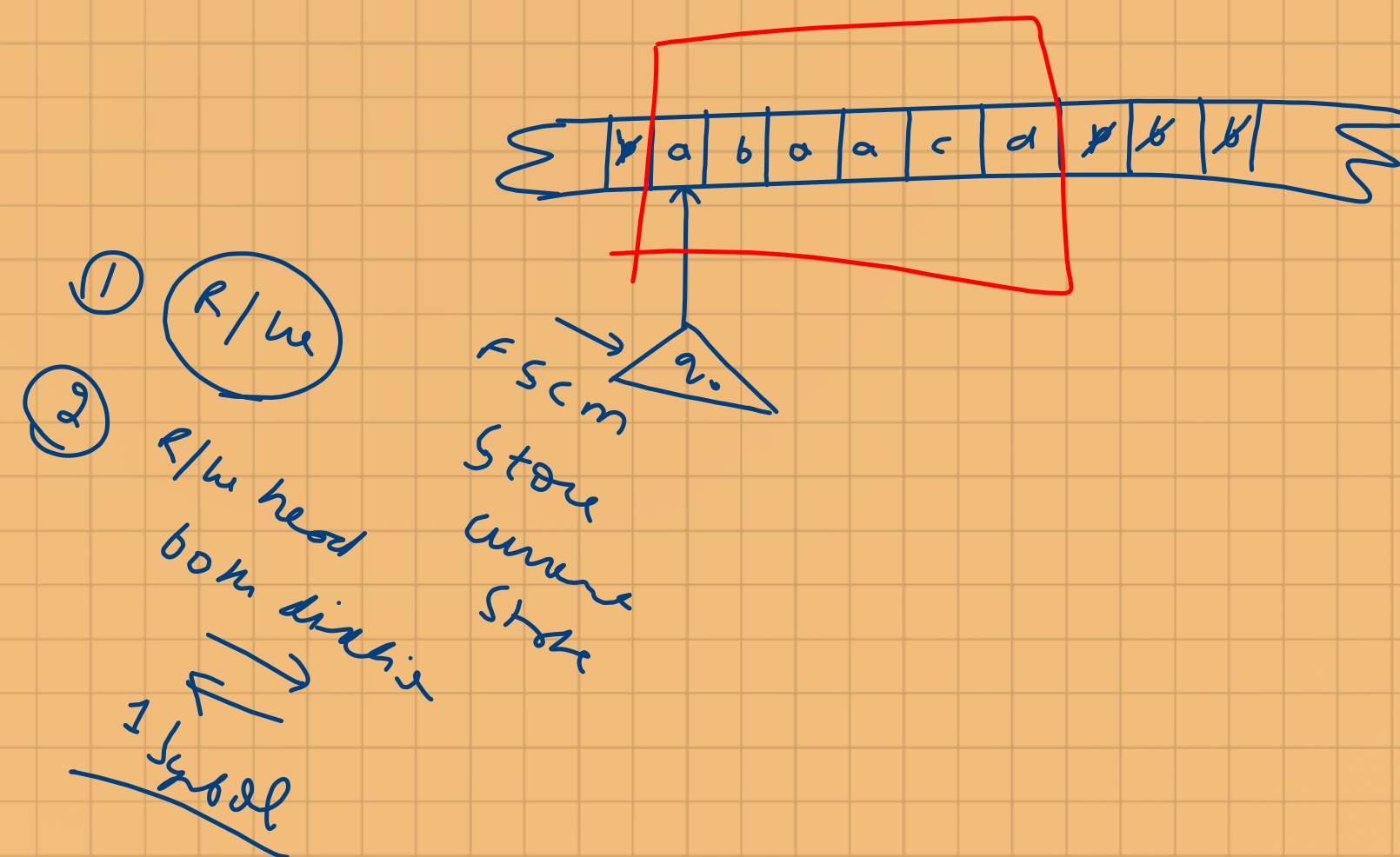




Introduction to T.M.

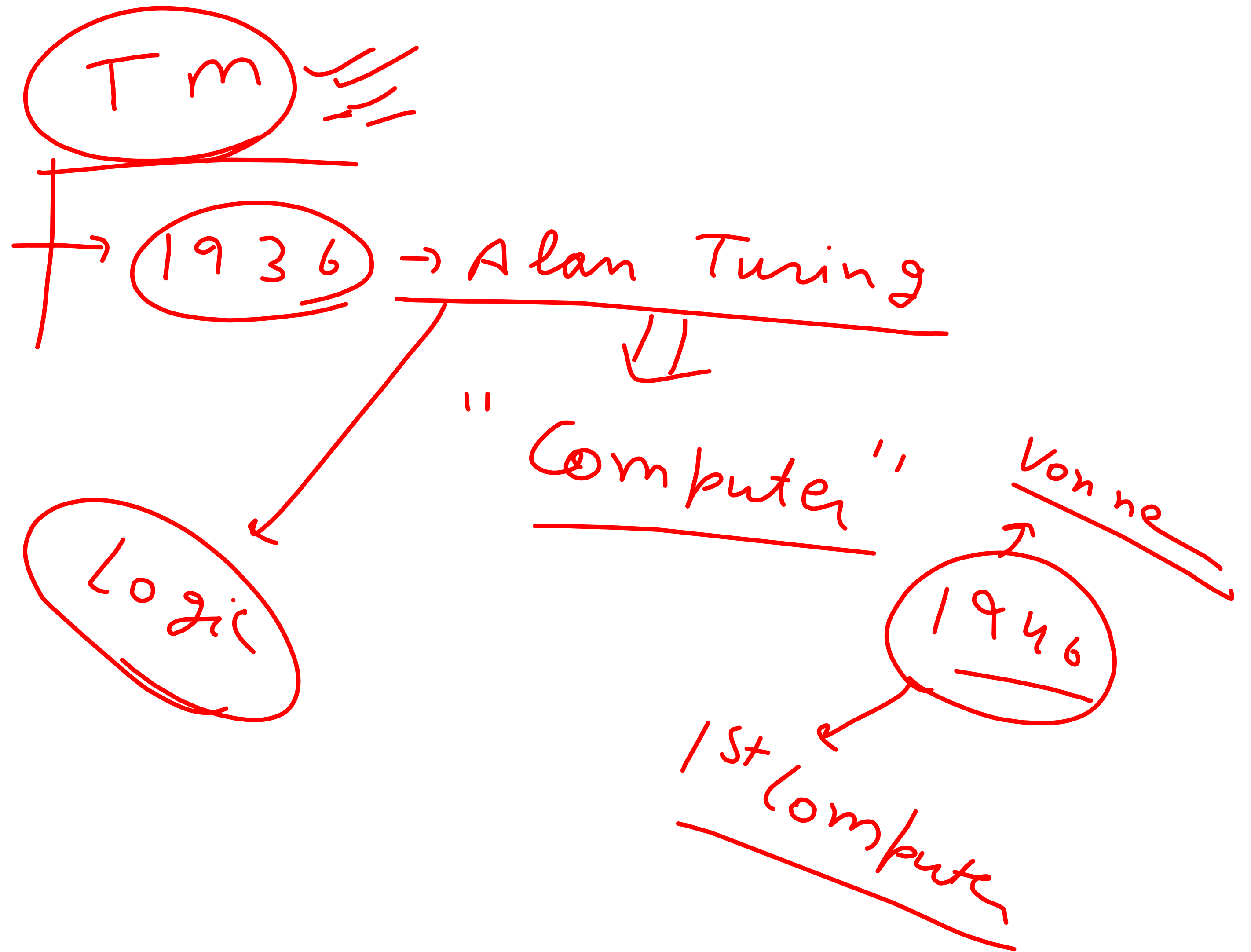




- ① Tm consists of tape of ∞ length
divided into cells & one cell store
one symbol at a time
- ② Except for some finite portion which contain
if rest of the cells store blank
- ③ Hence nonblank portion of tape is finite
but actual tape is infinite



- ④ Tm has r/w head which is positioned to 1st symbol of I/P string
- ⑤ one end of r/w head is connected to tape while other end is connected to FSCM
- ⑥ R/w head can read only one symbol at a time & it can change symbol also
- ⑦ It can move only one cell at a time either forward or backward





Formal defⁿ of TM:-

TM is "7 tuple"

$TM = (Q, \Sigma, \delta, q_0, F, \Gamma, \gamma)$

$\emptyset, \# \dots$

Tape symbol

Whatever symbols
used in the

I/r Alphabet
symbols

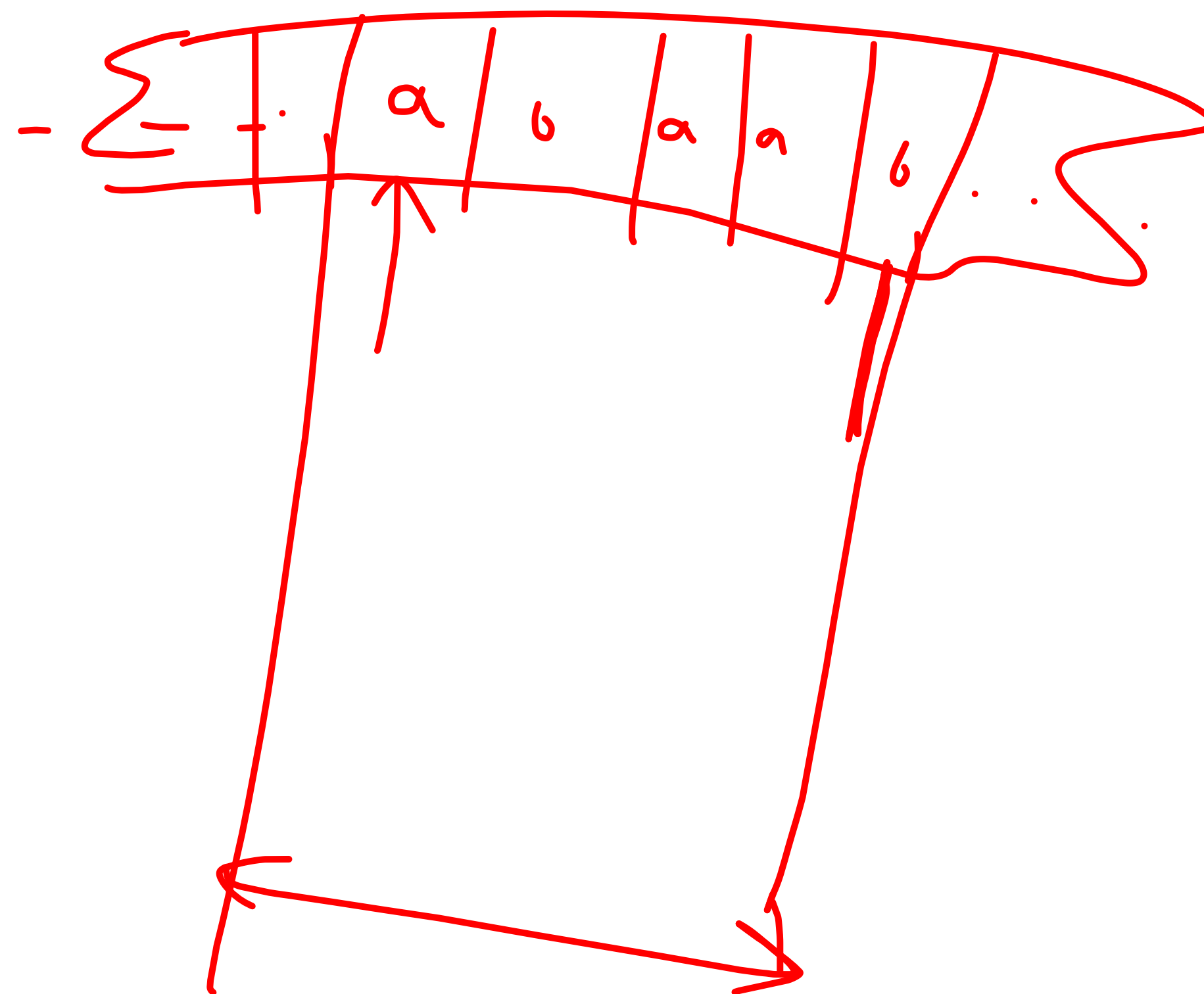
$\Sigma = \{a, b\}$

$a \in \Sigma$
 $a \in \Gamma$

	x	y	x
Σ	$\{a, b\}$	$\{a, b\}$	$\{a, b\}$

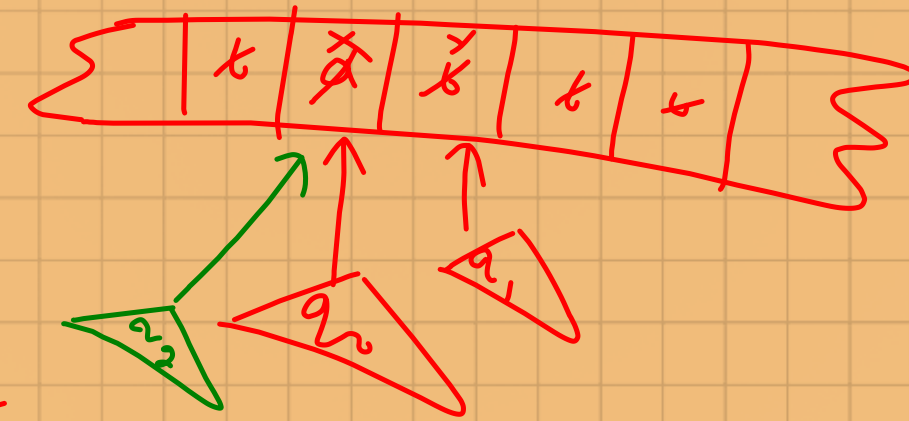
$\Gamma = \{a, b, x, y\}$

$\Sigma \subset \Gamma$





$$\underline{Q \times \Gamma} \rightarrow \underline{Q \times \Gamma \times 0} \quad \delta:-$$



$$\begin{aligned} \delta(q_0, a) &= (q_1, x, R) \\ \delta(q_1, b) &= (q_2, y, L) \end{aligned}$$

Standard TM

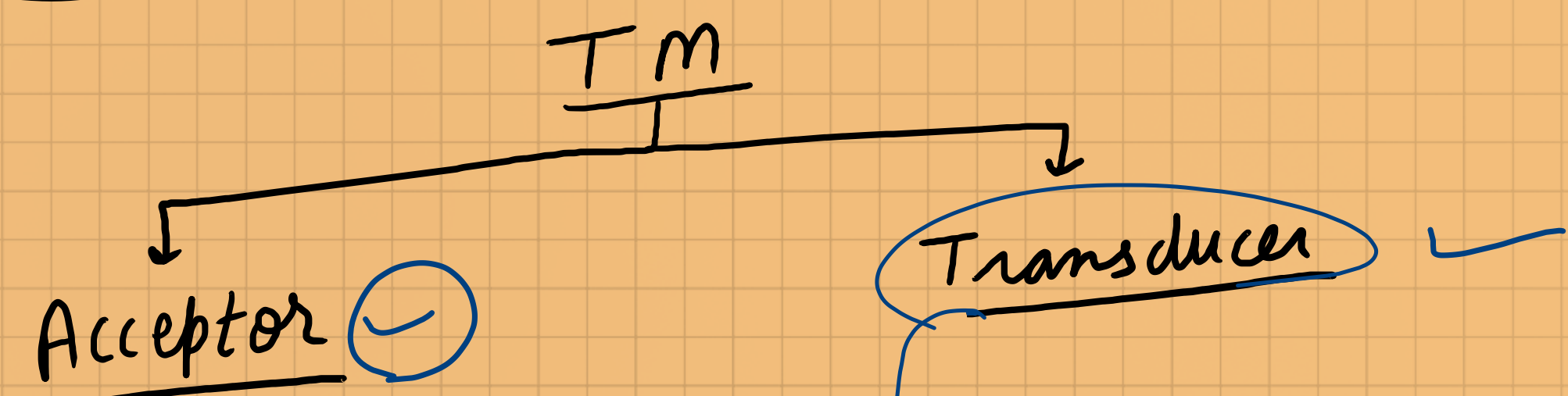
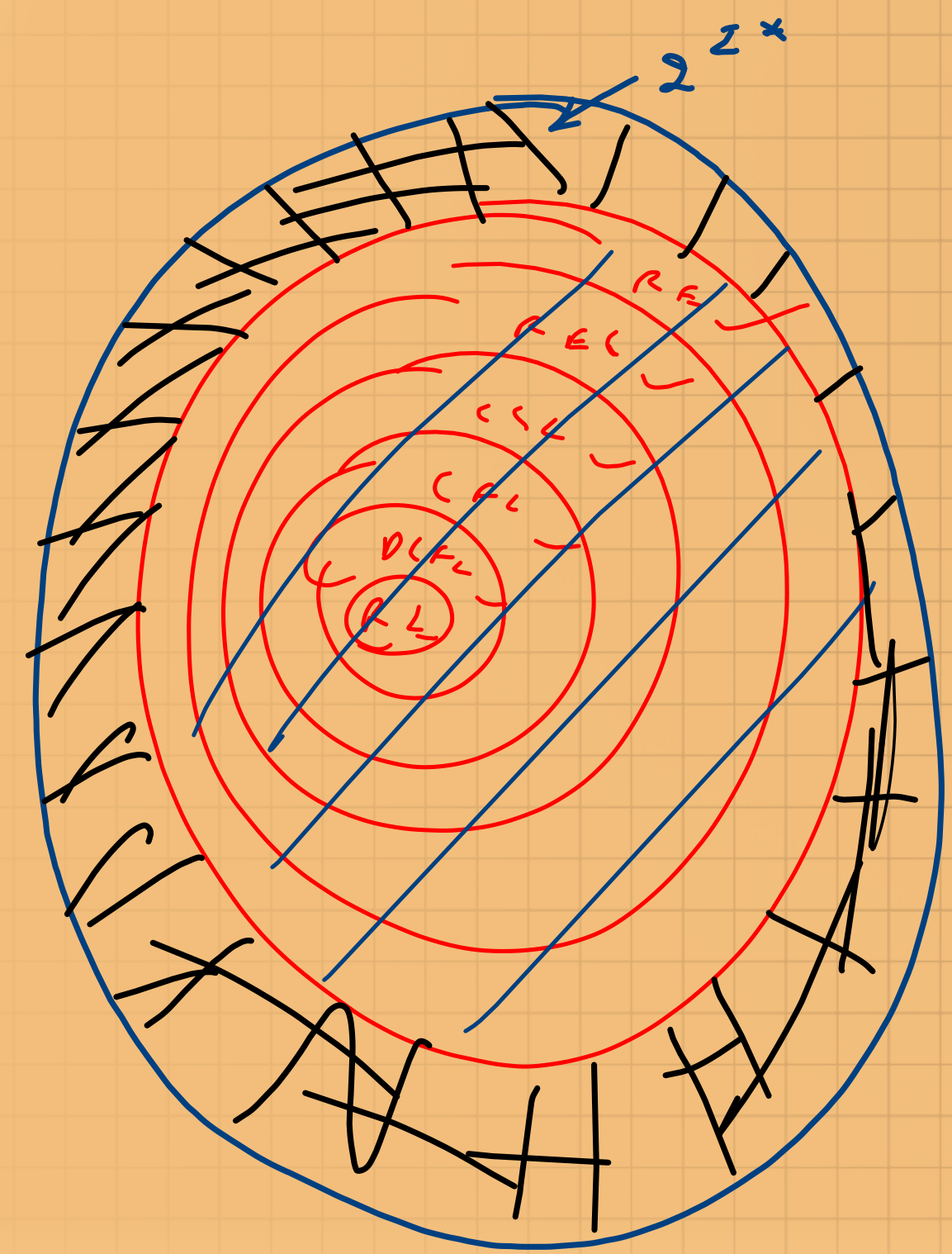
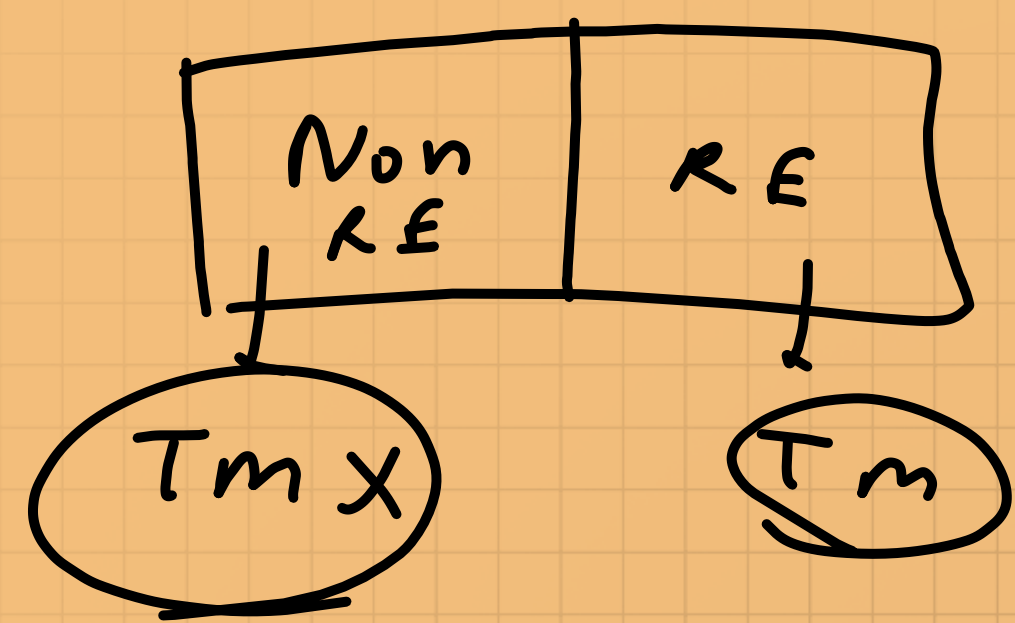
$\Downarrow$

DTM

$q_f \rightarrow \underline{\text{no more}}$

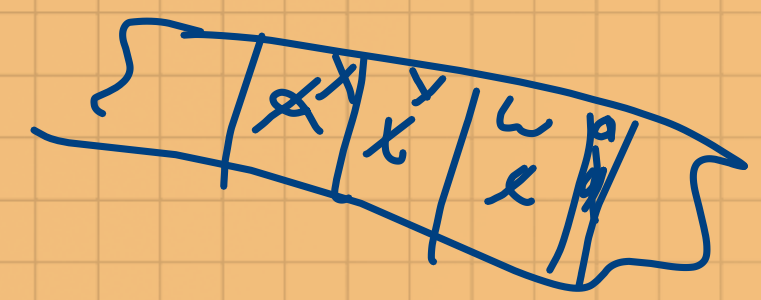
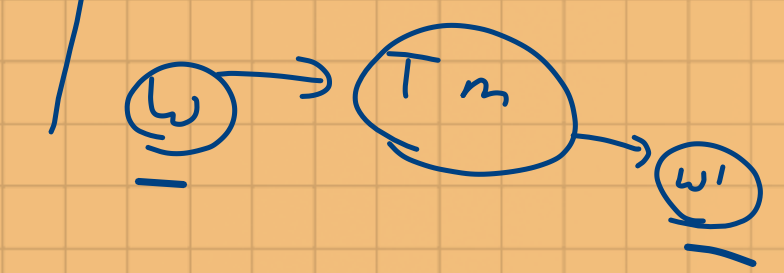


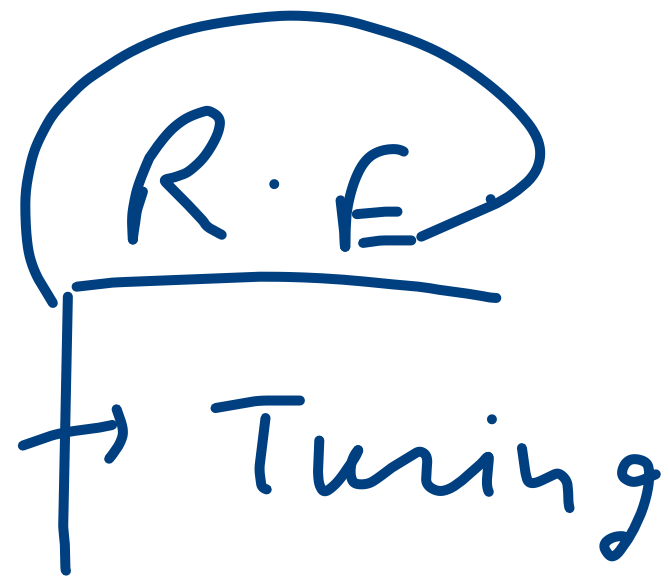
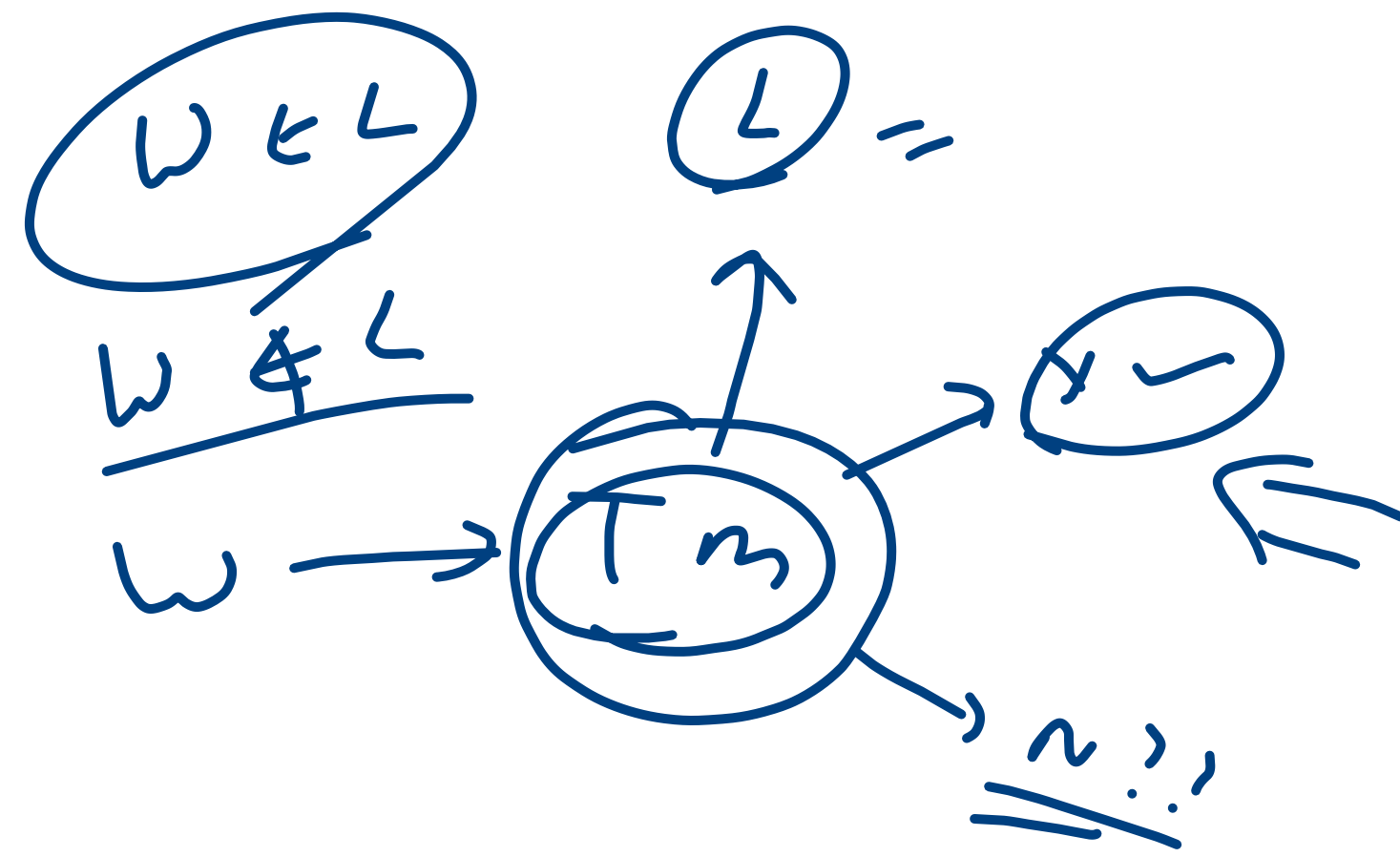
2^{ϵ^*}



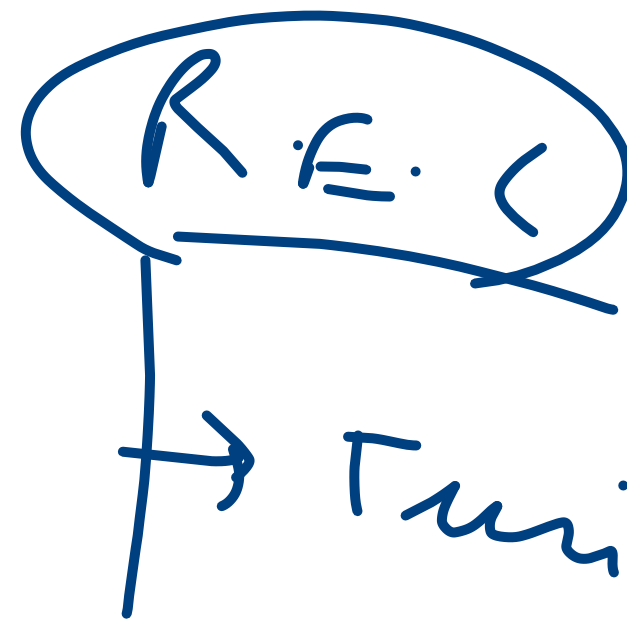
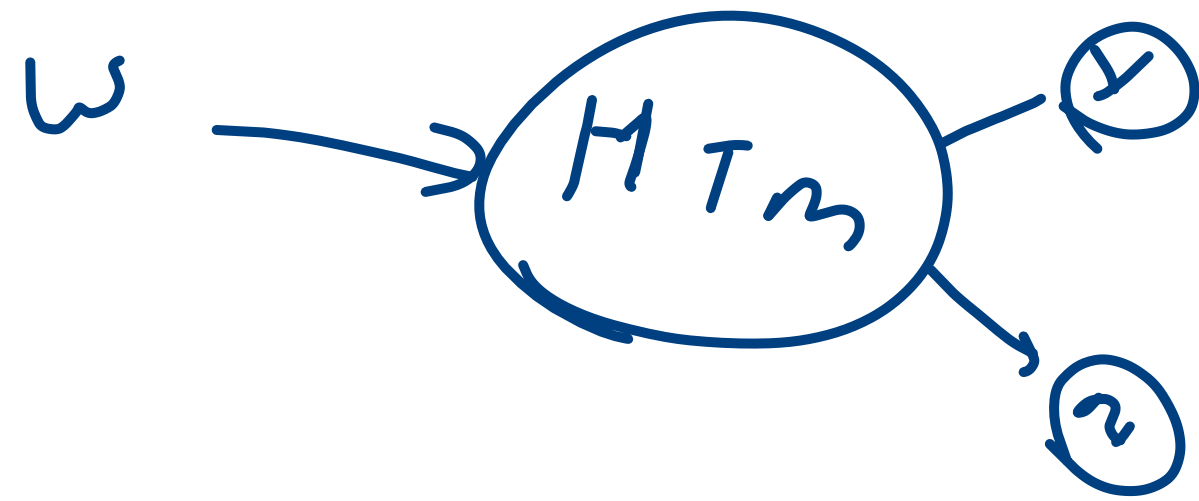
→ As an acceptor it accepts
R.E. Languages

$RE \subseteq$
 $\subseteq CS$
 $\subseteq CFL$
 $\subseteq DCL$
 $\subseteq R^2$

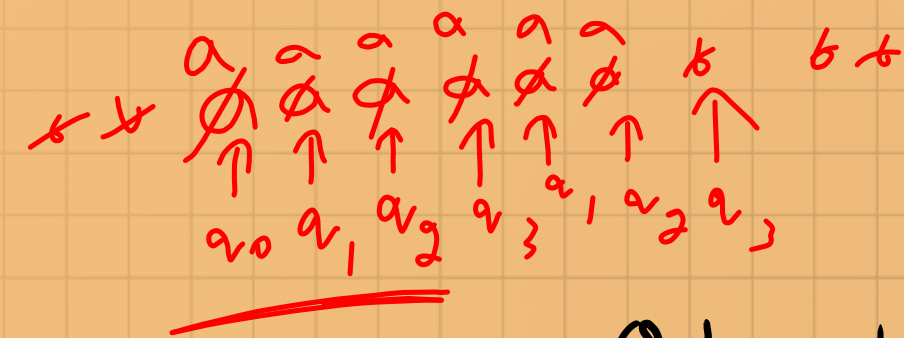




Acceptable Languages

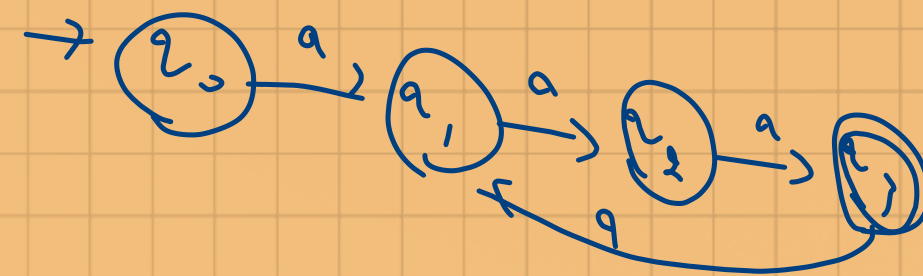
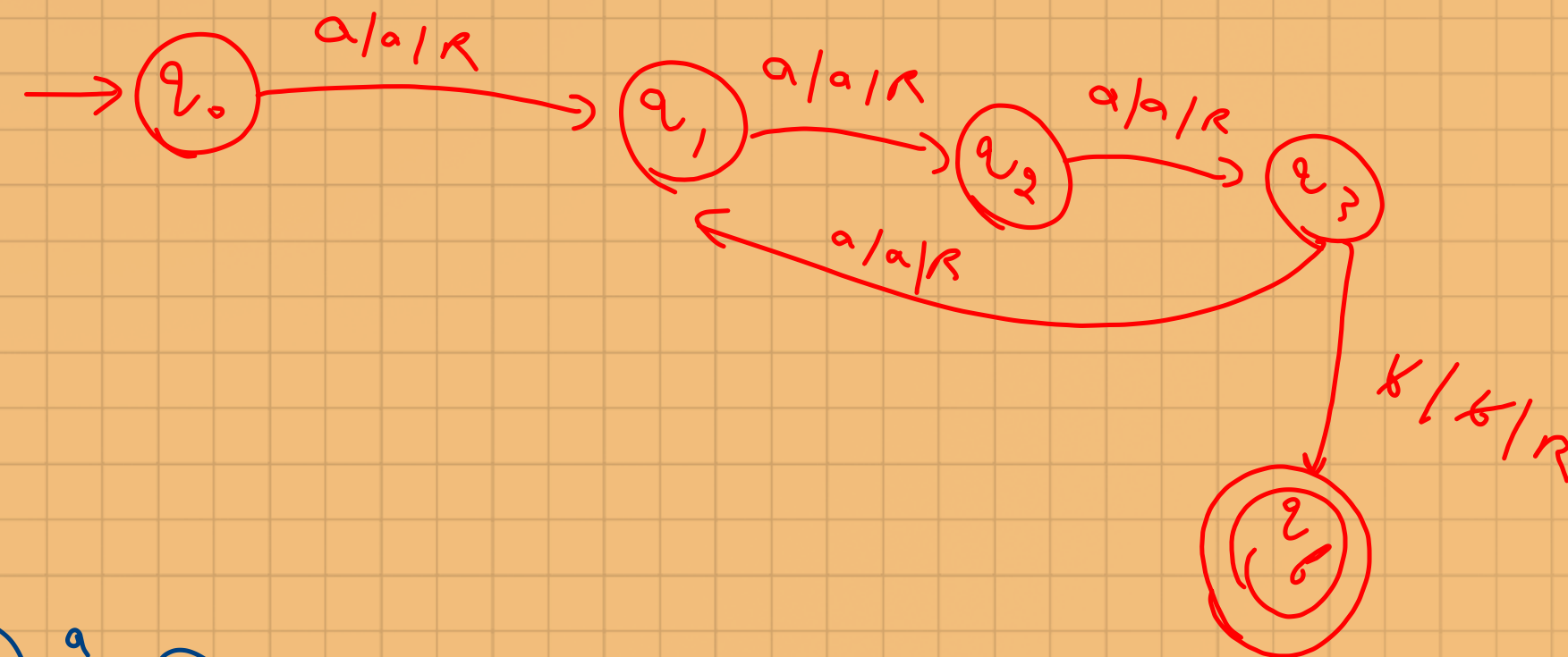


Decidable Languages



TM as acceptor

Q1 $L = \{ \underline{a^{3n}} \mid \underline{n \geq 1} \} \Rightarrow \underline{R-L} \checkmark$



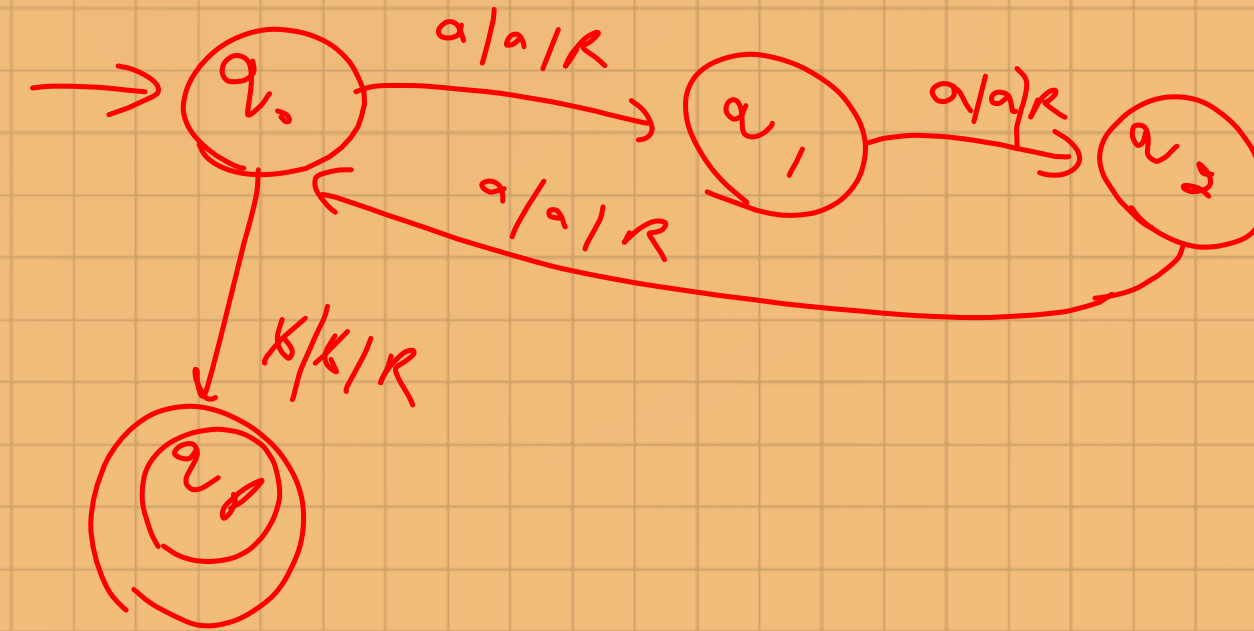


$\Sigma \{a, b\}$

i_0

$L = \{a^{3n} \mid n \geq 0\}$

FA

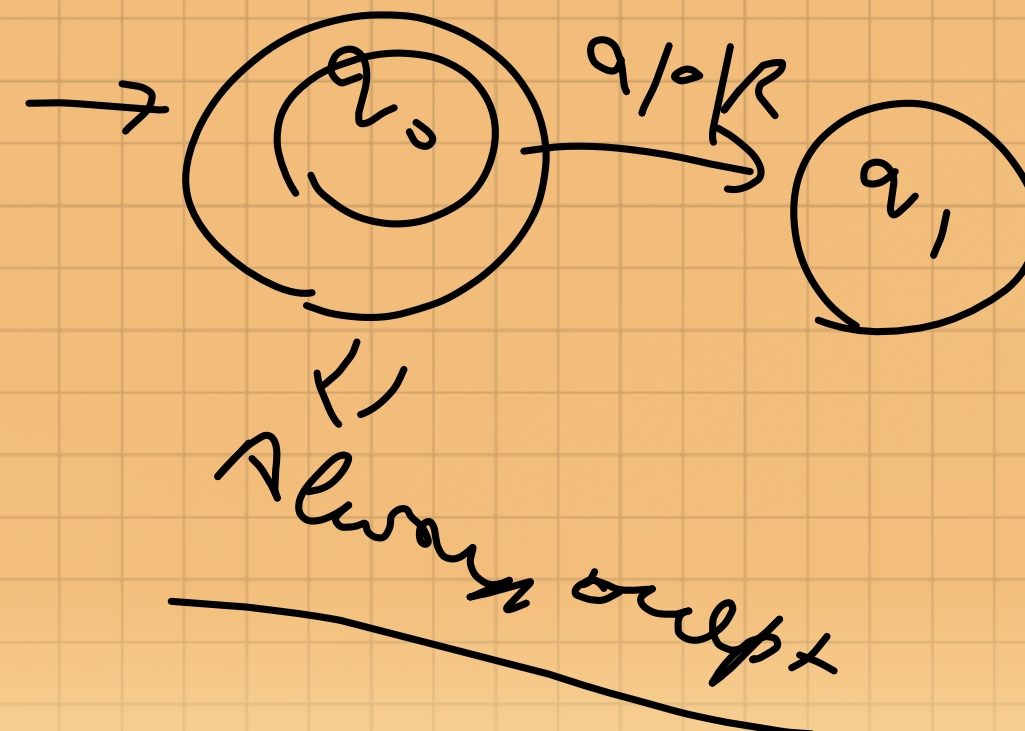




Unlike FA & PDA T.m.
accept the string immediately
by entering one of final state

Do not make
initial a final
to accept ϵ string

[Regardless of the fact that
T.m has read entire string
or not]



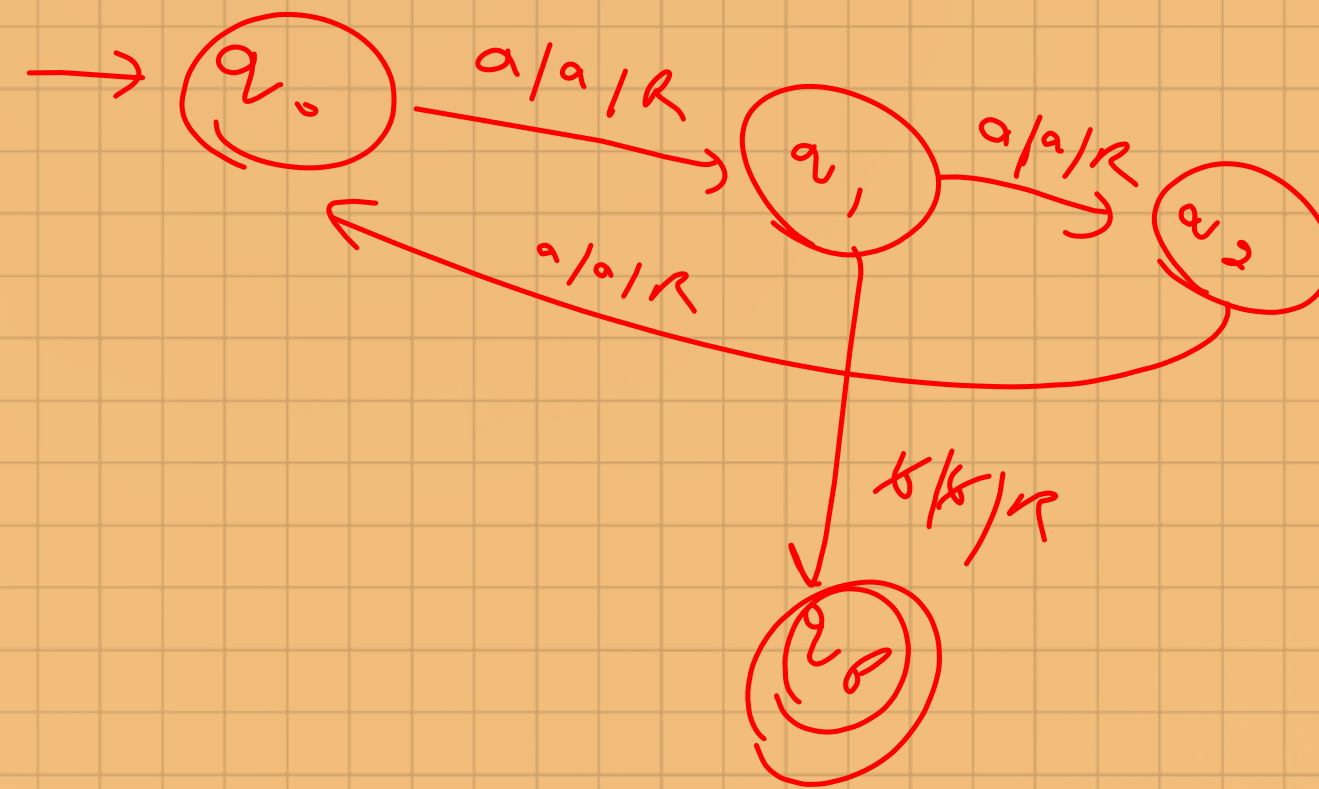


Imp. Points

- No Transition on Final State
- If transition is given on final state then it will be ignored by TM
- If TM ends any one of Final state then string will be accepted blindly.

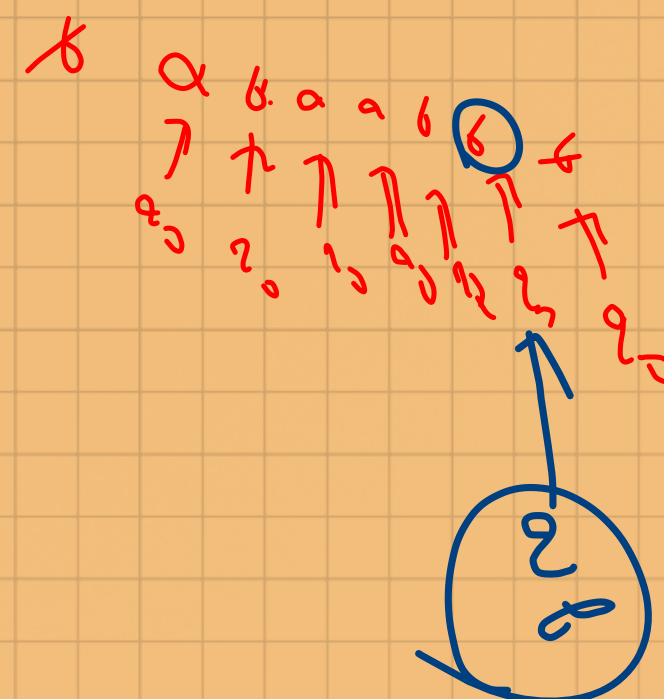
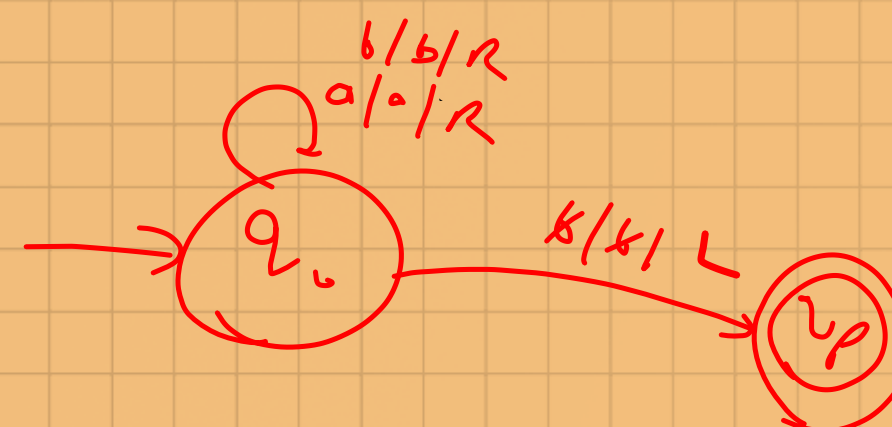
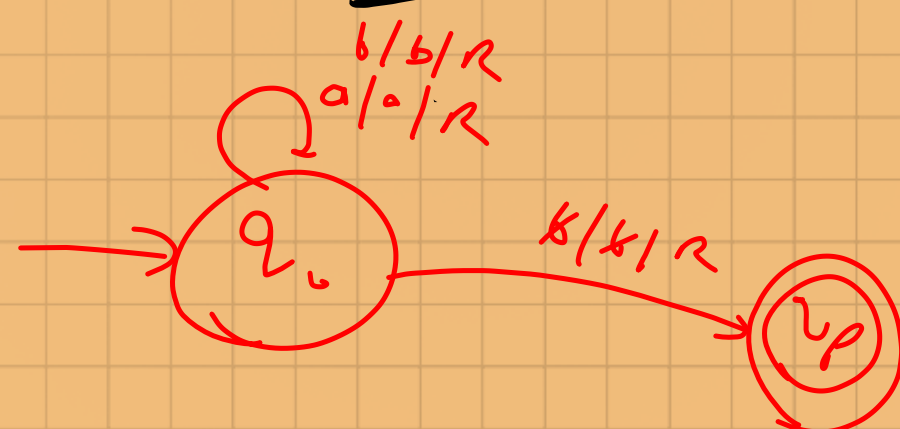


Q3 $L = \{a^{3n+1} \mid n \geq 0\}$



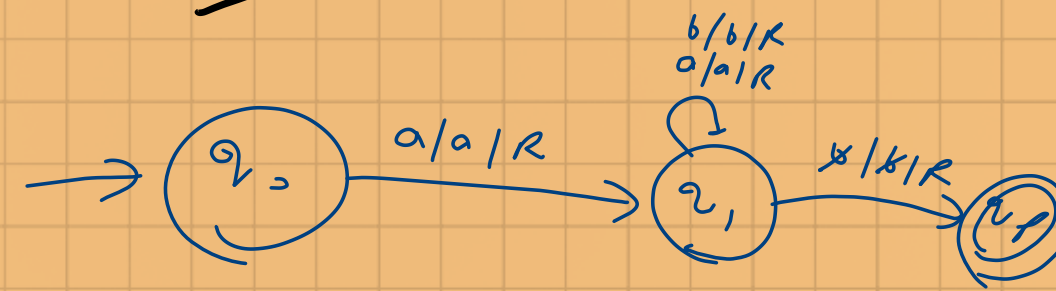


Q4 $L = (a+b)^*$





Q5 $L = a(a+b)^*$

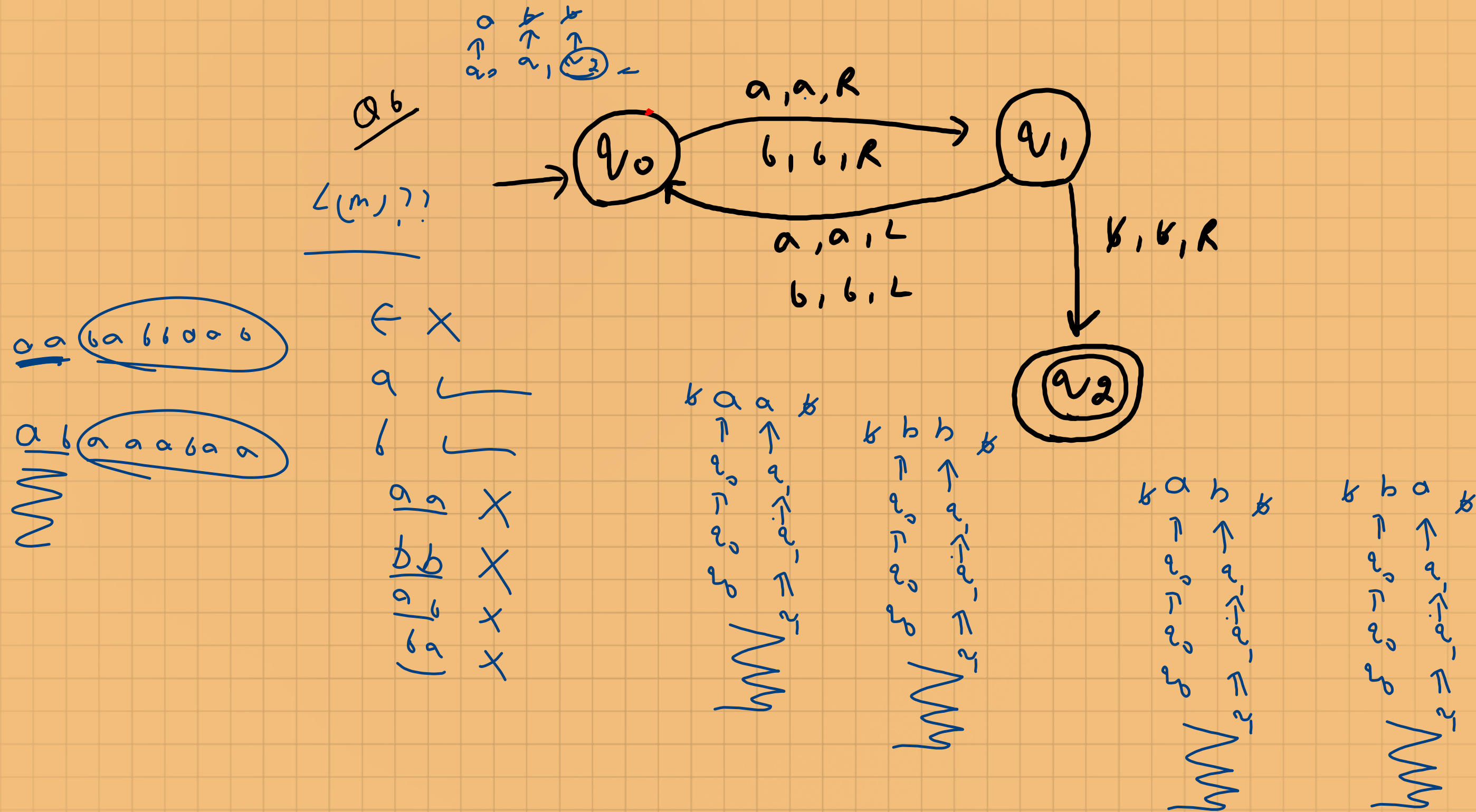


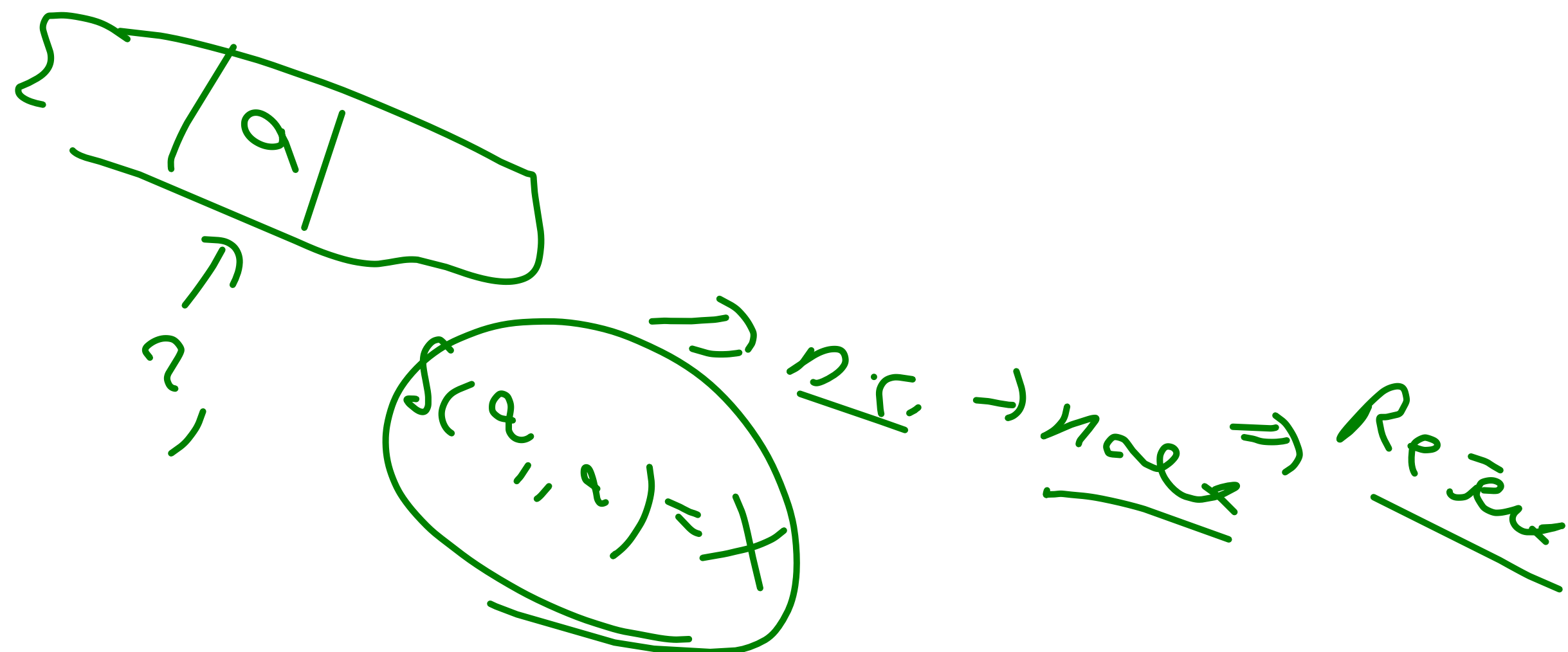
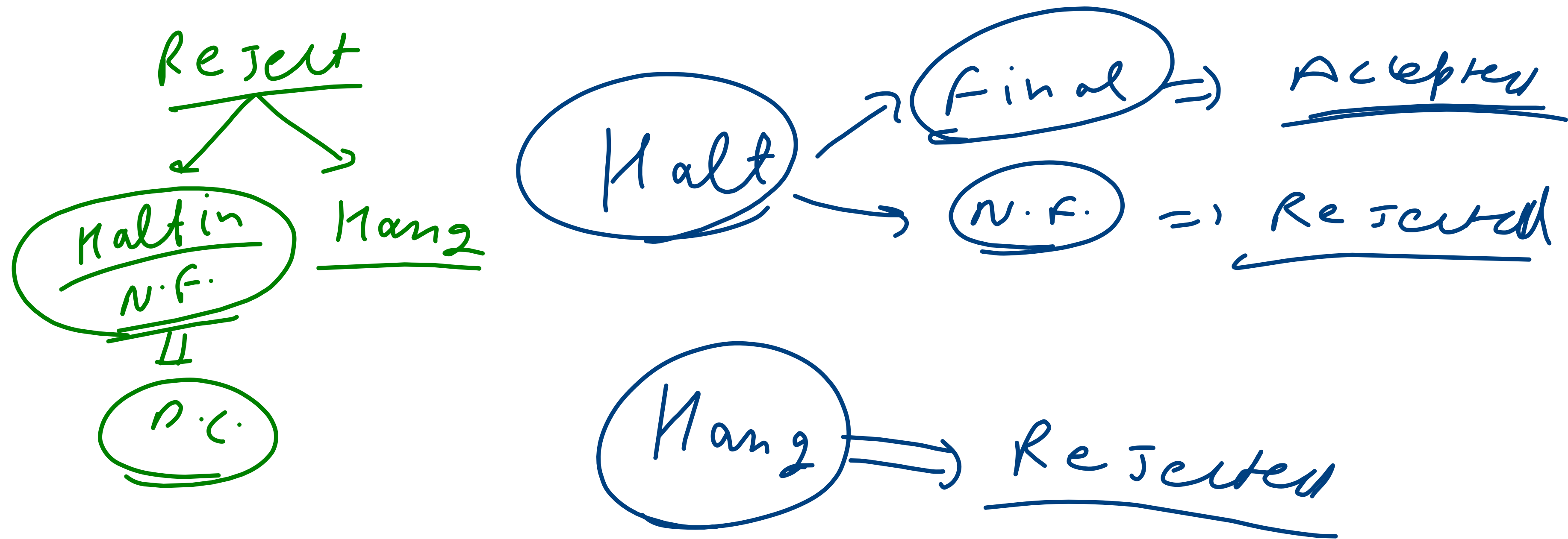


$$\underline{L(m)} = \underline{\{a, b\}} \Rightarrow \underline{(a+b)}$$

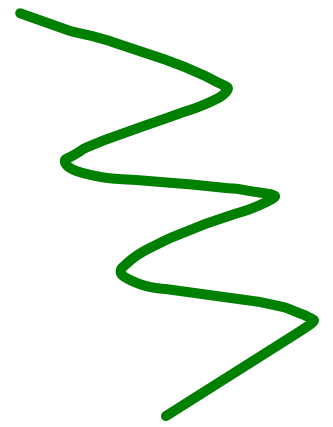
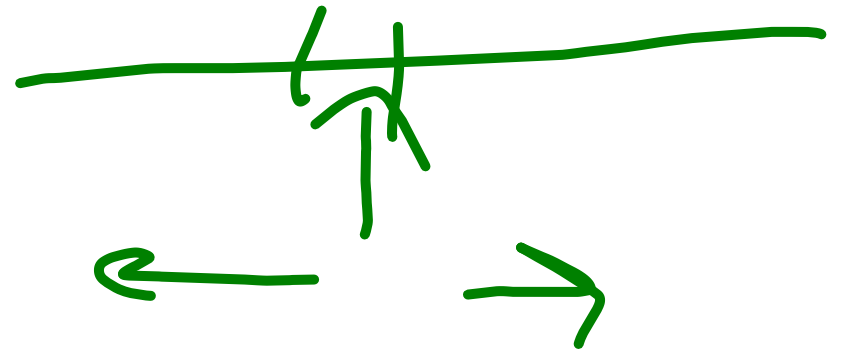
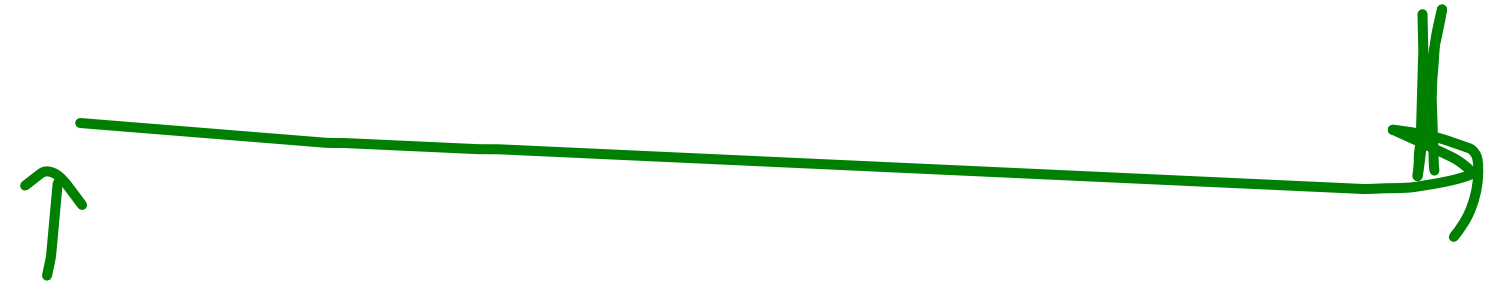
→ Halt & Reject = $\{ \epsilon \} =, \underline{\epsilon}$

$\rightarrow \text{Hanging Retard} = \underline{(a+b)(a+b)(a+b)^x}$





FA, PDA → Neuer Name





- ① Tm will accept string by halting in one of the final states.
- ② Tm can reject strings by halting in D.C.
- ③ Tm can reject string by hanging



Summary

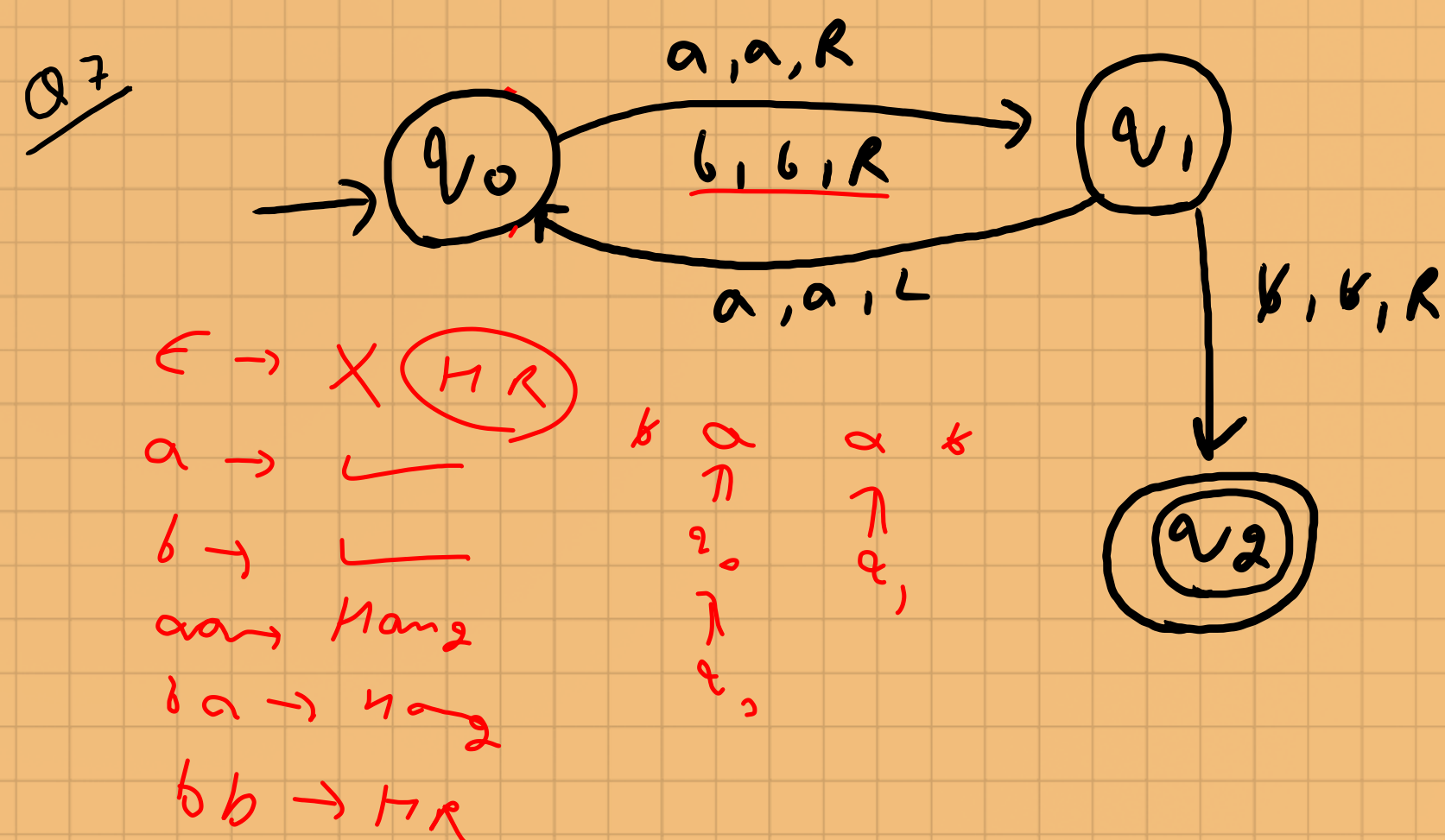
- $n \text{ alt} \rightarrow \{\epsilon, a, b\}$
- $\text{hang} \rightarrow (a+b)^+(a+b)^+$
- $L(m) \rightarrow (a+b)^+$
- $\text{halt \& reject} \rightarrow \epsilon$

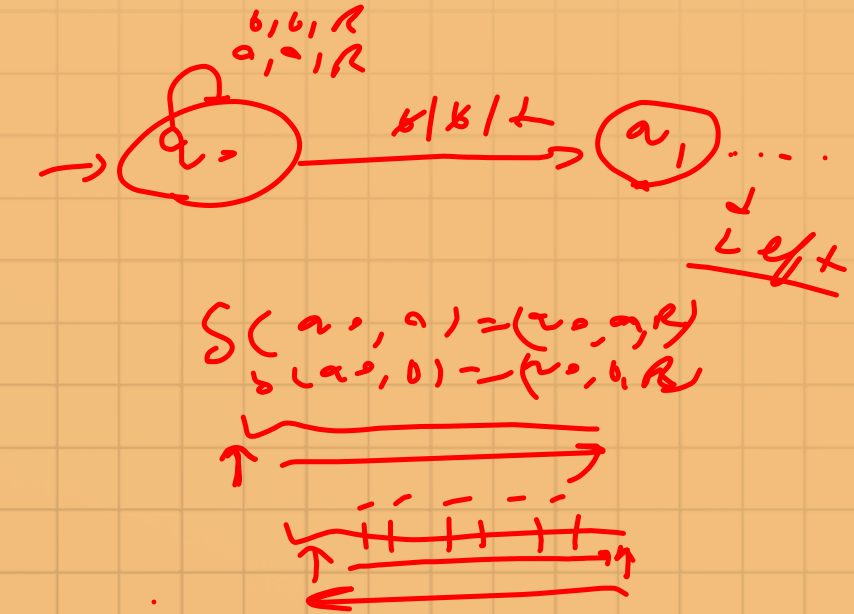
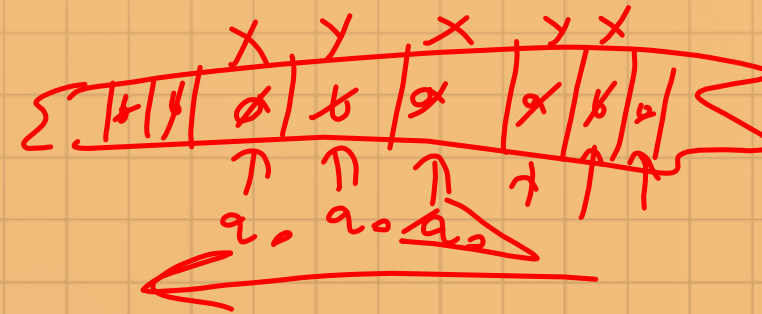


Hang & Reject $\Rightarrow (a+b)a(a+b)^*$

Accept $\Rightarrow (a+b)$

Hang & Reject $\Rightarrow \epsilon + (a+b)b(a+b)^*$





Note:-

→ If R/w head is allowed to move only in one direction then TM is equivalent to FA i.e. now this modified TM can accept only regular languages.

→ So in GATE if TM came & $L(M)$ find then simply see if only one direction movement then $L(M)$ is regular but vice versa not true.

One direction $\rightarrow$ Regular
Regular $\rightarrow$ 2 direction



$S(a_3, b) = X$
Halt & Reset

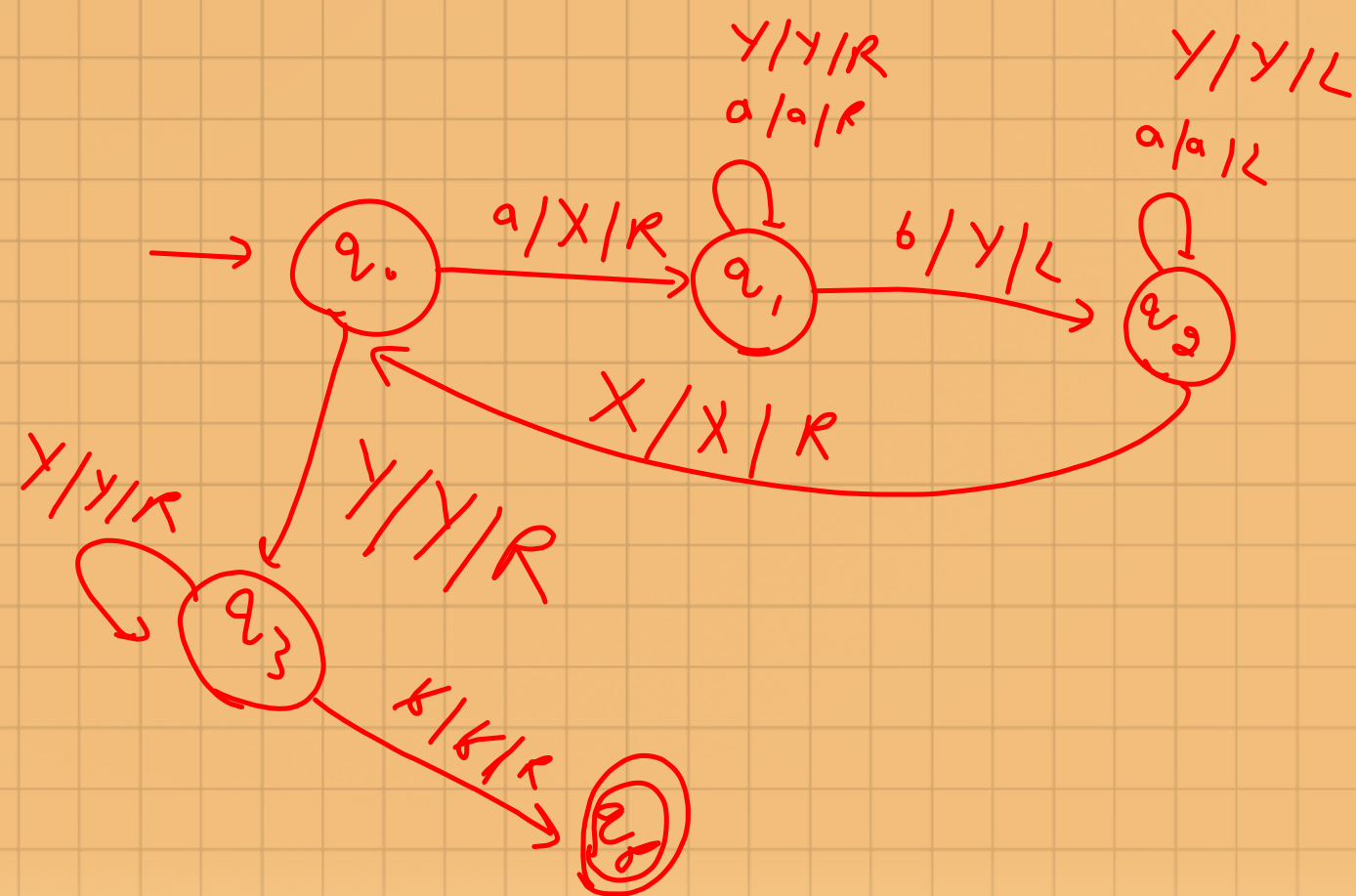
X X X Y Y
~~b~~ ~~a~~ ~~a~~ ~~b~~ ~~b~~ ~~b~~ ~~b~~
↑ ↑ ↑ ↑ ↑
 q_2 q_2 q_3 q_3 q_3

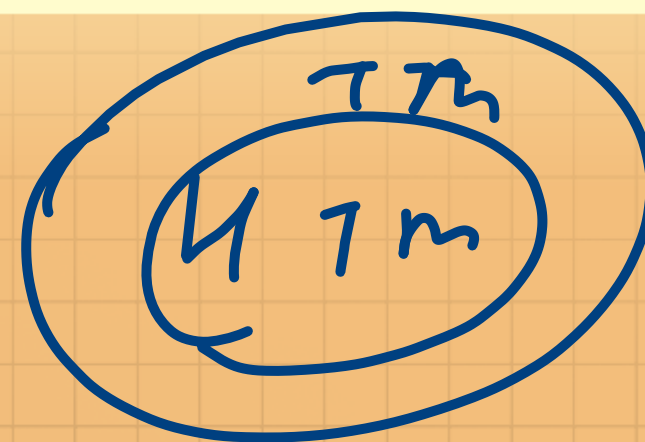
~~b~~ X X X Y Y
~~a~~ ~~a~~ ~~a~~ ~~b~~ ~~b~~ ~~b~~
⇒ ↑ ↑ ↑ ↑
 q_0 q_1 q_1 q_1

Halt & Reset
 $S(a, b) = X$

Q $L = \{a^n b^n \mid n \geq 1\}$ $\Rightarrow$ com dir
CFL
R X

X X X X Y Y Y Y
~~b~~ ~~a~~ ~~a~~ ~~a~~ ~~b~~ ~~b~~ ~~b~~ ~~b~~
↑ ↑ ↑ ↑
 q_3 q_3 q_3 q_3





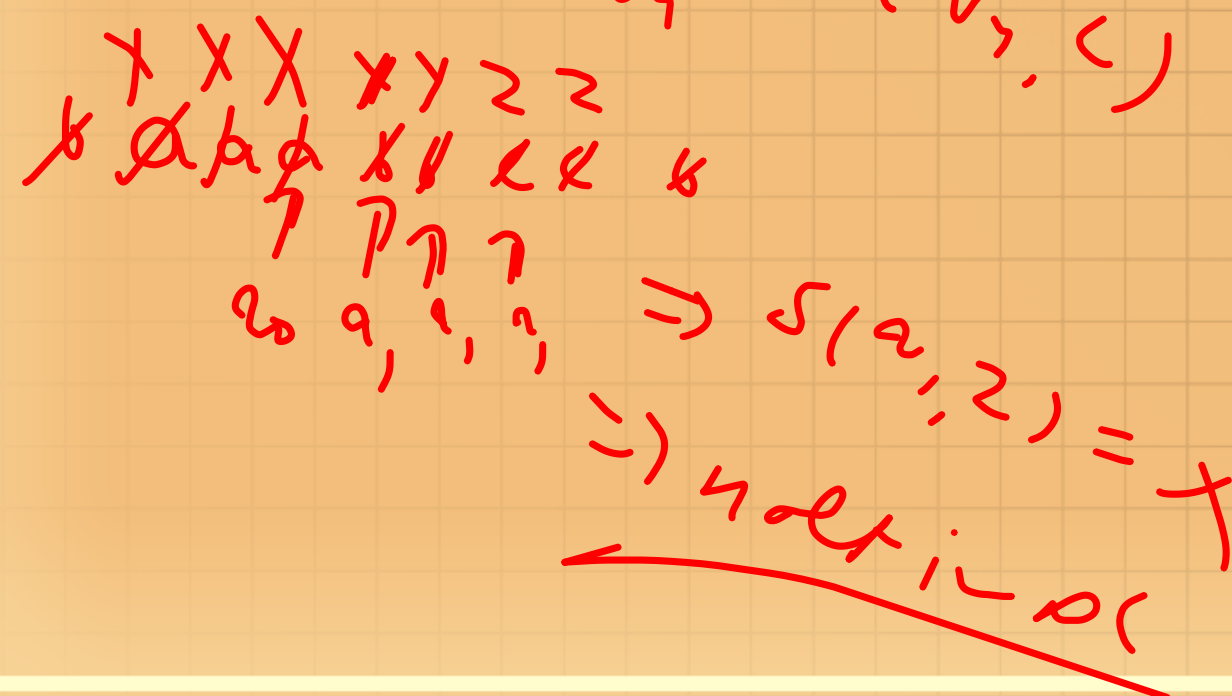
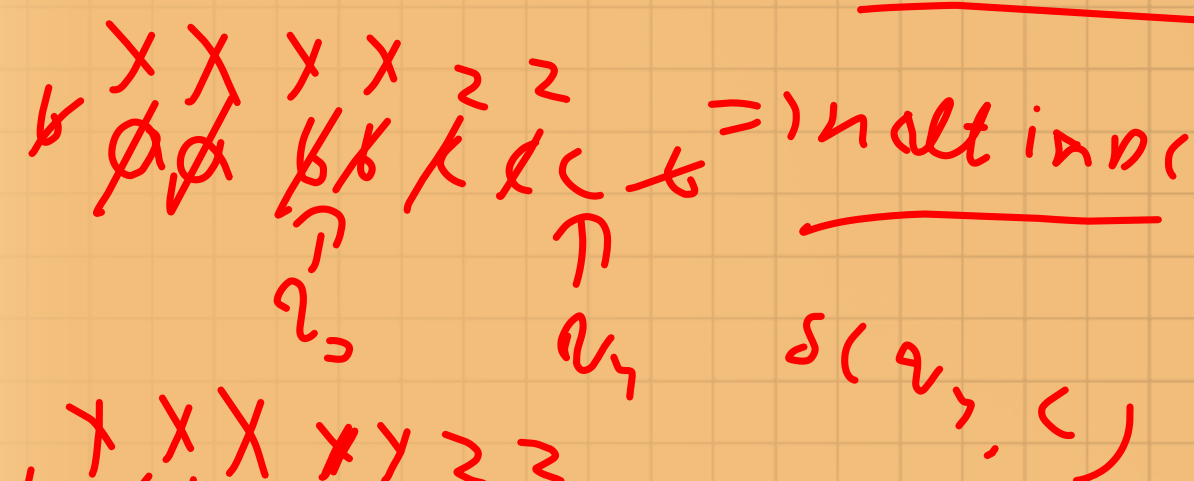
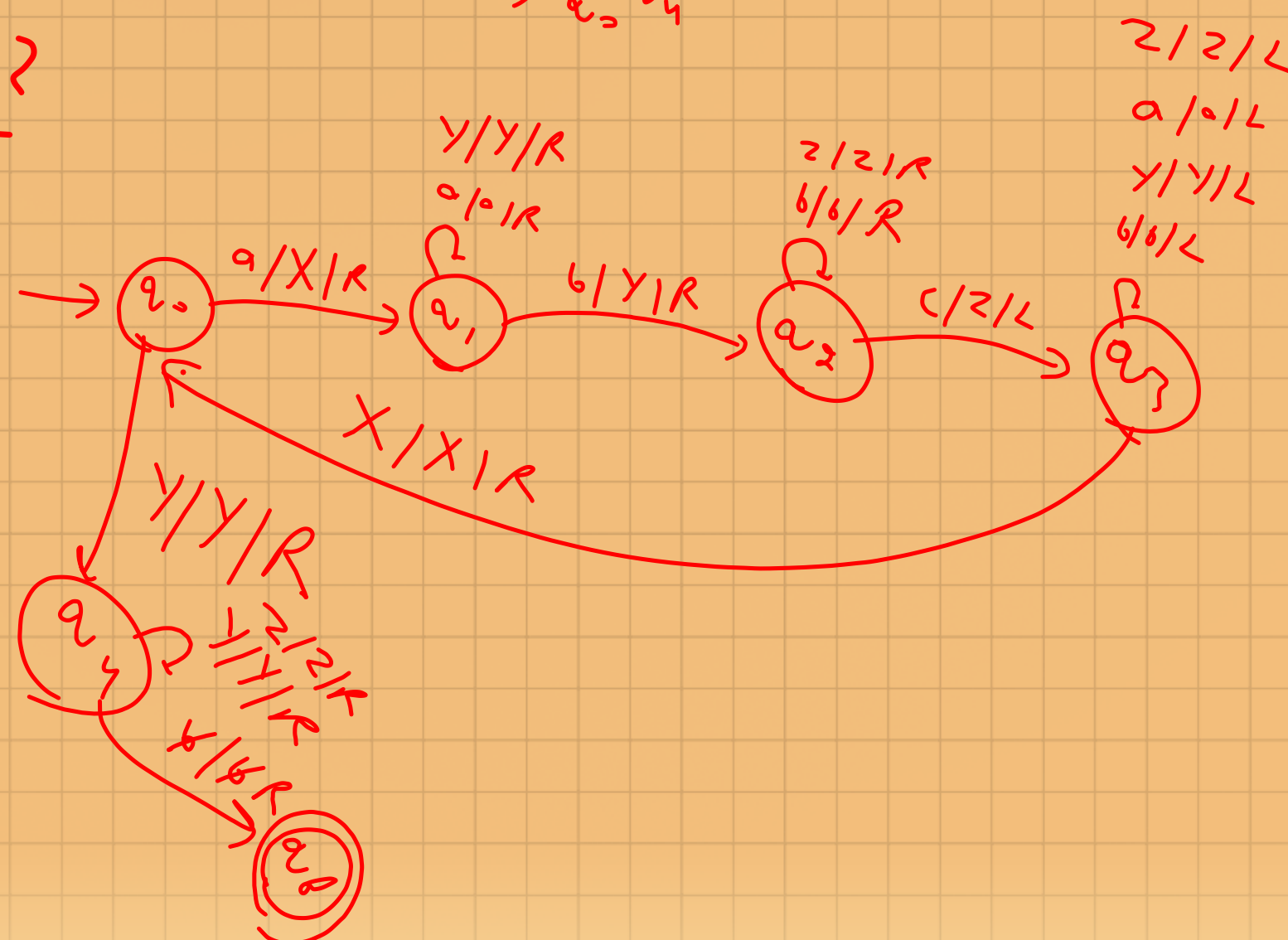
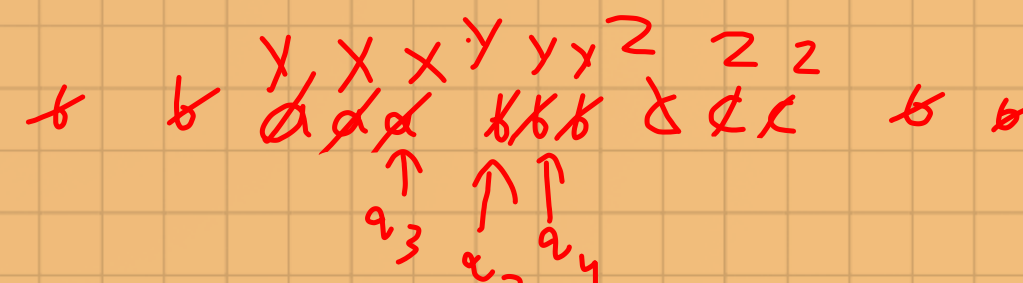
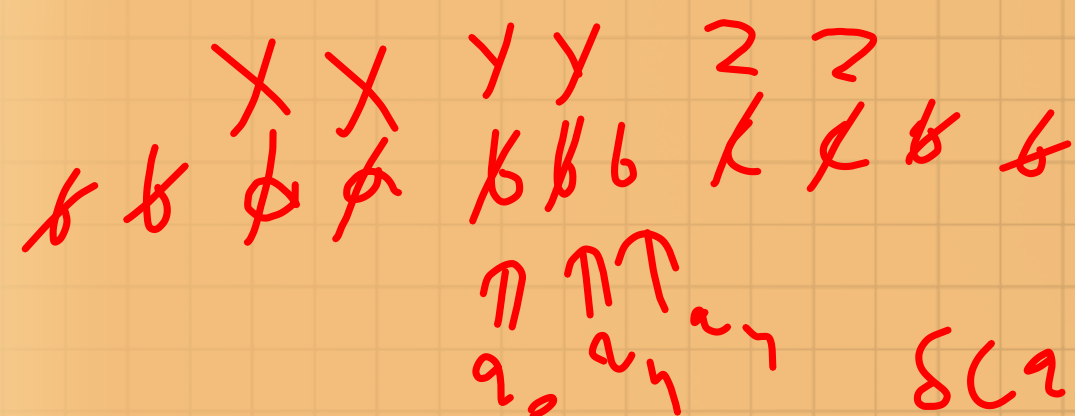
$\Rightarrow$ $CSL \neq \{ \text{every } CSL \}$ $\rightarrow RE$

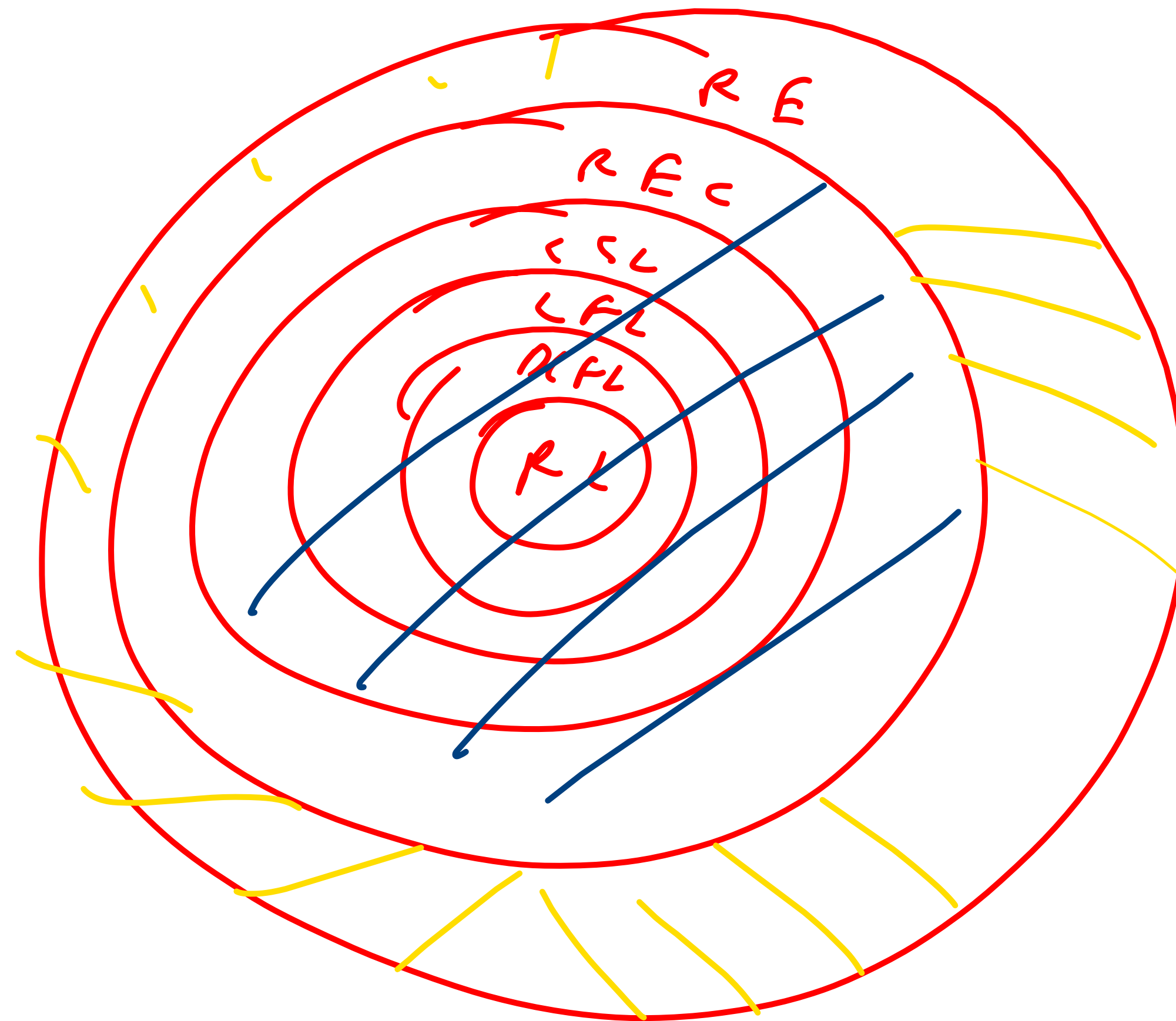
Q $L = \{ a^n b^n c^n \mid n \geq 1 \}$

Is $\rightarrow$ TM

Accepts it

$\Rightarrow$ halt in pc.







$$a * b$$

