# Combining Machines

$$\begin{tikzcd} M_1 \arrow[r, "a"] \arrow[d, "b"] & M_2 \\ M_3 & \end{tikzcd}$$

(i) Start in the initial state of $M_1$

(ii) Operate as $M_1$ until it halts

(iii) If the current scanned symbol is

- $a$:
  - (i) Initiate $M_2$
  - (ii) operate as $M_2$
- $b$:
  - (i) Initiate $M_3$
  - (ii) operate as $M_3$

$$\left.\begin{aligned} M_1 &= (K_1, \Sigma, \delta_1, s_1, H_1) \\ M_2 &= (K_2, \Sigma, \delta_2, s_2, \underline{H_2}) \\ M_3 &= (K_3, \Sigma, \delta_3, s_3, \underline{H_3}) \end{aligned}\right\} \text{all are disjoint}$$

$\Longrightarrow$ $M = (K, \Sigma, \delta, s, H)$

where $K = K_1 \cup K_2 \cup K_3$

$s = s_1$

$H = H_2 \cup H_3$

For each $\sigma \in \Sigma$ and $q \in K - H$, $\delta(q, \sigma)$ is defined as follows:

(a) if $q \in K_1 - H_1$, then $\delta(q, \sigma) = \delta_1(q, \sigma)$

(b) if $q \in K_2 - H_2$, then $\delta(q, \sigma) = \delta_2(q, \sigma)$

(c) if $q \in K_3 - H_3$, then $\delta(q, \sigma) = \delta_3(q, \sigma)$

(d) if $q \in H_1$

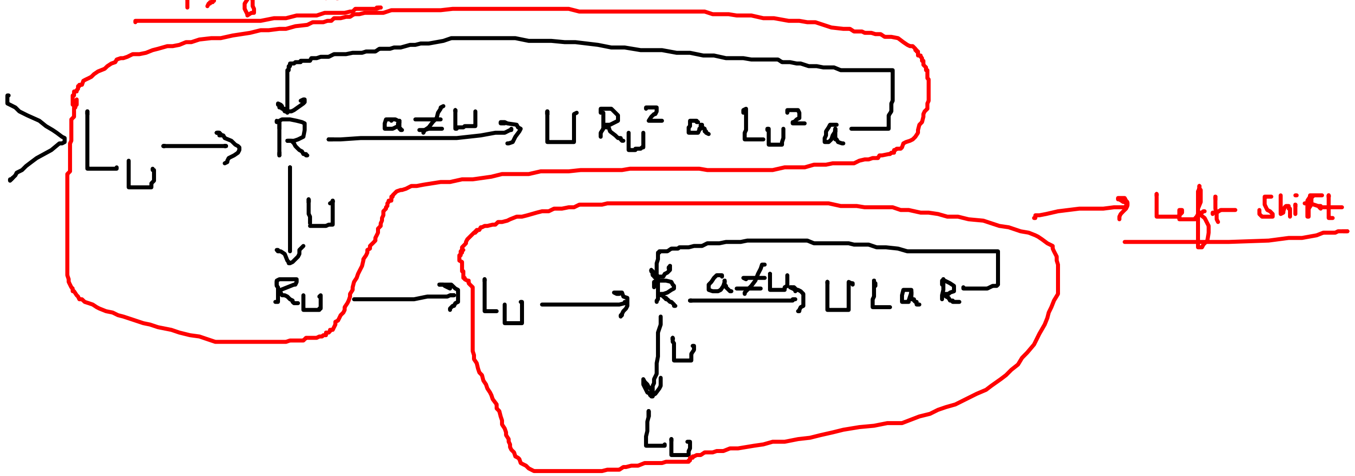
then

$\delta(q, a) = s_2$

$\delta(q, b) = s_3$

and $\delta(q, \sigma) \in H$ otherwise $\quad \sigma \neq a,\ \neq b$

Copying Machine




$\sqcup w \underline{\sqcup} \vdash \sqcup w \sqcup w \underline{\sqcup} \vdash w \sqcup w \underline{\sqcup}$

# Computing with TM

The input string, with no blank symbol in it, has a leftmost symbol $\triangleright$, with a blank to the left, and blank to the right

$(s, \triangleright \sqcup w)$

Let $M = (K, \Sigma, \delta, s, H)$ be a TM such that

$H = \{y, n\}$

w is accepted → yes — Accepting Configuration

w is rejected → no — Rejecting Configuration

(1) if $(s, \triangleright \sqcup w)$ yields an accepting configuration then M accepts an input w

(2) if $(s, \triangleright \sqcup w)$ yields an rejecting configuration then M rejects an input w

Decidable Machine

or

~~Turing Acceptable Machine~~

M decides a ~~language~~ $L \subseteq \Sigma_0^*$ where $\Sigma_0 \subseteq \Sigma - \{\sqcup, \triangleright\}$

Turing Decidable Machine

or

Acceptable

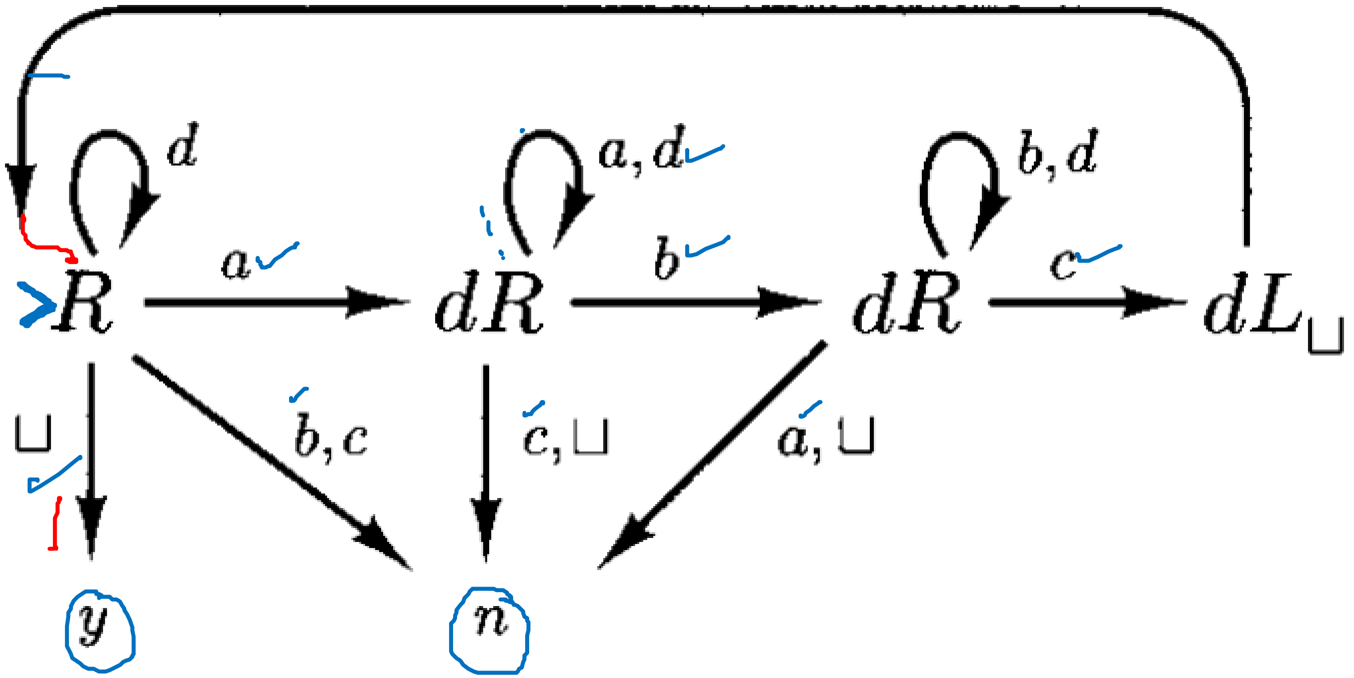
if for $\forall$ strings $w \in \Sigma_0^*$ the following is true:

(i) if $w \in L$ then M accepts $w$

(ii) if $w \notin L$ then M rejects $w$

L : $\boxed{\text{Recursive Language}}$

$L = \{a^n b^n c^n : n \geq 0\}$ ⟶ Construct a Turing Decidable Machine.




$\{a^n b^n c^n : n \geq 0\}$

aabbbcc ⟶ "n"

aabbcc ⟶ "y"

dadbbdc ⟶ $\boxed{\text{Stage1}}$

dddd$\boxed{b}$dd ⟶ $\boxed{\text{Stage2}}$

rejecting

▷⊔ aabbcc ⊢ ▷ ⊔ a abbcc

⊢ ▷ ⊔ d abbcc

⊢ ▷ ⊔ d abbcc

⊢ ▷ ⊔ dabbcc

⊢ ▷ ⊔ dadbcc

⊢ ▷ ⊔ dadbcc

⊢ ▷ ⊔ dadbcc

⊢ ▷ ⊔ dadbdc

⊢ ▷ ⊔ dadbdc

⊢ ▷ ⊔ dadbdc

⊢ ▷ ⊔ dadbdc

⊢ ▷ ⊔ dddbdc

⊢ ▷ ⊔ dddbdc

⊢ ▷ ⊔ dddddc

⊢ ▷ ⊔ dddddc

⊢ ▷ ⊔ dddddd

⊢ ▷ ⊔ dddddd ⊢ 'y' ⟶ yes

aabbcc is accepted

$\triangleright \sqcup a\,aabb\,cc$