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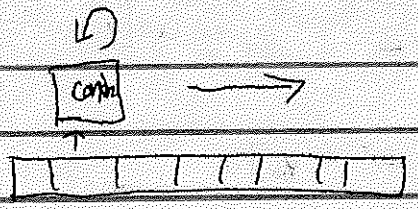
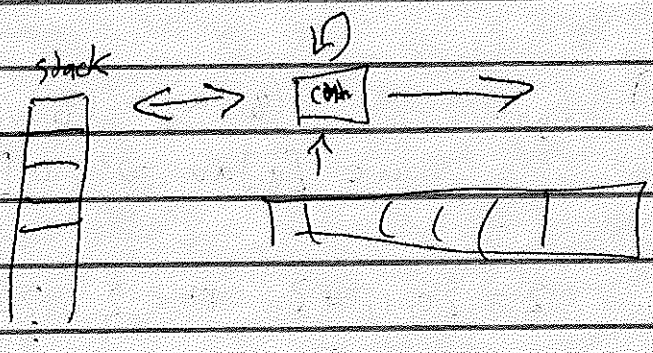
Turing Machines

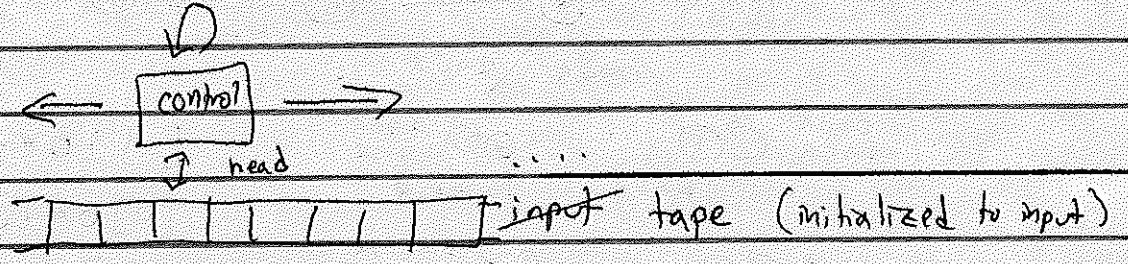
DFAs



PDAs



TMs



control : read 1 char, look at state
update char, update state, move L or R

$$\delta : Q \times \Gamma \to Q \times \Gamma \times \{L, R\}$$

$(Q, \Sigma, \Gamma, q_0, \delta, q_a, q_r)$

$\sqcup \notin \Sigma$ $\Sigma \subset \Gamma$ accept reject

$\sqcup \in \Gamma$ state state

config $= \Gamma^* \times Q \times \Gamma^*$ $w \in L(t)$ iff

$u[q_i]v$ tape $= uv$ $w \in \Sigma^*$ $[q_0]w \Rightarrow^* u[q_a]v$

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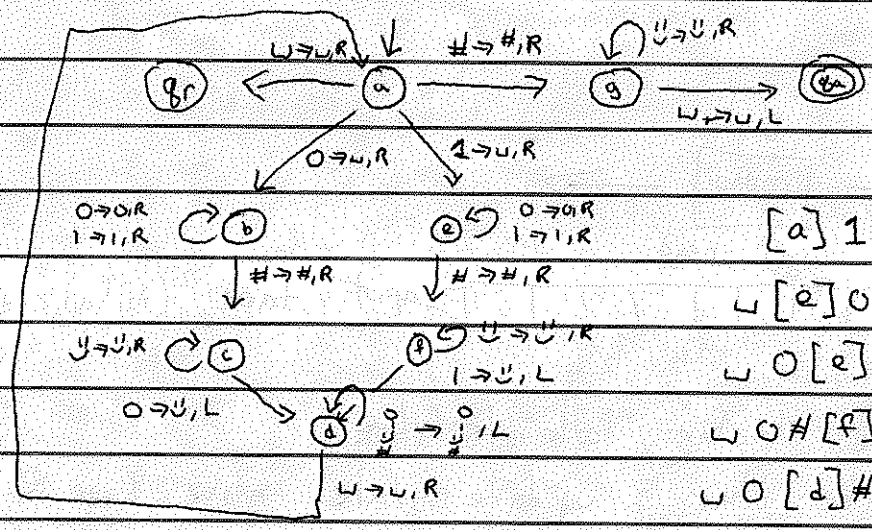
$$\frac{}{u[q_i]v \Rightarrow^* \sqcup u[q_i]v\sqcup}\ \text{blank} \qquad \frac{}{u[q_i]v \Rightarrow^* u[q_i]v}\ \text{refl}$$

$$\frac{u[q_i]v \Rightarrow^* x[q_j]y \quad x[q_j]y \Rightarrow^* f[q_k]g}{u[q_i]v \Rightarrow^* f[q_k]g}\ \text{trans}$$

$$\frac{\delta(q_i, a) = (q_j, b, R)}{u[q_i]av \Rightarrow^* ub[q_j]v}\ \text{right} \qquad \frac{\delta(q_i, a) = (q_j, b, L)}{uc[q_i]av \Rightarrow^* u[q_j]cbv}\ \text{left}$$

$B = \{w\#w \mid w \in \{0,1\}^*\}$ $\quad \Sigma = \{0, 1, \#\}$ $\quad \Gamma = \Sigma \cup \{\sqcup, \cup\}$



trace = "computation history"

$[a]10\#10$	$\sqcup\sqcup\#[c]\cup 0$
$\sqcup[e]0\#10$	$\sqcup\sqcup\#\cup[c]0$
$\sqcup 0[e]\#10$	$\sqcup\sqcup\#[d]\cup\cup$
$\sqcup 0\#[f]10$	$\sqcup\sqcup[d]\#\cup\cup$
$\sqcup 0[d]\#\cup 0$	$\sqcup[d]\sqcup\#\cup\cup$
$\sqcup[d]0\#\cup 0$	$\sqcup\sqcup[a]\#\cup\cup$
$[d]\sqcup 0\#\cup 0$	$\sqcup\sqcup\#[g]\cup\cup$
$\sqcup[a]0\#\cup 0$	$\sqcup\sqcup\#\cup[g]\cup$ blank
$\sqcup\sqcup[b]\#\cup 0$	$\sqcup\sqcup\sqcup\#\cup\cup[g]\sqcup$
	$\sqcup\sqcup\sqcup\#\cup[qa]\cup\sqcup$ ✓

computable f

$f(w) = v$ iff $[q_0]w \Rightarrow^* u[q_h]v\sqcup^*$

$w \in \Sigma^*$ $\quad v \in \Gamma^*$

q_h = "halt state"