7-1

A Turing Machine is a control + memory → finite

memory — a tape of symbols

a linear sequence — from an alphabet

infinitely long (book – on right, us – in both)

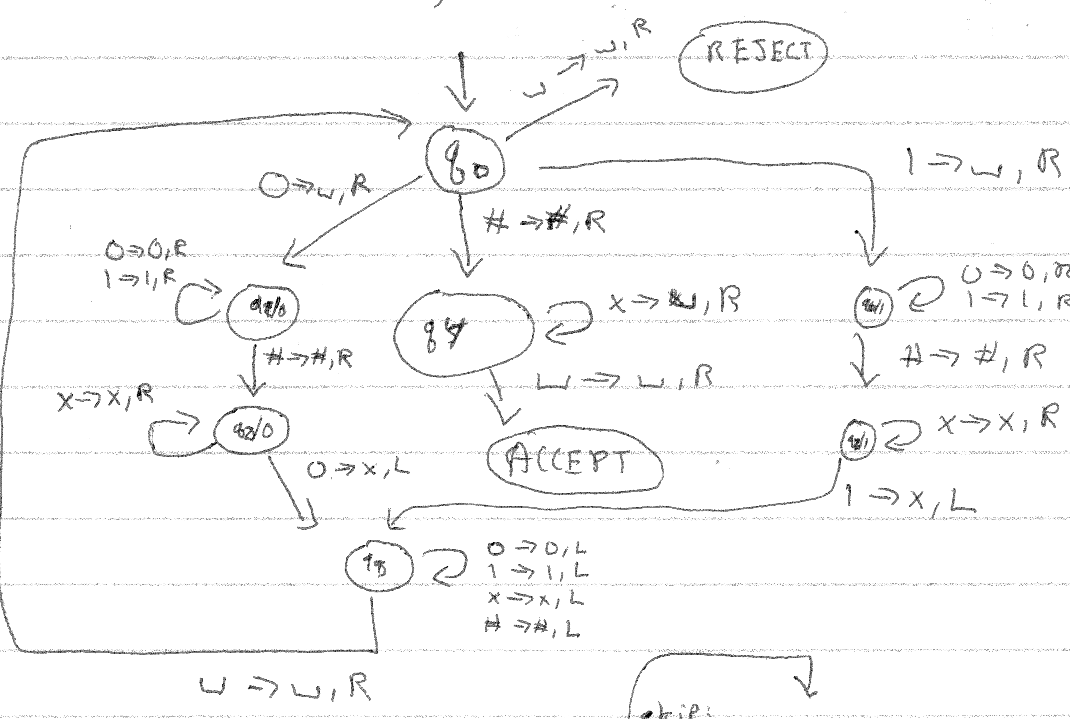
the machine has a "head" which is where memory access currently is

read and write

initialized to the input (from alphabet, except not ⊔)

two special states — ACCEPT and REJECT

$\{ w\#w \mid w \in \{0,1\}^* \} \notin \Sigma_0$ $\quad$ $⊔^*(0|1)^*\#x^*(0|$




```
loop:  c = read , right
       if (c = #) goto check_rhs_mt
again: ~~write(read)~~ ~~read~~  c2 = read, right
       if (c2 ≠ #) goto again
rhs:   c3 = read , right
       if (c3 == x) goto rhs
       if (c3 ≠ c) goto REJECT
```

```
skip:
  c4 = read , left
  if (c4 == ⊔) right, goto loop
  goto skip:
check_rhs_mt:
  c5 = read , right
  if (c5 == x) goto c_r_m
  if (c5 == ⊔) accept
  reject
```

17-2

[q0] 010#010
[q1/0]10#010
1[q1/0]0#010
10[q1/0]#010
10#[q2/0]010
10[q3]#x10
1[q3]0#x10
[q3]10#x10
[q3]⊔10#x10
[q0]10#x10
[q1/1]0#x10
0[q1/1]#x10
0#[q2/1]x10
0#x[q2/1]10

0#[q3]xx0
0[q3]#xx0
[q3]0#xx0
[q3]⊔0#xx0
[q0]0#xx0
[q1/0]#xx0
#[q2/0]xx0
#x[q2/0]x0
#xx[q2/0]0
#xx[q3]xx
#[q3]xxx
[q3]#xxx
[q3]⊔#xxx
[q0]#xxx

[q4]xxx   w[8]w
[q4]xx
[q4]x
[q4]⊔
[ACCEPT]

7 → 33

n#n
$n \times (n+1+n)$
$(n+1) \times (n+1+n+1) + 1$
$O(n^2)$

State	Character/READ	Next	Write	Direction
q0	0	q0/0	⊔	R
q0	1	q0/1	⊔	R
q0	⊔	REJECT	⊔	R
q0	#	q4	⊔	R

17-3

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

Q : a finite set

Σ : an alphabet of input, $\sqcup \notin \Sigma$

Γ : an alphabet of the tape, $\sqcup \in \Gamma$, $\Sigma \subset \Gamma$

q_0 : start state $\in Q$ $\qquad q_a \neq q_r$

q_a : accept state $\in Q$

q_r : reject state $\in Q$

δ : $Q \times \Gamma \Rightarrow Q \times \Gamma \times \{L, R\}$

$(Q - \{q_a, q_r\})$

$L(t) = \{ w \mid w \in \Sigma^*$ and $x[q_0]wy \Rightarrow^* u[q_a]v$
for some $u, v \in \Gamma^* \}$
for some $x, y \in \sqcup^*$

$u[q_i]v \Rightarrow^* x[q_k]y$

iff $u[q_i]v \Rightarrow a[q_j]b$ $\qquad u[q_i]v \Rightarrow^* u[q_i]v$

$a[q_j]b \Rightarrow^* x[q_k]y$

$\Rightarrow^*$ is the transitive, reflexive closure of $\Rightarrow$

$\delta(q_i, b) = (q_j, c, R)$

$\underbrace{ua}_{u}[q_i]bv \Rightarrow \underbrace{uac}_{u}[q_j]v'$ $\qquad q_i, q_j \in Q \quad u, v \in \Gamma^*$

$b, c \in \Gamma$

$v' = \sqcup$ if v is ε

v otw.

$\delta(q_i, b) = (q_j, c, L)$ $\qquad ua = u'$ if $u' \neq \varepsilon$

$ua[q_i]bv \Rightarrow u[q_j]acv$ $\qquad \sqcup \quad u' = \varepsilon$

$u'[q_i]bv$