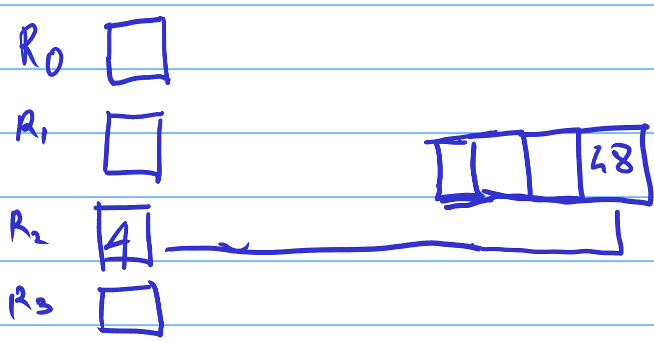
$a^2 \rightarrow$ Write 'a' on tape 2

$L^2_\sqcup \rightarrow$ keep moving left on tape two till blank

Random access Turing Machine → fixed no. of registers

↓ fixed infinite tapes

↓ instruction set



eg instruction set

Read 2	$R_0 := T[R_2]$
	$R_0 := 48$
Write j	$T[R_j] := R_0$
Store j	$R_j := R_0$
Load j	$R_0 := R_j$
load =c	$R_0 := c$
⋮	
add, sub, jump	
hlt	(halts program)

$(k, R_0, R_1, \ldots R_{x-1}, T)$

For halted configuration $k=0$

PDA → Sextuple

TM → Quntuple

FA → Quntuple

RATM: $[k, \pi]$ → all registers

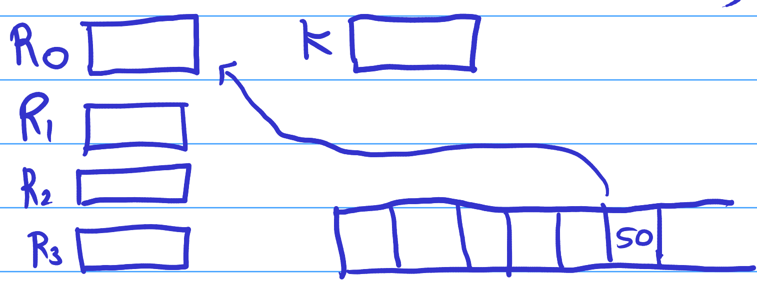
Counter

T → Tape contents

[Read TB]

3 ; 1, 0, 4, 0 {(2, 20), (4, 48), }

→ T: {(i, d) ...}



$T[10] = T[10]+5$
$= 55$

load =10 $R_0 := 10$

Store 1 $R_1 := R_0$

Read 1 $R_0 := T[R_1]$

add =5 $R_0 := R_0 + 5$

Write 1 $T[R_1] := R_0$

halt

$T[10] = T[10]+5$

$(1; 0, 0, 0, 0; \{(10, 50)\}) \vdash (2; 10, 0, 0, 0; \{(10, 50)\})$

$\vdash (3; 10, 10, 0, 0; \{(10, 50)\}) \vdash (4; 50, 10, 0, 0; \{(10, 50)\})$

$\vdash (5; 55, 10, 0, 0; \{(10, 50)\}) \vdash (6; 55, 10, 0, 0; \{(10, 55)\})$

a deterministic TM is $(K, \Sigma, \delta, s, H)$

δ function from $(K-H) \times \Sigma$
to $K \times (\Sigma \cup \{\leftarrow, \rightarrow\})$

A deterministic TM is *(K, ∑ , δ, s, H)*

Where δ is a function from (K-H) X ∑ *to* KX(∑ U{←, →})

A non-deterministic Turing machine is a quintuple

M= (K, ∑ , Δ, s, H) where K, ∑ ,s, *and H are as for standard TM*

Δ is subset of

((K-H) X ∑) X (KX(∑ U{←, →}))

→ TMs can recognize unrestricted grammars (or just "grammars")

→ These languages are recursively enumerable grammar

→ LHS of a rule may consist of more than one non terminal (Atleast 1)
RHS too, Some rules must reach terminals though

$S \rightarrow aA$
$SAa \rightarrow aAB$

NDTM, DTM exist

Unrestricted $G = (V, \Sigma, R, S)$ V

$\Sigma \subseteq V$ $V-\Sigma$

$S \in V-\Sigma$

R $\{V^*(V-\Sigma)V^* \rightarrow V^*\}$

$V = \{S, a, b, c, A, B, C, T_a, T_b, T_c\}$
$\Sigma = \{a, b, c\}$, and
$R = \{$

$V = \{S, a, b, c, A, B, C, T_a, T_b, T_c\}$,
$\Sigma = \{a, b, c\}$, and
$R = \{S \to ABCS$,
$S \to T_c$,
$CA \to AC$,
$BA \to AB$,
$CB \to BC$,
$CT_c \to T_c c$,
$CT_c \to T_b c$,
$BT_b \to T_b b$,
$BT_b \to T_a b$,
$AT_a \to T_a a$,
$T_a \to e\}$.

$(ABC)^n T_c$ to
$(A)^n (B)^n (C)^n T_c$

$(A^n)(B^n)(C^n)T_c$
to $a^n b^n c^n$

aabbcc

$S \to ABCS$
$\to ABC\cancel{A}BCS$
$\to ABCABCT_c$
$\to ABACBCT_c$
$AABCBCT_c$
$AABBCcT_c$
$AABBCT_c c$
$AABBT_b cc$
$AABT_b bcc$
$AAT_a bbcc$
$AT_a abbcc$
$T_a aabbcc$
aabbcc