

Normal NTM : $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\}$

Don't Write TM : $\delta : Q \times \Gamma \rightarrow Q \times (\Gamma \cup \perp) \times \{L, R\}$
bottom
a character or not
ie don't write

$\rightarrow \bigcirc \xrightarrow{a \rightarrow R} \bigcirc \xrightarrow{a \rightarrow b, L}$

compile : DWTM \rightarrow NTM ; only δ changes

input : δ_{DW} output : δ_N

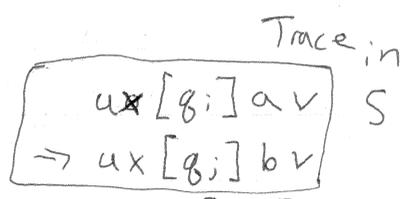
If $\delta_{DW}(q_i, a) = (q_j, \perp, dir)$
 then $\delta_N(q_i, a) = (q_j, a, dir)$

Stay-TM : $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R, S\}$

\rightarrow don't move or stay

compile : STM \rightarrow NTM

input : δ_S output : δ_N
 Q_S Q_N

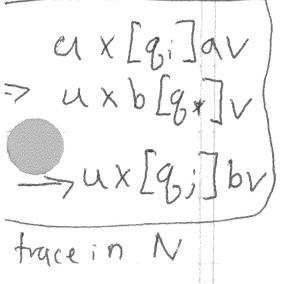


If $\delta_S(q_i, a) = (q_j, b, S)$
 then [option 1] $\delta_N(q_i, a) = \delta_N(q_j, b)$ // fails on loops

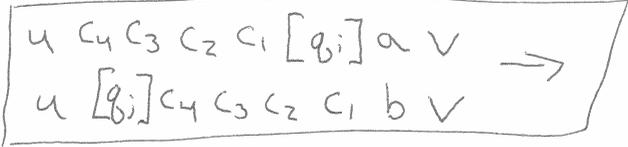
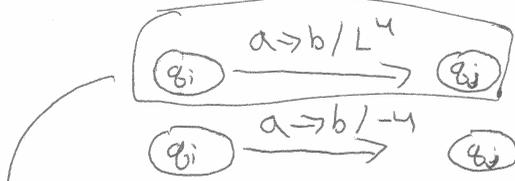
[option 2] $\delta_N(q_i, a) = (q^*, b, R)$

$\forall q \in \Gamma \quad \delta_N(q^*, q) = (q_i, q, L)$

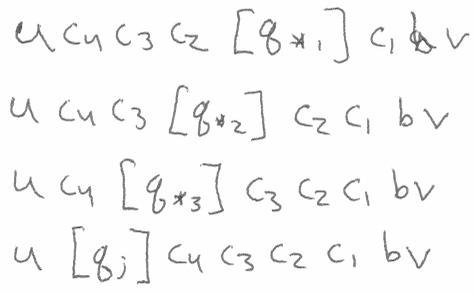
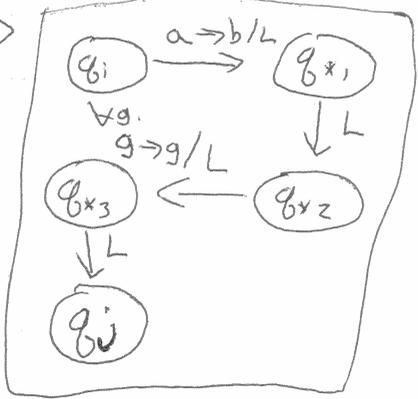
Add q^* to Q_N



Many Move TM : $\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{L, R\} \times \mathbb{N}$
 $\times \mathbb{Z} \leftarrow \text{int} \quad \text{nat}$
 $\delta(q_i, a) = (q_j, b, L, k)$ then we move k spots left



M/M trace



Many Tape TM
 k -TM



$$\delta : Q \times \Gamma^k \rightarrow Q \times (\Gamma \times \{L, R\})^k$$

k -configuration : $u_1 a_1 \left[\begin{matrix} b_1 v_1 \\ \vdots \\ q_i \\ \vdots \\ b_k v_k \end{matrix} \right]$

2 -configuration : $u_1 a_1 \left[\begin{matrix} b_1 v_1 \\ q_i \\ b_2 v_2 \end{matrix} \right]$

$$\delta(q_i, b_1, b_2) = (q_j, (c_1, L), (c_2, R))$$

$$u_1 a_1 \left[\begin{matrix} b_1 v_1 \\ \vdots \\ q_i \\ \vdots \\ b_2 v_2 \end{matrix} \right] \rightarrow u_1 \left[\begin{matrix} a_1 c_1 v_1 \\ q_j \\ a_2 c_2 v_2 \end{matrix} \right]$$

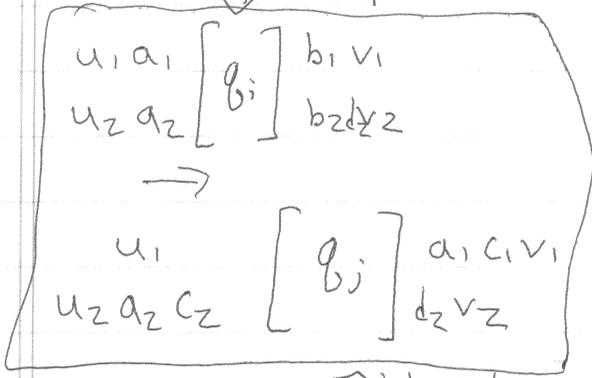
19-3/

$u_1 a_1 b_1 v_1 \# u_2 a_2 b_2 v_2$ X

1-config

$[q_i] u_1 a_1 \hat{b}_1 v_1 \# u_2 a_2 \hat{b}_2 v_2$ ✓

interpret



2-config

$u, v \in \Sigma^*$
 $a, c, b, d \in \Gamma$

many
many
many
step

interpret

$[q_i] u_1 \hat{a}_1 c_1 v_1 \# u_2 a_2 c_2 \hat{d}_2 v_2$

1. find head 1, remember the char
2. find head 2,
3. change tape 2
4. seek head 1
5. change tape 1
6. go all the way left

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