CPSC 421/501   Oct 23, 2023

Today:
   – Finish PALINDROME
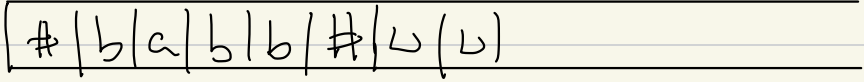_____

Chap
3,4
{
   – Multi-tape TM
   – Non-det*   TM
   – Standardized TM
   – Universal   TM
}
_____

{
   Ch 4.2
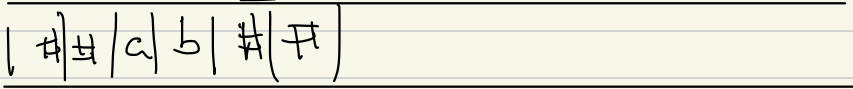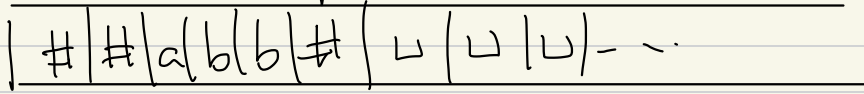   Uncomputability in CPSC 421
}

PALINDROME

$\{a,b\}$

$$= \left\{ w \in \{a,b\}^* \mid w^{rev} = w \right\}$$

(q_0) | a | b | a | b | b | a | ␣ | ␣ | ␣ | .. |

Idea: (1) $\Gamma = \{a, b, ␣, \#\}$

$\left(q_{move}\atop R\right)$ | # | b | a | b | b | a | ⊔ | ␣ | ␣ | .. |

first
saw
"a"

move L

$\left(q_?\right)$ | # | b | a | b | b | | ␣ | ␣ | .. |

if we
read "b"
then reject

if we read
"a" keep going

| # | b | a | b | b | # | ⊔ (⊔)

if

1st & last
symbols match

q move left

| # | # | a | b | b | # | ⊔ | ⊔ | ⊔) - ~

| # | # | a | b | # | #)

⊔ a b

$U, \# \to R$

q_{accept}

$q\ reject$

q_0

$a \to \#, R$

$b \to R$

$\#, R$

$b \to \#, R$

$q\ move\ R\ saw\ "a"$

$\#, U \to L$

$q\ compare\ saw\ a$

$q\ move\ R\ saw\ "b"$

$a, b \to R$

$a, b \to R$

$\# \to R$

$a \to \#, L$

$\# \to R$

$\#, U \to L$

$a \to R$

$q\ compare\ saw\ b$

$q\ moving\ L$

$\# \to R$

$b \to \# L$

$a, b \to L$
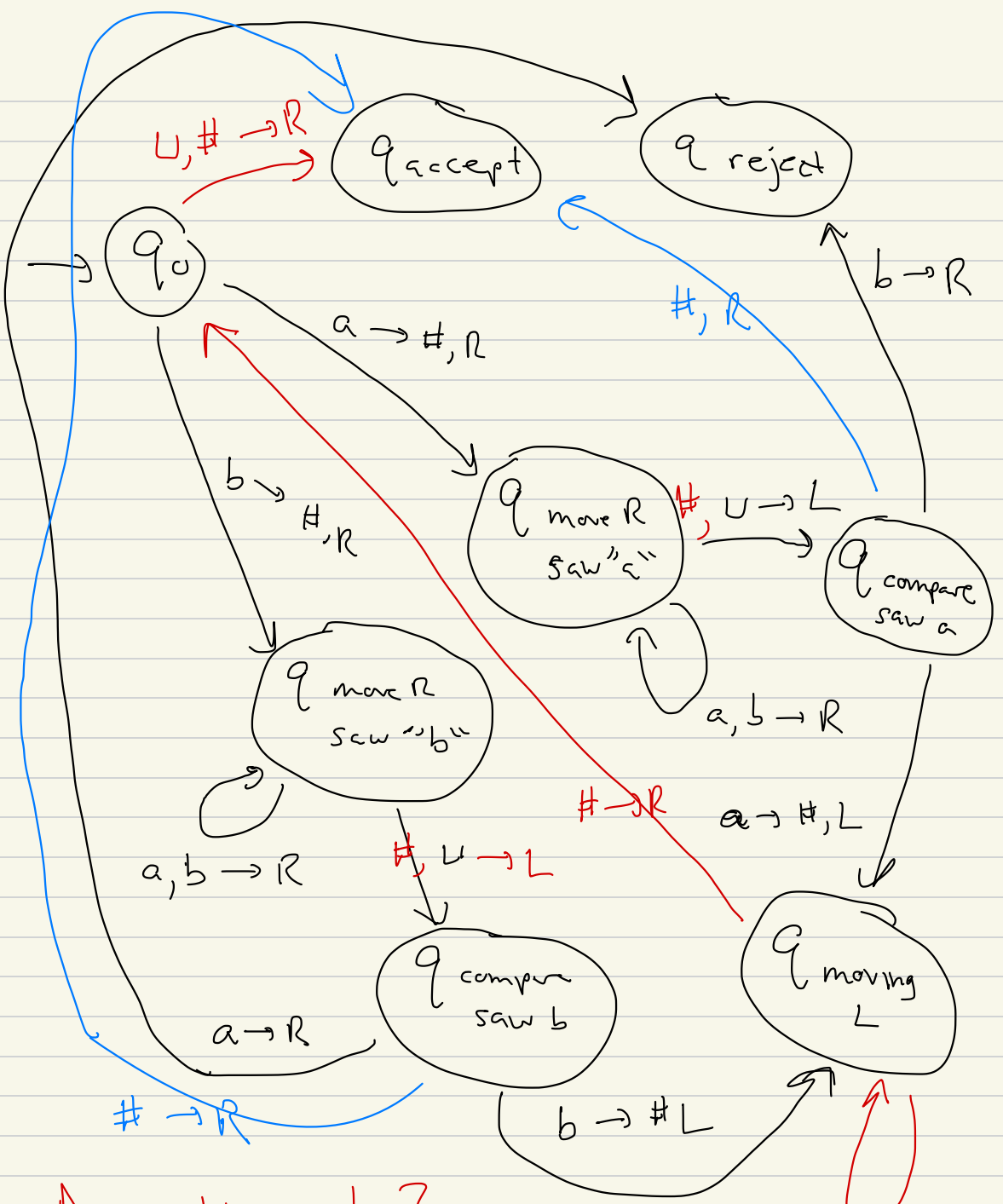
Does this work ?
In all cases

(1) We are convinced that the

TM already built:

   - correctly rejects even length
     non-palindromes

What abot
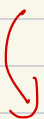   - accept even length palindromes?
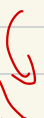
| | a | b | b | a | ⊔ | ⊔ | - - - |

↳

▽
b b
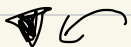
↳ # # b #⃖

↳ # # #⃖ #

q_{max} ↰
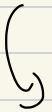
q_0 # # #⃖ #⃖
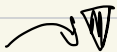
What about accepting palindromes
of odd length ?

| | a | a | a | ⊔ | ⊔ | _ _ |

a #   ← moved L

# # #

⌣

Multi - tape TM :

2-tape TM:

tape 1

q_0
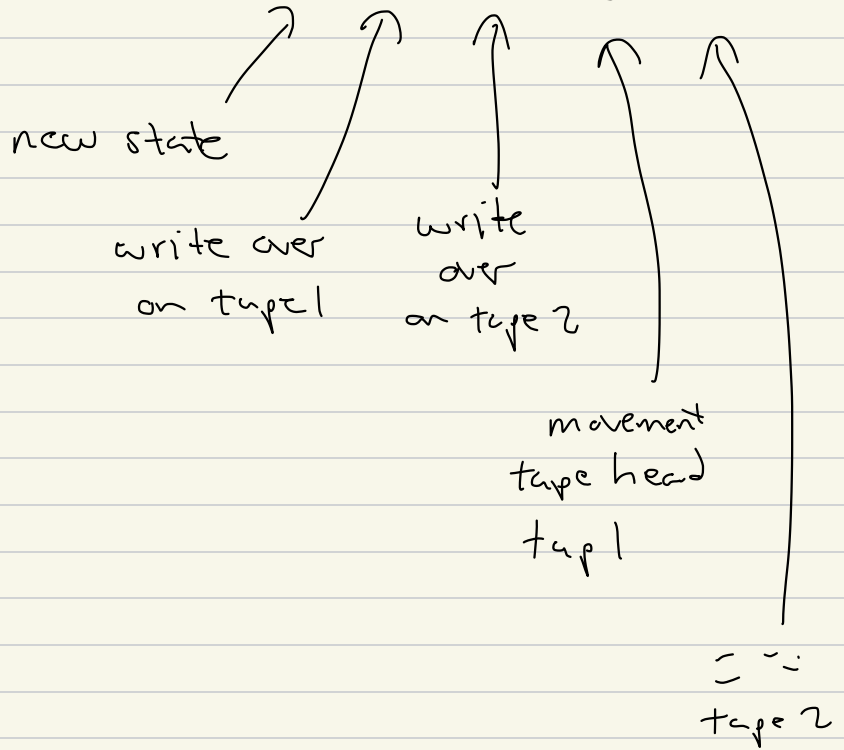
Q

tape 2

initially :   input   a a a

Formally : $\left(Q, \Sigma, \Gamma, \delta, q_0, q_{acc}, q_{rej} \right)$

$\delta : Q \times \Gamma^2 \longrightarrow Q \times \Gamma^2 \times \{ L, R, S \}^2$

So:

$$\delta(q, r_1, r_2) = \left(q', r_1', r_2', \begin{matrix} L \\ R \\ S \end{matrix}, \begin{matrix} L \\ R \\ S \end{matrix} \right)$$

new state

write over
on tape 1

write
over
on tape 2

movement
tape head
tap 1

⌐ ⌐
tape 2

(1) How long does palindrome
take to solve on 1-tape

| a | a | a | a | a | a | a | s | a | ⊔ | ⊔ |

\# steps $\Longleftrightarrow$ time

for
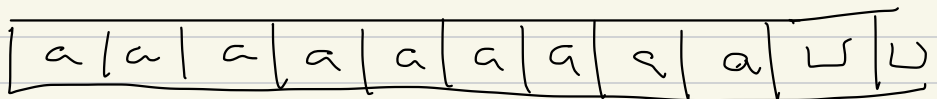
1-tape
palindrome
als

$\approx$ order (n^2)

where $n =$ size of input

$=$ length of input as

string