CPSC 421/501 Oct 29, 2025

- Goal:

(1) Build Turing machines for
  - Addition, Multiplication, Sorting, ...

(2) Build Universal T.m.'s

(3) Build Delightful T.m.'s

[Def 8.10, "Uncomputability in CPSC..."]

i.e. T.m.'s that recognize

$ACCEPTANCE_{TM}$ and

Mysterious T.m.'s [Thm 8.12]

Today... PALINDROME ...  ...

Good news: Midterm delayed 2 weeks.

Great news: Same content, same place

Bad news: Nov 10-12 reading break

(and Midterm: Nov 14) plan ahead

Good news: Final exam on Dec 19

(plenty of time to learn/review

until last class, Dec 5

Bad news: Final Exam: Dec 19, 8:30 am

Bad news: 2 missed classes

$\Rightarrow$ may only have time for 1 of 2

Vote soon {
- How not to prove P vs NP
- Gödel incompleteness

No presentations unless we have time

Good/Bad news: CPSC 501, you should let me know of your essay topic $\leq$ 2 weeks

$$\text{PALINDROME}_{\Sigma} \overset{\text{def}}{=} \{ s \in \Sigma^* \mid s^{\text{rev}} = s \}$$

$$(\sigma_1 \cdots \sigma_n)^{\text{rev}} = \sigma_n \sigma_{n-1} \cdots \sigma_1$$

e.g.

"Madam, I'm Adam."

$$\left(\sigma^{\text{rev}} = \sigma \quad \sigma \in \Sigma \right)$$

$s_1 =$ madamimadam

$s_2 =$ abba

$\Rightarrow$

$s_1, s_2 \in \text{PALINDROME}_{\Sigma}$

$\Rightarrow s_1 s_2 s_1$ also

$\Rightarrow$

Using

$$(s_1 s_2 s_3)^{\text{rev}} = s_3^{\text{rev}} s_2^{\text{rev}} s_1^{\text{rev}}$$

Etc.

Other palindromes over Σ

race car

racecar

taco cat

tacocat

tacocatracecarracecartacocat

abcefgr ... rgfecba

Me: PALINDROME $_{\Sigma}$, $\Sigma = \{a\}$

Class: PALINDROME $_{\Sigma}$, $\Sigma = \{a,b\}$

Notation (General) $\delta : Q \times \Gamma \to Q \times \Gamma \times \{L,R\}$

Abbrevs:  (Cheat/note sheet)

(1) $a \to a, R \rightsquigarrow a \to R$ write same symbol

(2) $a \to R$, $b \to R$ $\rightsquigarrow a,b \to R$ (don't change tape contents)

universal blank symbol ␣ [Sip]

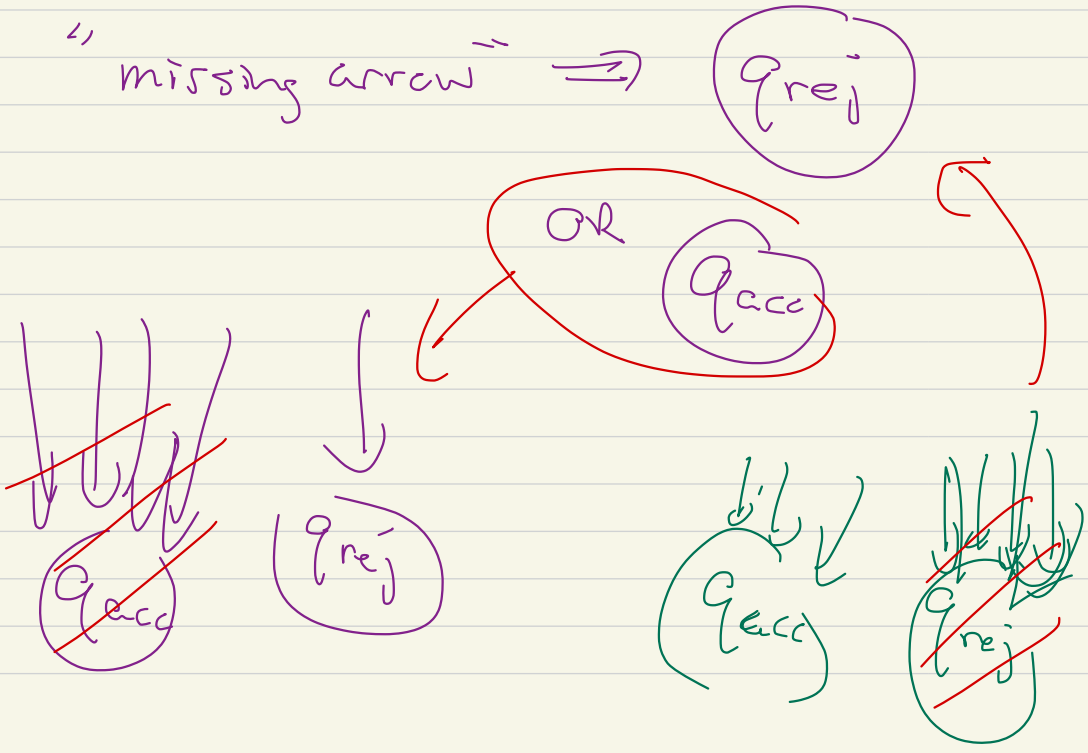
③ a → (␣, L)
b → (␣, L)
a, b → (␣, L)

④ "Any missing arrows" -- ?? [Sip]

Be explicit

On exam, be explicit if

"missing arrow" ⟹ q_{rej}



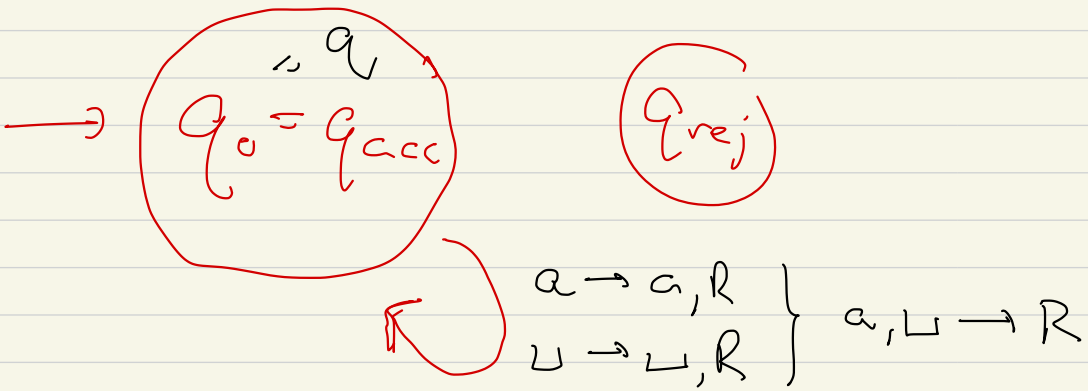
Ex: Turing machine for

$PALINDROME_\Sigma$, $\Sigma = \{a\}$

i.e.

$= \{a\}^*$ over $\Sigma = \{a\}$

Rem: this is OK!



$$\delta(q_{acc}, a) = (\text{any state}, \text{any symb}, R)$$

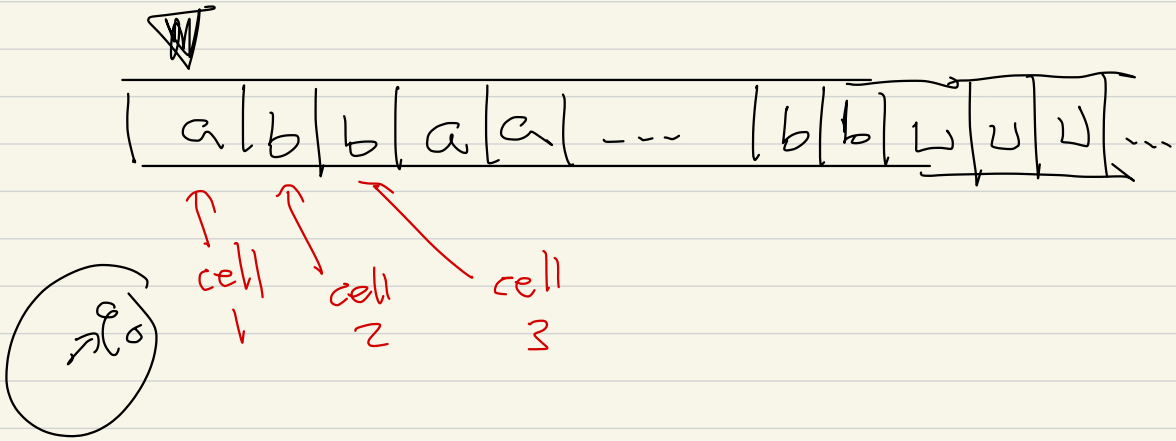
$$\left.\begin{array}{l} \delta(q_{acc}, \sqcup) = \\ \delta(q_{rej}, a) = \\ \delta(q_{rej}, \sqcup) = \end{array}\right\} \text{etc}$$

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

$$M = (Q, \Sigma, \Gamma, \delta, q_0, q_{acc}, q_{rej})$$

$\{a\}$ input symb $\quad \{a, \sqcup\}$ tape symbols

PALINDROME$_\Sigma$, $\Sigma = \{a, b\}$



High level idea for T.m.

algorithm = ???

Algorithm =

$\Sigma = \{a, b\}$

$\Gamma = \{a, b, \sqcup, \underbrace{a', b', \dot{a}, \dot{b}}_{\text{any finite list}}$

a' = an a, but we've read this a before

$\dot{a}$ = this is a, but we're at cell #1

Step 1: Compare 1st and Last symbol of input $S = \sigma_1 \cdots \sigma_n$

Step 2: Compare 2nd sym & 2nd to last symbol

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