CPSC 421/501 Nov 3:

- Midterm on Nov 5:
  - 1 hour long + 5 min to upload to gradescope
  - Open Book:
    - You can use textbook, handouts,
    - You can use any amount of notes

    - You cannot use any other sources, either online or not
  - Start time 9:30am
  - You will need to leave your Zoom camera on and mute yourself.
  - Bring your UBC ID to the midterm

- Contact me (jf@cs.ubc.ca) if

1. you haven't received Canvas test message of 8:21 am, Tuesday, Nov 3,

OR

2. you are in time zone that requires you to begin between 9 pm and 6 am and you'd like the alternate midterm at 8:30 pm Pacific (Daylight Savings) Time.

We are almost done with 421:

- new material! Nov 10, 12
  17, 19
  part of 24, 26

501 presentations: during Nov 24, 26
Dec 1, 3

– All midterm question will require you to show some work

Additional Midterm Practice!

(1) (a) If L_1, L_2 are regular, is $L_1 \cup L_2$ regular?

(b) " " " " non-regular, is $L_1 \cap L_2$ nonregular?

(b) No — you have to give an example where L_1, L_2 non-regular, but $L_1 \cap L_2$ is regular?

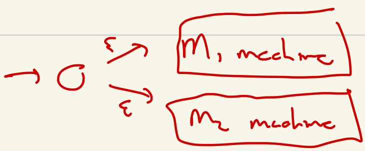
$L_1 = \{0^n 1^n\}$ (or any nonregular),

$L_2 = L_1^{comp} = \{0,1\}^* \setminus \{0^n 1^n\}$, then

$L_1 \cap L_2 = \emptyset$ regular.

(a) We know L_1, L_2 regular $\Rightarrow$ $L_1 \cup L_2$ regular

e.g. if L_1 recognized by M_1
L_2 " " M_2

NFA 

short explanation of why reg lang closed under $\cup$

(2) & (3)

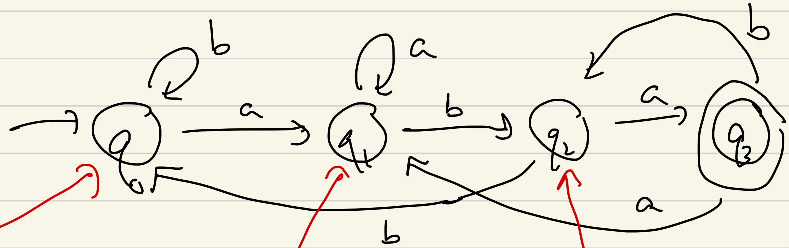
$$L = \{ s \in \{a,b\}^* \mid \text{end with } aba \}$$

(2) Give DFA, explain how it works

(3) " Turing machine deciding L, explain how it works.

[For Midterm 2019: specify Q and δ either by list of values, or state diagram. What is work tape Γ? Clearly indicate initial state, accept state, reject state.]

DFA!



Idea: To end with aba you must

(1) see an a somewhere

(2) then a immediately proceeded by a b

(otherwise back to having seen an a)

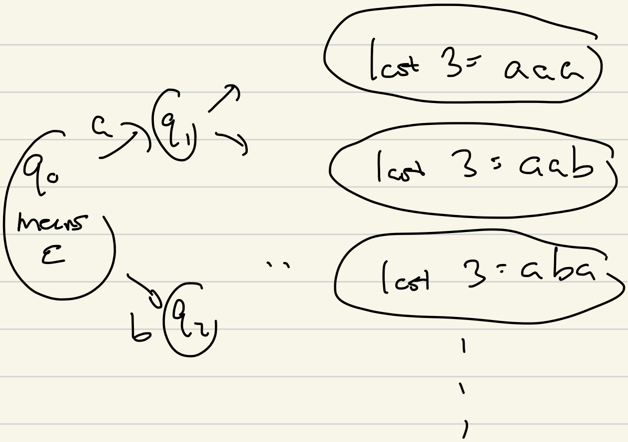
etc.

Or: Explain the same, state by state

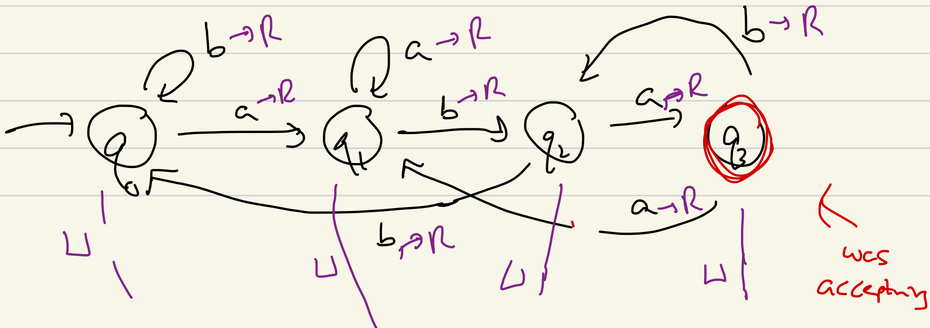
q_0 means ___ , q_1 means ___

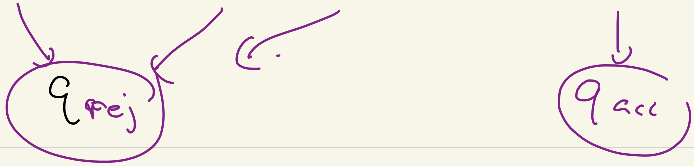
___

OR: it suffices to remember last 3 symbols



Turing machine: "equivalent"



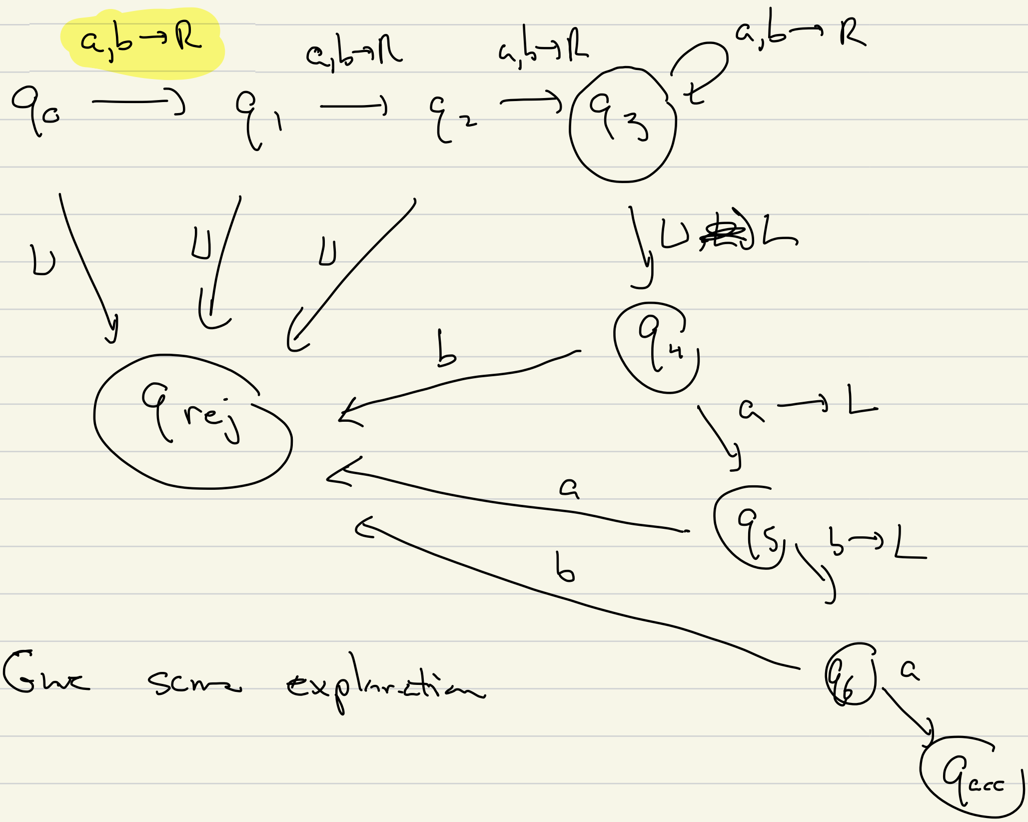


Another algorithm:

- proceed to ⊔
- then move 3 to the left

Special case

a	b	⊔	⊔	⊔



Give some explanation

TM can recognize – $\{0^n 1^n\}$

– PALINDROME

– $\{a, a^4, a^9, a^{16}, \ldots\}$

There is a countable number of TM algorithms

" " an uncountable " " languages (over any finite alphabet)

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④ $L = \{a^4\}$. Use Myhill-Nerode to show that any DFA recognizing L has ≥ 6 states

Idea: $\mathrm{AccFut}_L(w)$

for various w.

Also: since $\Sigma = \{a\}$, try

$w = \varepsilon, a, a^2, \ldots$

$AccFut_L(\varepsilon) = \{a^4\}$

$\quad\text{"}\quad (a) = \{a^3\}$

$\quad\quad (a^2) = \{a^2\}$

$\quad\quad (a^3) = \{a\}$

$\quad\quad (a^4) = \{\varepsilon\}$

$\quad\quad (a^5) = \emptyset$

these all 1 element sets with different elements, and

0 element set

Rem: $\Sigma = (a, b)$, then still hold,

and

$AccFut_L$ (anything with ≥ 1 b) $= \emptyset$

Recall: for $L = \{0^n 1^n\}$

$AccFut(0^k) = \{1^k, 01^{k+1}, \ldots\}$

We say, e.g. shortest elm't in is 1^k

which are distinct for all $k \in \mathbb{N}$

Five min break 10:25 → 10:30

More questions:

$$\text{TIMES} = \left\{ a \# b \# c \;\middle|\; \begin{array}{l} a, b, c \in \{0,1\}^* \\ \text{and} \\ \text{" } a \cdot b = c \text{ "} \end{array} \right\}$$

PERF_SQ_BINARY

$$= \left\{ a \in \{0,1\}^* \;\middle|\; \begin{array}{l} a \text{ in binary} \\ \text{rep perfect sq} \end{array} \right\}$$

pseudo-code

① for $n = 1$ to a

② see if $n \cdot n = a$

Implement on TM!

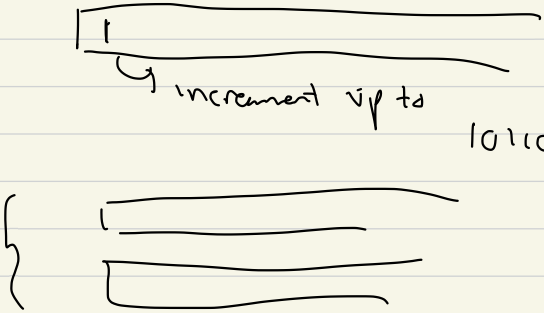
→ input tape (store a)

→ tape to store n

→

input tape 101101⊔⊔⊔...

counter n



tape 2

increment up to 101101

used to multiply n·n

tapes 3

" 4

There's a map $\{2\}^{\mathbb{N}} \to \mathbb{R}$

1011111

→ 0,1011111

the map is not bijection ...

Exams! "explain" "show that"

"justify your answer"

→ "give a formal proof"

$\{ \text{languages over } \{a,b\} \}$

$= \text{Power}(\{a,b\}^*)$

We know, from Cantor's theorem;

if S is countably infinite, then

then there is surjection

$$S \xrightarrow{\text{can't be surjective}} \text{Power}(S)$$

bijection, "countably infinite" $\mathbb{N}$

bij

can't be surjective

So

Midterm does not cover Ch. 4

but

{ standardized DFA's }

({ " graphs })

{ " TM }

are all countable

but if Σ alphabet

{ languages over Σ } is uncountable

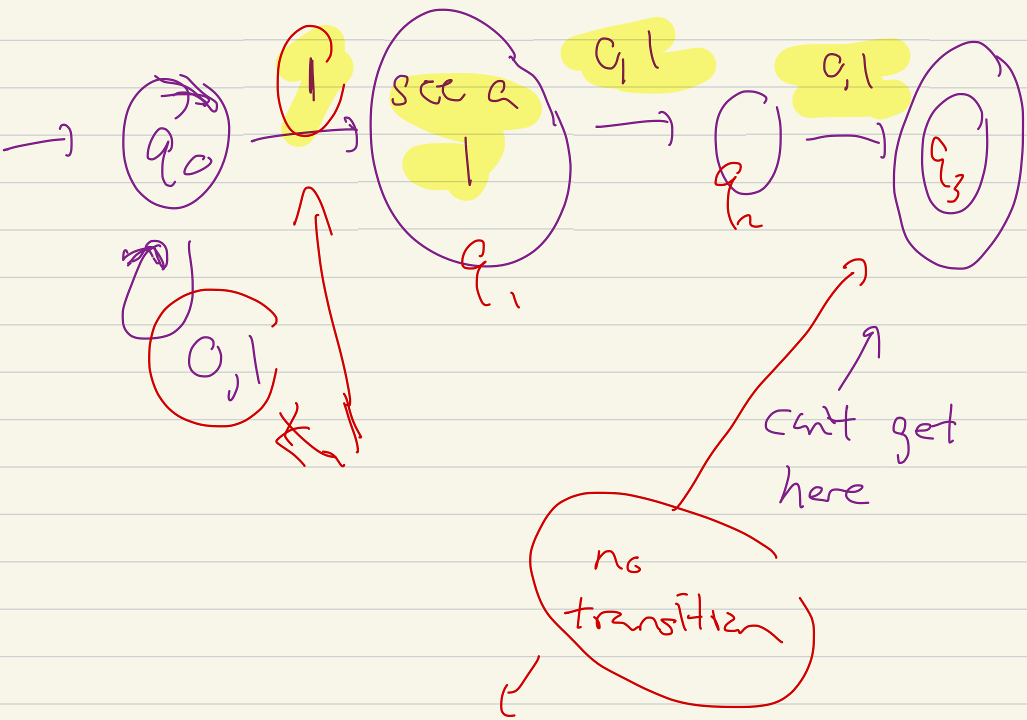
the empty language $= \emptyset$

$\neq \{ \varepsilon \}$

CLASS ENDS

Size of $|\emptyset| = 0$

NFA recognizes $(0,1)^* \mid (0,1)^2$



$\delta(q_3, 0) = \emptyset$

$\delta(q_3, 1) = \emptyset$