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Topic 7 - Turing Machines

Week 13

▼ who invented the turing machine?

Alan Turing

▼ what is a turing machine

- deterministic finite automaton with RAM

- unbounded memory

- FA that gives instructions on how to traverse an infinite tape with cells in it, where an input is given

- each cell has a character (blank symbol is considered a character) so a cell with ■ is called an empty cell

  ○ replacing a cell with a ■ is like deleting whatever was in that cell before

▼ what are the components of a turing machine?

▼ tape alphabet Γ

all input alphabets/variables INCLUDING the blank symbol ■

▼ input alphabet Σ

variables you'll use (i.e a,b)

Σ is a subset of Γ

▼ tape head

points to current input (kinda like algorithms like bubble sort pointer)

reads and writes

- ▼ finite set of states Q

    set of all states in the turing machine

- ▼ start state q_1

    is an element of Q

- ▼ accept and reject states q_acc, q_rej

    once reached the process will terminate, even if there's still inputs

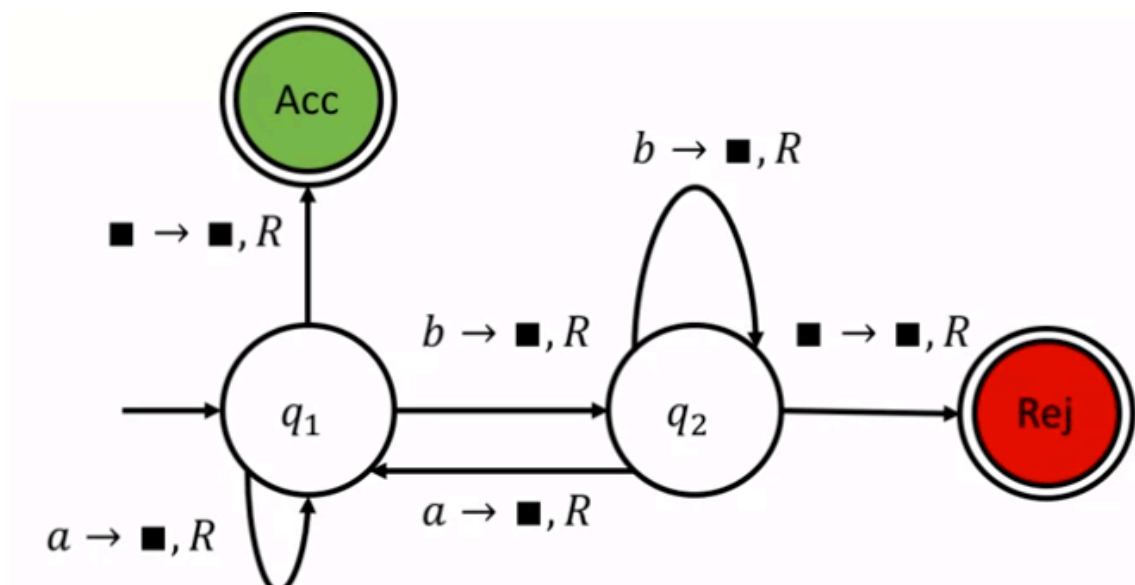   TM will accept the original function not the current; same goes for reject

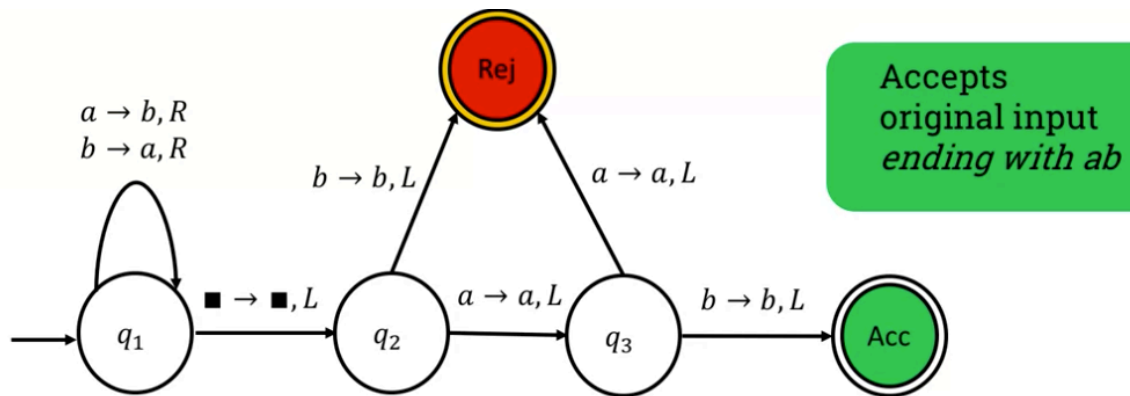   - the current or new string is not equivalent to the original string

- ▼ transition function: δ: Q X Γ → (Q X F{L,R})

    it's format is:

    input, replace input with, direction (L or R) it will move on to after cell is replaced

- examples:

$a \rightarrow b, R$
$b \rightarrow a, R$

$b \rightarrow b, L$

$a \rightarrow a, L$

Rej

Accepts
original input
ending with ab

$\blacksquare \rightarrow \blacksquare, L$

$a \rightarrow a, L$

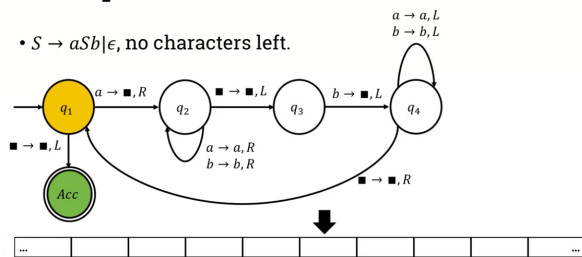$b \rightarrow b, L$

q_1 q_2 q_3 Acc

making TMs

all CFGs are recognisable by TMs

example for not RE but CFG:

Example $a^n b^n, n \geq 0$

• $S \rightarrow aSb | \epsilon$, no characters left.

example for not RE or CFG:

$$a^n b^n c^n, n \geq 0$$