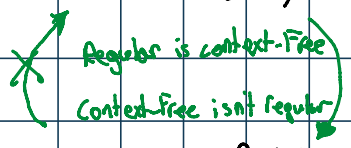
Lecture 20 : Turing Machines

December 7, 2020 5:26 PM

a^* a^*b^* => Regular languages (what is accepted by finite automatas NFAs and DFAs)

↳ Represented by regular expressions here.

what about languages that aren't regular?



$a^n b^n$ ww^R => Context-Free languages (what is accepted by automatas that have access to a stack PDAs)

what about languages that aren't context-free

$a^n b^n c^n$ ww =>

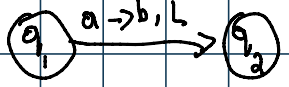
* what is a Turing Machine?

. An automaton that has access to a different type of memory. An infinite tape instead of a stack. A read/write head moves to left or right, one step at a time on the symbols in the input tape. The diagram controls its behavior.

. At each step of computation in Turing machine : ① Read symbol under the head

② write a symbol (to replace) under the head

③ Move right or left, one cell.

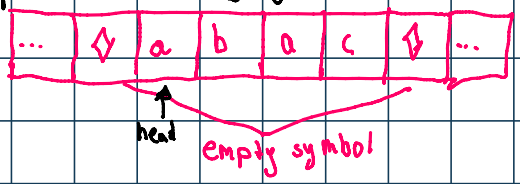


a -> b : if read a, overwrite a with b, move left.

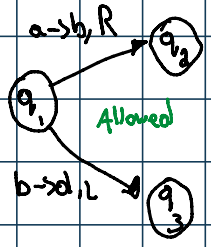
Example string : "abac"

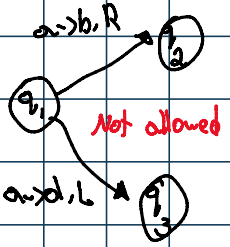
. Since we're dealing with an infinite tape, we fill the cells before and after our input string.

. If the head points to an empty symbol then the string is lambda.



. Turing machines are deterministic, by having a clear instruction we don't give it a choice. The path to take depends on the input character that is being read.





. TMs can have partial transition functions. We don't need to define possible transitions for every particular symbol in the alphabet. Like for abac, we don't have any path when we read c

. In that case, the machine halts. A TM halts when there is no more possible paths/moves according to

the transition diagram.

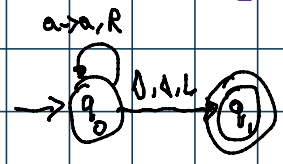
- TMs can act like Acceptors (like FSMs / PDA). Accept when in final state.

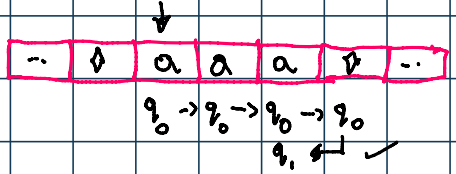
A final state can't have any outgoing transitions. Once it reaches a final state, it halts.

Accept => Halt in a final state.

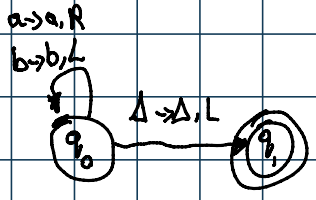
Reject => Halt in a non-final state OR enter an infinite loop

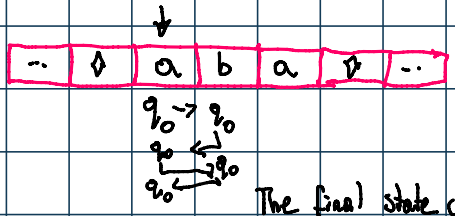
Example of Turing machine for a regular language: $L(a^*)$





Example of Infinite loop:

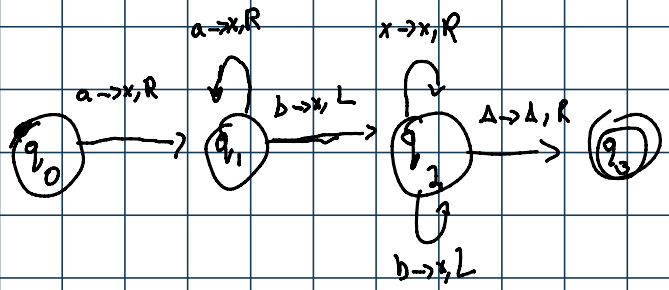




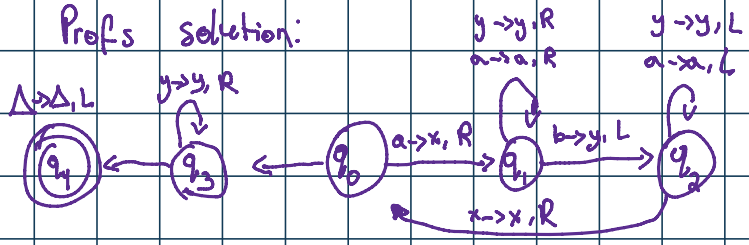
The final state cannot be reached.

Exercise: Design a TM for $\{a^n b^n : n \geq 1\}$

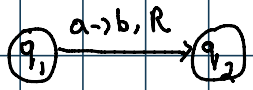
ab aabb aaabbb -> x
aba ba



Prof's solution:



- Formal definition:

→ $\delta(q_1, a) = (q_2, b, R)$ 

$M = (Q, \Sigma, \Gamma, \delta, q_0, \square, F)$