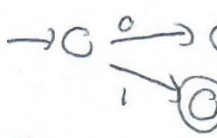
- Midterm on Wednesday (in this classroom, 4~~-5~~pm)
- Based on the Homework 1-6 (and 7)
- 45 minute test, seated alphabetically
- Put up today: Practice Problems { - true/false, multiple choice - two problem with a few parts
- Some of Practice Problems I'll do on Monday
- You can bring an 8*11½ 2-sided sheet of notes
- §3.1 is covered, only part about (determistic TM)
  - You can read "TM" as "multi-tape TM"
- DFA's & TM: Describe via { values of δ or



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e.g. We know: Power(ℕ) is uncountable

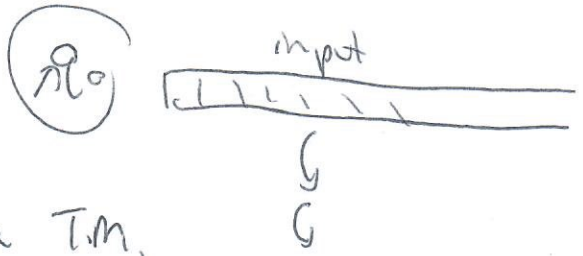
← you can use unless explicitly told otherwise

Notes: { Write the Pumping Lemma
" asymptotic ratio tests
" DFA is $(Q, \Sigma, \delta, q_0, F)$ _ _
NFA _ _

AcceptFutures$(L, s) = \{t \mid st \in L\}$

How to make a quick $1M: P vs. NP...

§7.1: Turing machine



Recall: The time that a T.M., M, takes on input s, is just the number of steps until it halts, either in q_{acc} or q_{rej}.

We say that a T.M., M, runs in time $t(n)$, where $t: \mathbb{Z}_{\geq 0} \to \mathbb{R}_{\geq 0}$ if for every input, s, to M ~~of size~~ M halts in time $\leq t(n)$, where $n = |s|$.

We define, for $f(n): \mathbb{Z}_{\geq 0} \to \mathbb{R}_{\geq 0}$

$$TIME(f(n)) = \{\text{Languages, } L, \text{ recognized by a T.M. in time } t(n), \text{ for some } t \text{ with } t(n) = O(f(n))\}$$

So $TIME(n^3) = \{$Languages recognized by a Tm. running in time $O(n^3)$ ~~on~~ a multi-tape TM$\}$

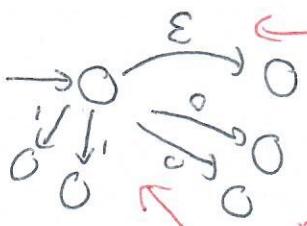
$$PolyTime \stackrel{def}{=} \bigcup_{k=1,2,\ldots} TIME(n^k)$$

$=$ ← tends not to depend on the model, TM, C-program

Common algorithms: graph colouring, sorting, dynamic programming, $\ldots \in P = PolyTime$

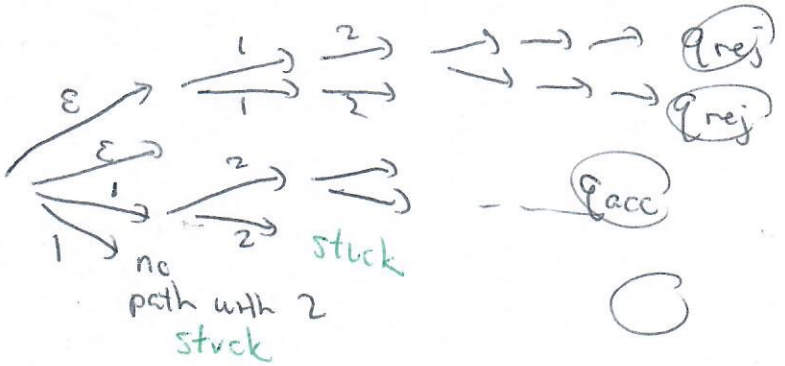
Non-deterministic TM's:

DFA:  deterministic procedure

NFA: 

$\Sigma = \{0,1,2\}$

NFA on input 1201101...2



NFA "accepts" input w if (at least one) same path reaches q_{acc}
"doesn't accept" -- all paths get stuck or land in q_{rej}

Non-deterministic TM:

Deterministic TM (multitape):

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

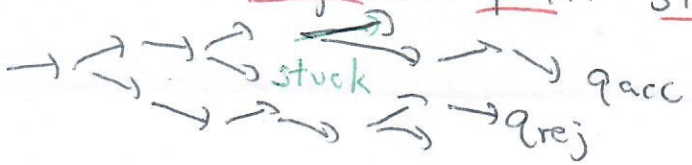
$$Q \times \Gamma^k \to Q \times \Gamma^k \times \{L,R,S\}^k$$

Non-deterministic multitape:

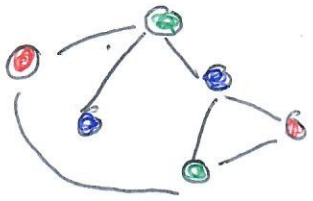
$$\delta : Q \times \Gamma \to \text{Power}(Q \times \Gamma \times \{L,R\})$$

$$Q \times \Gamma^k \to \text{Power}(Q \times \Gamma^k \times \{L,R,S\}^k)$$

A non-det TM (NTM) runs in "time" $t(n)$ if on input S, if every possible configuration path "stops" in time $\leq t(n)$

"Stops": 

E.g. $3COLOR = \{ \langle G \rangle \mid$ G is a graph that can be 3-coloured $\}$



red
green
blue

NP = Non-det Poly Time $= \bigcup_{k=1,2,3,\ldots} NTIME(n^k)$

$NTIME(f(n)) = \{$ Languages recognized by a non-det TM in time $O(f(n))\}$

$3COLOR \in NP$:

Algorithm: guess ~~1~~ colour for 1st vertex

etc. guess nth vertex

verify if it works