

CS3000

6/17 - Tues!!

## Admin

- Second chance HW 6/18 9pm } optional!!
- XL exam 6/18 during class } → not scanned
- reggrade requests for exam 2, HWS close 6/18 9pm  
↳ reg after that, or for 2<sup>nd</sup> chance in email later

## Agenda

1. TSP
2. P vs. NP
3. TRACE / grade Confirmation

## 1. Travelling Salesperson Problem in TSP

Context first!

run-time classes

$\Theta(1)$

$\Theta(\lg n)$

$\Theta(n)$

$\Theta(n \lg n)$

$\Theta(n^2)$

$K$  is constant

$\Theta(2^n)$

$K$  is constant

$\Theta(n!)$

SSSP



Dijkstra's  
BFS

APSP



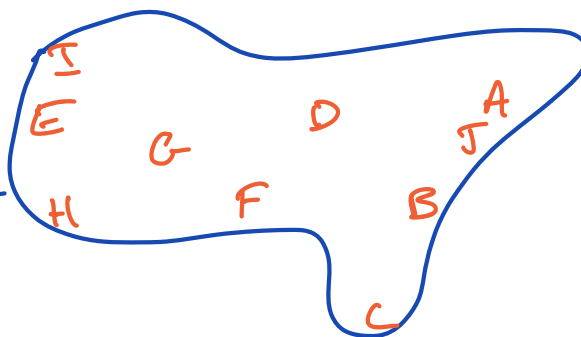
Floyd Warshall

- optimization
- solve in poly time
- used with maps

intractable!!

TSP - similar FedEx

- visit  $n$  cities
- minimize: distance, time, cost
- solve: ordering of cities



the only known way for TSP

- try all orderings
- keep the best one

~  $\Theta(n!)$

$n!$  solutions, but that's  
not a real solution  
~

What we know about TSP

1. there is no poly time soln that we know of
2. we haven't ruled out that it might exist

QED

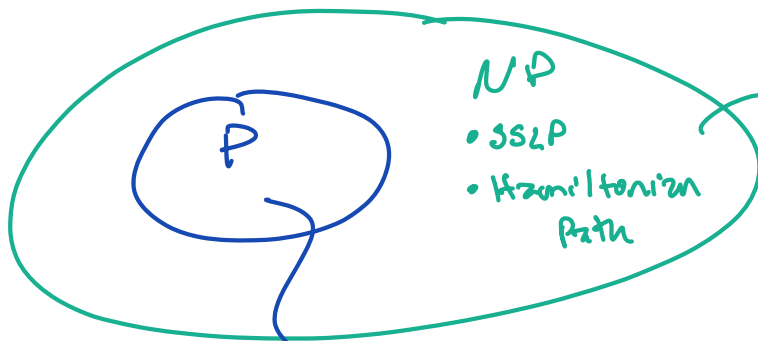
Unsolved in CS ~ millenium problem  
\$1M to solve

## 2. P vs. NP

→  $P = NP?$   $P \neq NP?$  nobody knows!

- P - solved in poly time  
by a deterministic Turing Machine  
(actual computer)

NP - solved in poly time  
by non deterministic Turing  
(fake computer)



haven't found poly time soln,  
but can verify solution in poly time

P, NP relate to: decision problem

yes/no

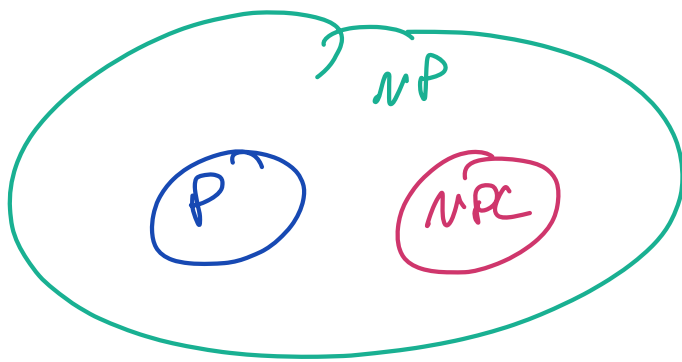
→ opt → decision

SSSP

is there a path  
from S to U < 5?

• SSSP

• Euler path



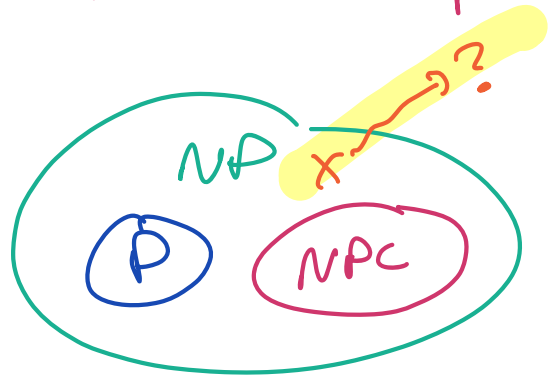
$NPC = NP$  Complete

- brute force soln exists
- no known poly time soln
- hardest of the  $NP$  problems

the problem...

we know  $P \subseteq NP$

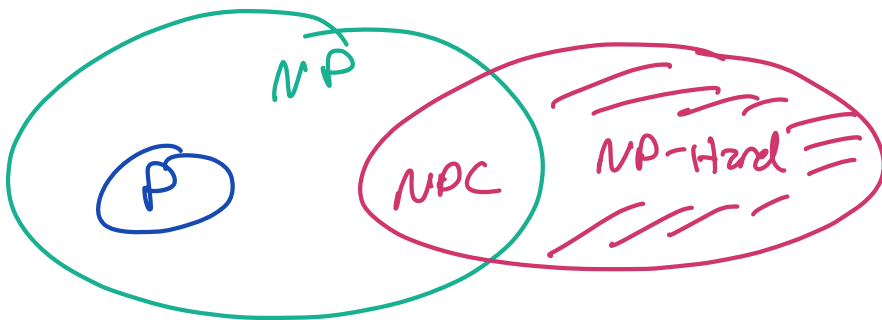
we don't know  $P = NP?$   
 $P \subset NP?$



$NP$  complete are related!  
 - solve one, solve them all !!

What we know so far...

if a problem is in  $NP$ , but not in  $P$ ,  
 then it is  $NP$  Complete



$NP$ -Hard:

- might not be  $NP$  complete
- might not be verifiable in poly time

in  $NP$  Hard, not in  $NP$   
 - will this program finish?

Halting problem Undecidable