



Provably Hard problems

Intractable

Exponential Time

$$P \stackrel{?}{=} NP$$

Reductions

Impossible

Intractable problem

Exponential-time
Algorithm

Guess password

a-z

26

12



26^{12}

Traveling Salesman Problem

Shortest route visiting
every city once

Some problems are intractable if any problem is

Reduction

problem A reduces to ^{problem} B
if Alg solves A by calling B as a function

Hard problem that all* other problems reduce to

Classes of Problems

P — have non-exponential-time algorithms

NP — checking an answer is in P

NP-complete — *x is in NP complete if* every problem in NP reduces to *x*

NP-hard — NP complete or harder

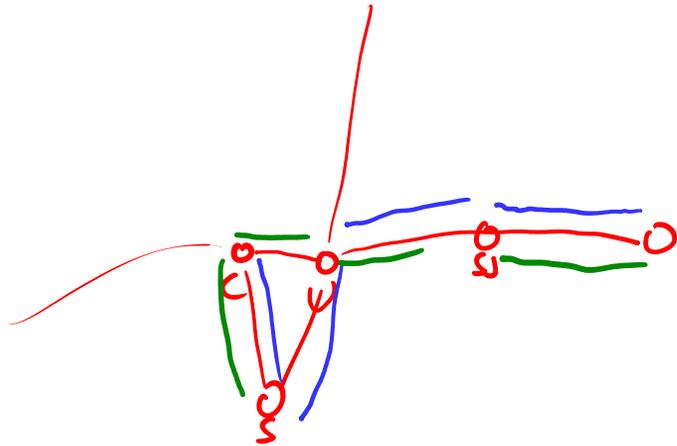
Unknown:

$P = NP$ or $P \neq NP$

Class or group of Algorithms based on data structure

Graph

Nodes
Edges



$O(n)$ Shortest path between 2 nodes

$O(2^n)$ Longest path between 2 nodes

$O(2^n)$ Shortest path between all nodes

Intractable:
most/least of ^{most} all options
nearly

Heuristic