SOLVING VS CHECKING

EULERIAN PATH — EASY TO CHECK

SIMPLE PATH THAT GOES THRU ALL EDGES EXACTLY ONCE

BFS — $\Theta(|V|+|E|)$

SIMPLE

HAMILTONIAN PATH

SIMPLE PATH THAT GOES THRU ALL VERTICES EXACTLY ONCE

NO POLY-TIME ALG KNOWN

~~$\Theta(|V|!000)$~~

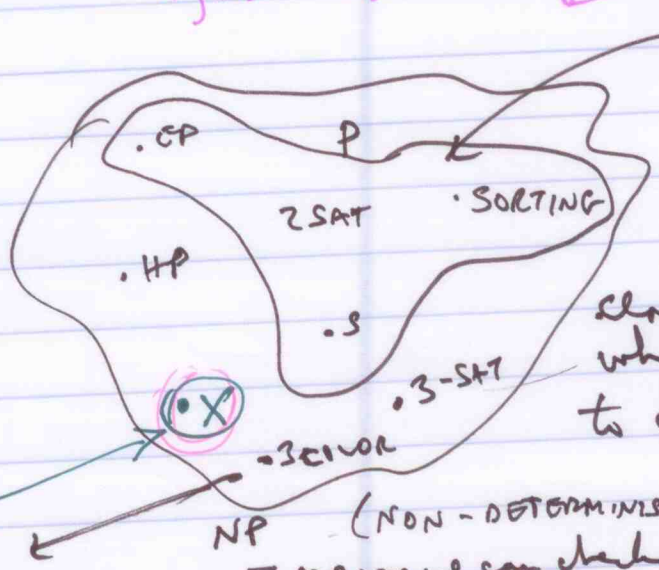
SEEMS HARD

GIVE YOU THE PATH → EULERIAN / HAMILTONIAN

CHECK | EASY

VERIFICATION

Classifying Problems — by how hard it is to check a solution.
— by how hard it is to get a solution

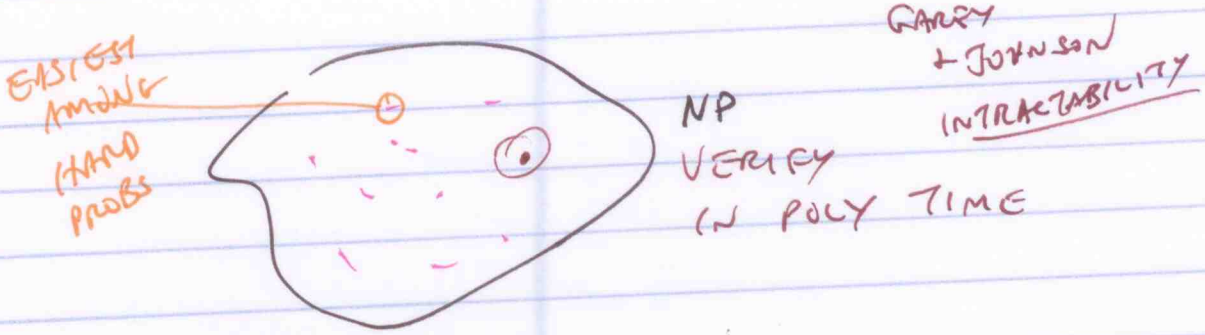


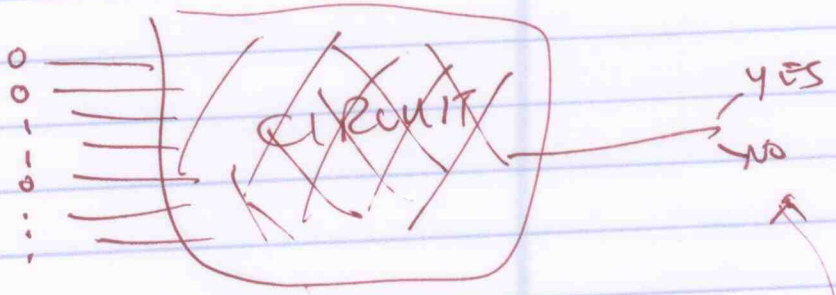
P ≠ NP ?

$1000000 CLAY INST

X - hardest problem in NP (verified in poly time)

X at least as hard as problem Y
which is known to be the hardest prob in NP.





SATISFIABILITY
CIRCUIT VERIFICATION
→ is there an input sequence of bits that yields "yes"

HARDEST

BOOLEAN EXPRESSION SATISFIABILITY

V

3-SAT BOOLEAN EXPR SATISFIABILITY

SOLVE

$\wedge$ $\vee$ $\neg$ XOR $\Rightarrow$ $\Leftrightarrow$ $\Leftarrow$

3-SAT BOOLEAN EXPRESSIONS

↳ 3-CNF (Conjunctive Normal form)

AND/OR/NOT

$(a \vee b \vee \bar{c}) \wedge (\bar{a} \vee b \vee c) \wedge (a \vee \bar{b} \vee \bar{d}) \wedge (\ \vee\ \vee\ ) \cdots$

↑ variables contain negated variables

CLAUSE

Given a 3-CNF boolean expression, is it SATISFIABLE

that is, is there an assignment of T/F to the variables that causes the expr. to be true?

a	b	c	d ...	Expr
0	0	1	0	⋮

exponentially many

2^n

T BINGO!

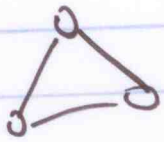
All false – NOT SATIS.

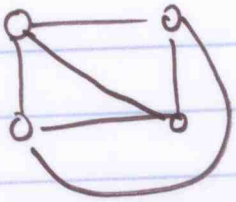
VERIFICATION

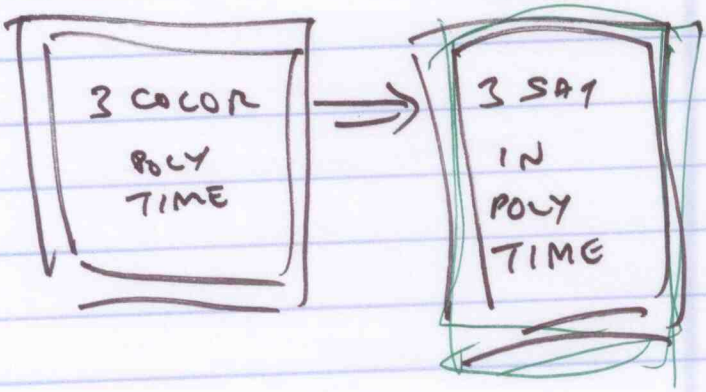
in NP 3SAT — HARDEST PROB IN NP

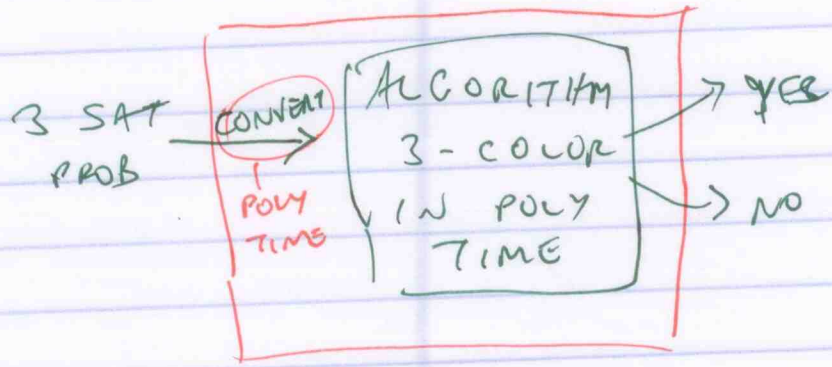
↘ SIMPLE PROB

in P 2SAT $(\ \vee\ ) \wedge (\ \vee\ ) \wedge (\ \vee\ ) \wedge \cdots$






3 COLOR
POLY TIME
3 SAT
IN POLY TIME


3 SAT PROB
CONVERT
POLY TIME
ALGORITHM
3-COLOR
IN POLY TIME
YES
NO