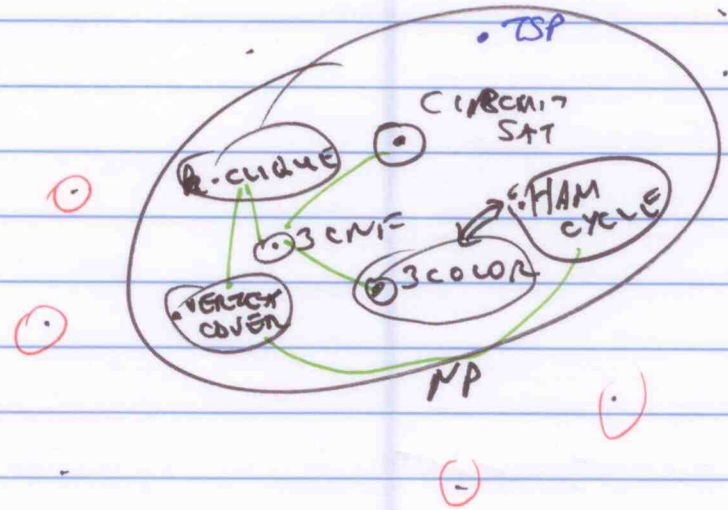
NP-Hardness / Completeness

↑ at least as hard as any problem in NP

↑ in the class as well



Polynomial verifier

$(\square \vee \square \vee \square) \wedge (\square \vee \square \vee \square) \wedge (\quad) \wedge \cdots \wedge (\quad)$

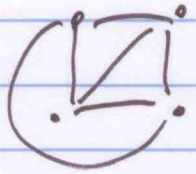
literals — variables or complemented vars.

2 CNF $(\square \vee \square) \wedge (\square \vee \square) \wedge \cdots \wedge (\quad)$

— POLY TIME

CLIQUE

Given G, is there a clique of size k?



k vertices — all $\binom{k}{2}$ edges

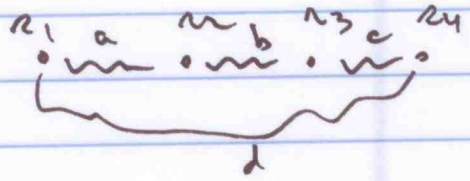
4-clique

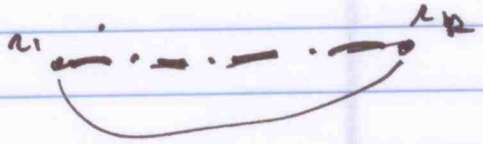
3-clique

2-clique

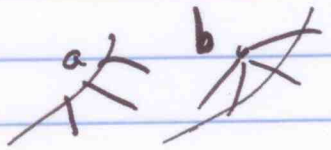
1-clique

5-clique

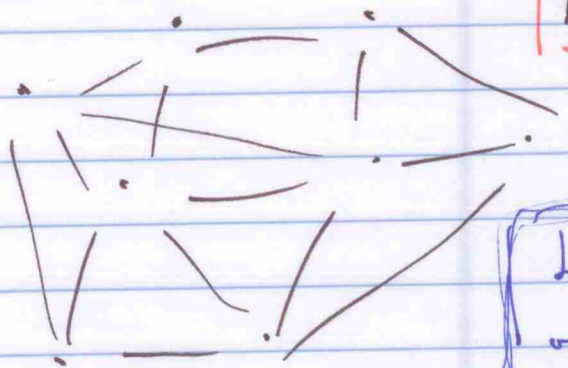




a b c d



TSP — NP-hard



~~least cost tour~~

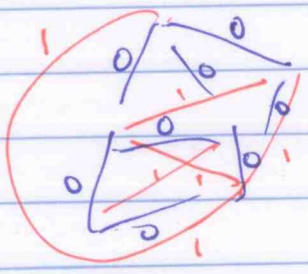
OPTIMIZATION

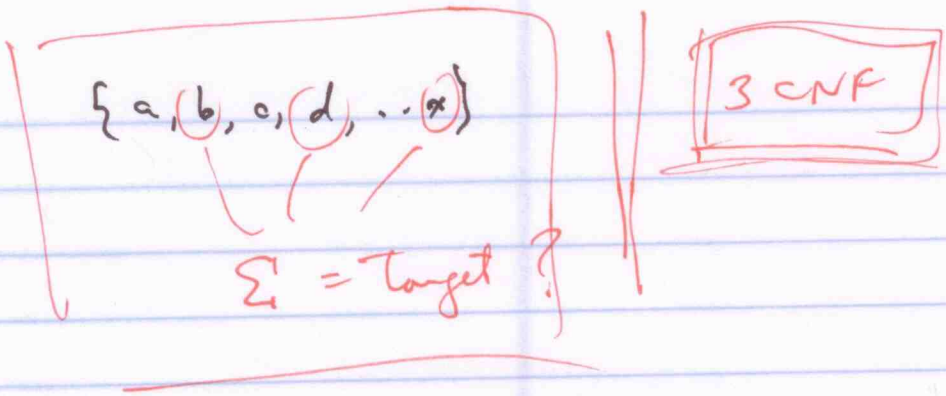
Is there a tour of cost ≤ K

Yes/No

in NP

Ham cycle → TSP ≤0




{a, b, c, d, .. x}
Σ = Target ?
3 CNF