# CSE 421 Algorithms

Richard Anderson Lecture 27 NP-Completeness and course wrap up

### Announcements

#### • Final Exam

- Monday, March 16, 2:30-4:20 pm
  Closed book, closed notes
- Practice final and answer key available
- This week's topic
- NP-completeness
- Reading: 8.1-8.8: Skim the chapter, and pay more attention to particular points emphasized in class
- It will be on the final







# $IS <_P VC$

- Lemma: A set S is independent iff V-S is a vertex cover
- To reduce IS to VC, we show that we can determine if a graph has an independent set of size K by testing for a Vertex cover of size n - K









- Lemma: S is Independent in G iff S is a Clique in the complement of G
- To reduce IS to Clique, we compute the complement of the graph. The complement has a clique of size K iff the original graph has an independent set of size K









## Number Problems

- Subset sum problem
  - Given natural numbers  $w_1, \ldots, w_n$  and a target number W, is there a subset that adds up to exactly W?
- Subset sum problem is NP-Complete
- Subset Sum problem can be solved in O(nW) time

# Subset sum problem

- The reduction to show Subset Sum is NPcomplete involves numbers with n digits
- In that case, the O(nW) algorithm is an exponential time and space algorithm

#### What is NP?

- Problems where 'yes' instances can be efficiently verified
  - Hamiltonian Circuit
  - 3-Coloring
  - 3-SAT
- Succinct certificate property

#### What about 'negative instances'

- How do you show that a graph does not have a Hamiltonian Circuit
- How do you show that a formula is not satisfiable?



