



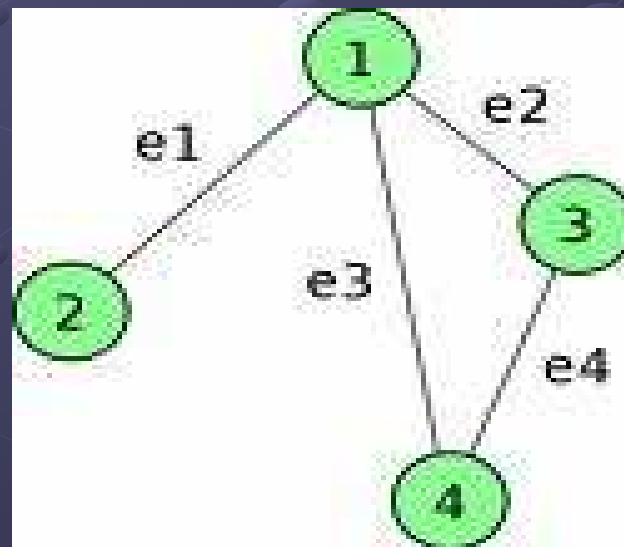
Graph Theory

Steve Gredell

Brian Witt

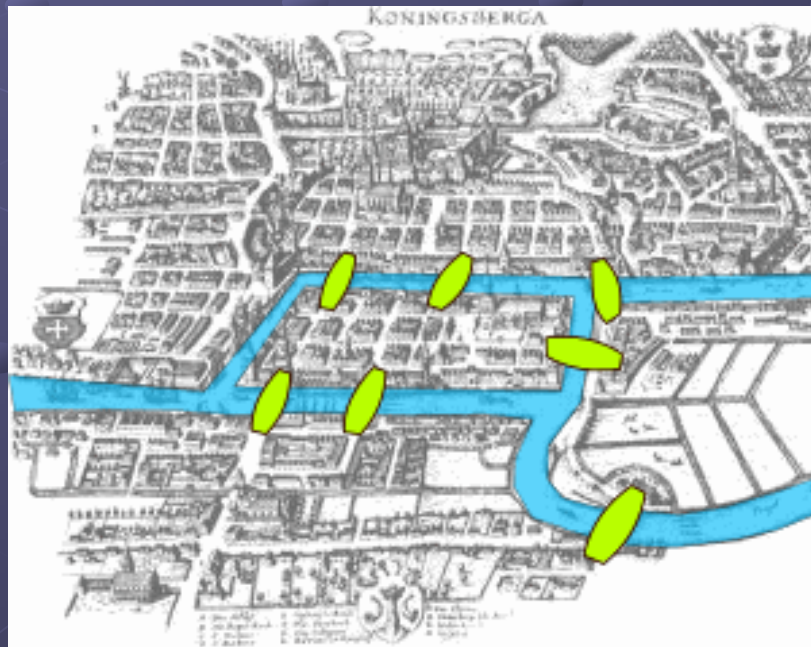
What Is a Graph?

- Mathematical structure used to represent relations between objects
- Nodes (or vertices) which are connected by edges
- Undirected, like a two way street, or directed, like a one way street



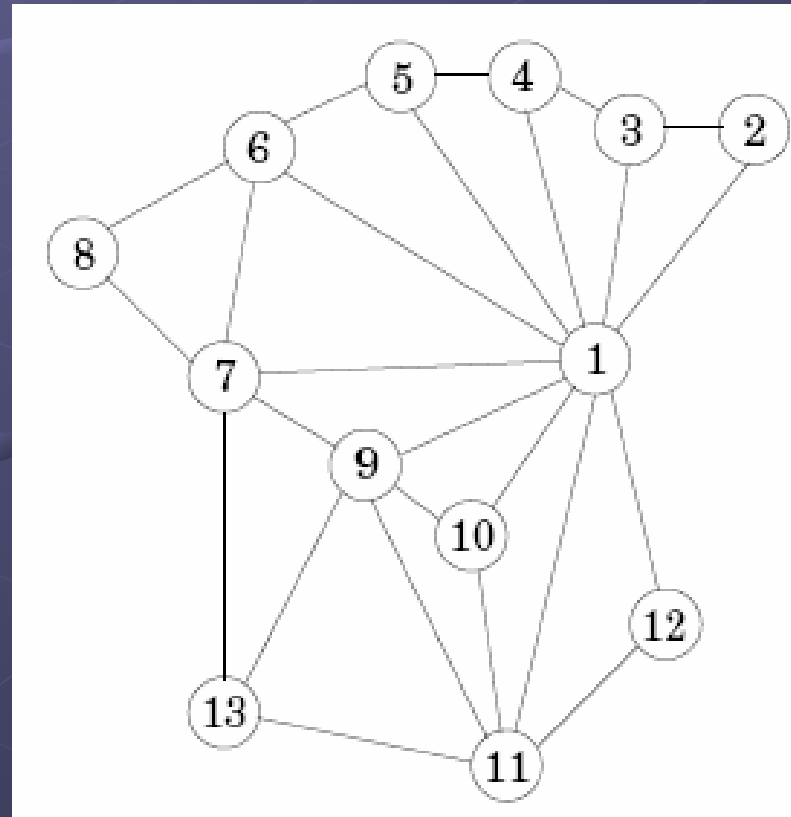
History

- Graph theory originated from topology and map making
- Leonhard Euler and the seven bridges of Königsberg

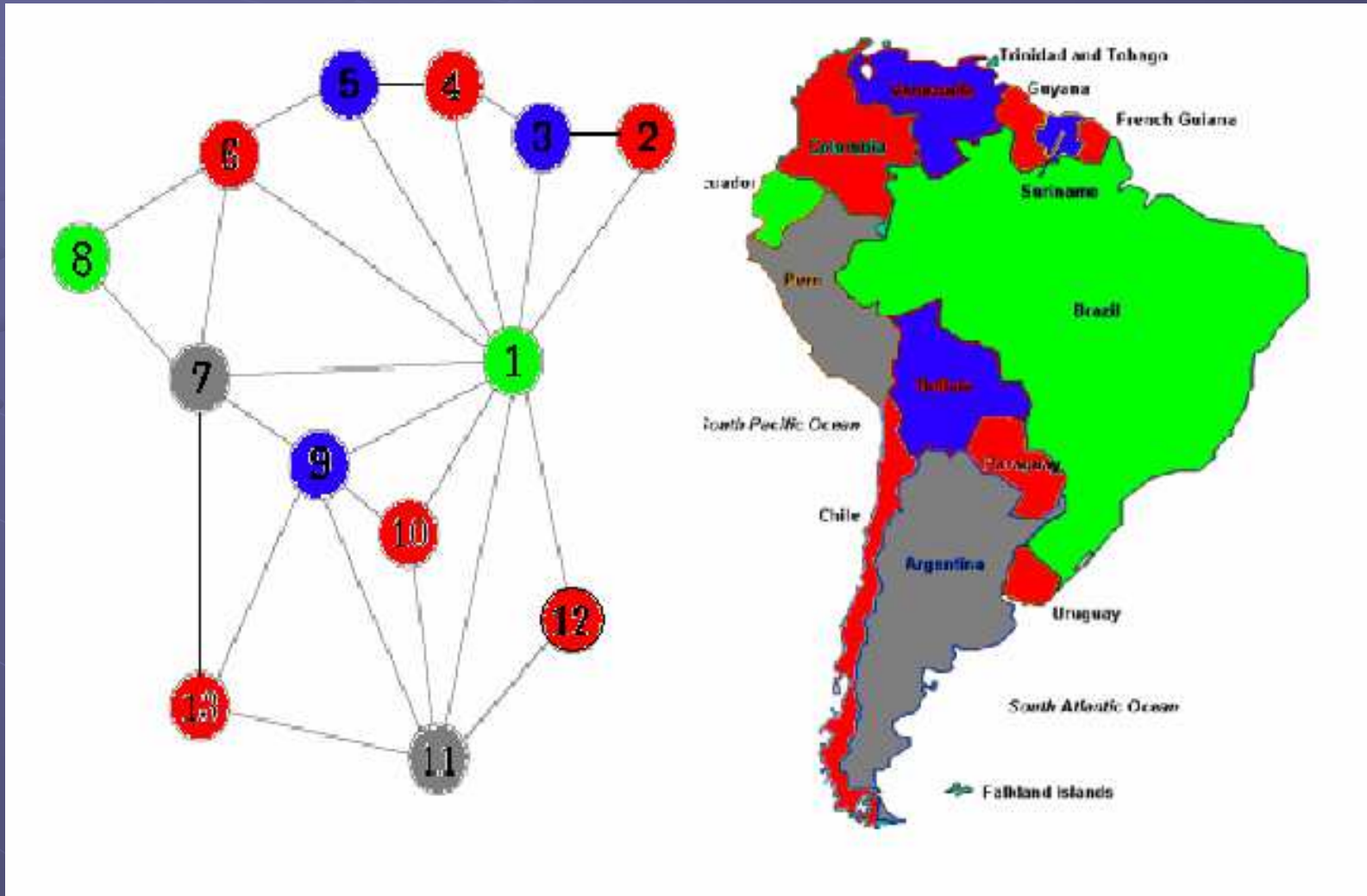


Map Coloring

- Four Color Theorem



Four Color Theorem



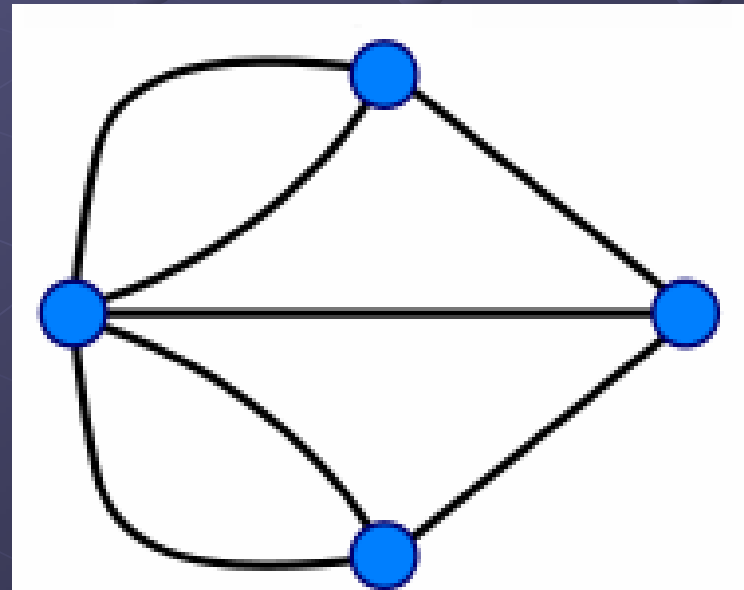
7 Bridges of Königsberg

- First explored by Leonhard Euler
- People of Königsberg liked to walk around in the afternoon
- Wanted to cross all seven bridges once and only once



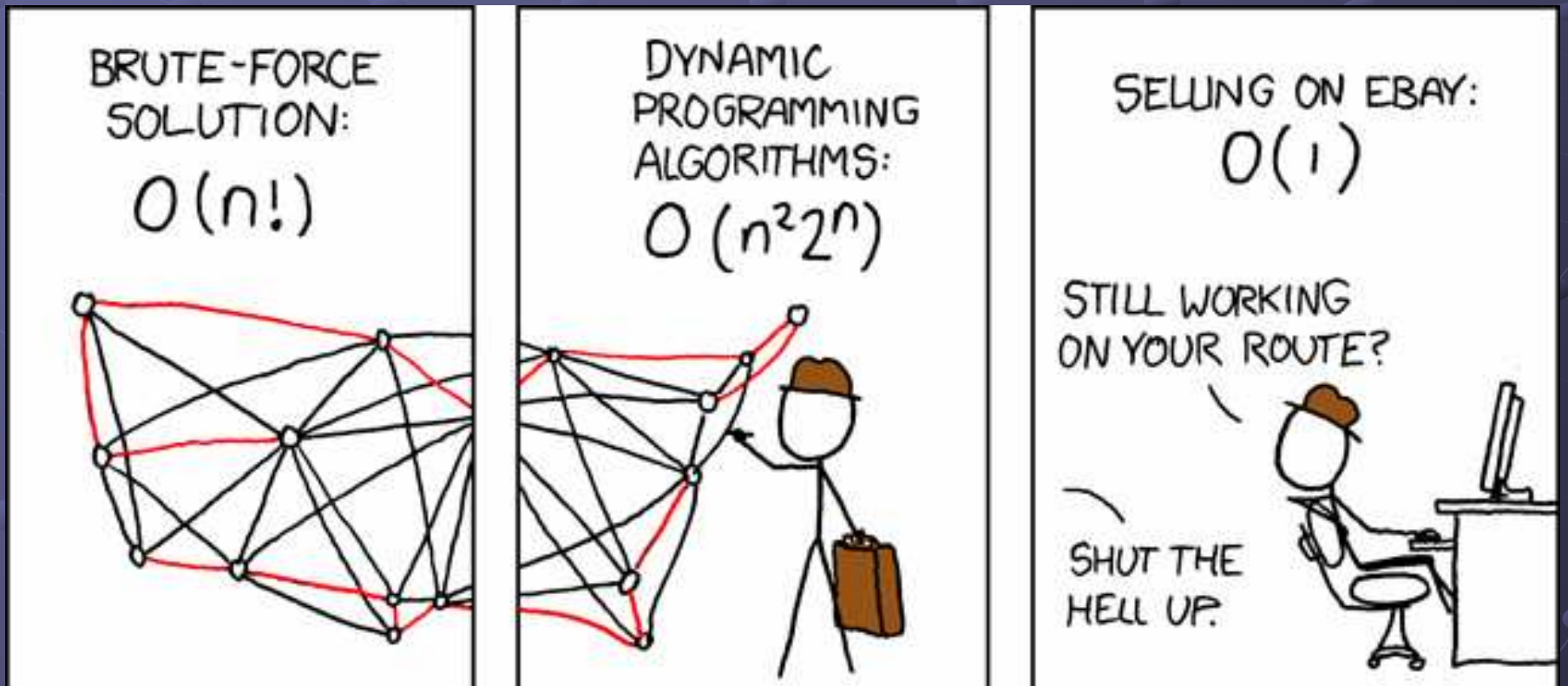
7 Bridges cont.

- Euler broke the problem into parts
- Land masses = nodes
- Bridges = edges
- Euler path/circuit named in his honor
- Only possible if each node has an even degree for cycle
- For Euler path, can have 2 nodes with odd degree



Traveling Salesman problem (TSP)

- One of the most heavily researched problems today
- NP-complete category of problems



NP-Complete Problems

- Nondeterministic Polynomial
- Not able to be solved for reasonable inputs
- Finding the 200th Fibonacci number with recursion
- 2^{138} steps to solve, faster than the TSP@ 2^n
- Divided by 1.75 petaflops (fastest computer today)
- Only $6.4995587438266819 * 10^{18}$ years to compute
- 6.5 quintillion years vs. 4.6 billion years of Earth
- More than a billion times longer than the history of the Earth

TSP cont.

- You sell door to door
- Have your own Cray XT5 Jaguar (1.75 petaflops)
- Run through a map of the 57 houses you must visit today
- Best case scenario, it will finish in 23.5 hours!

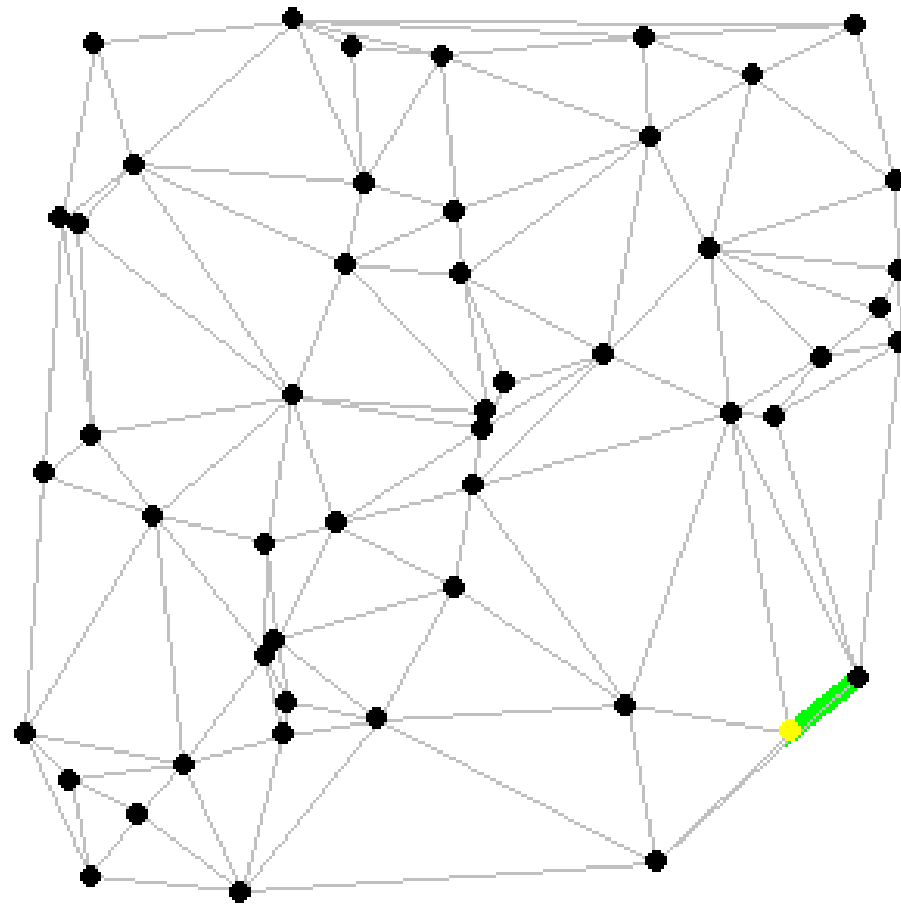
Applications of Graphs

- Google Maps, Mapquest, Tom Tom....
- Dijkstra's Algorithm



Dijkstra's Algorithm

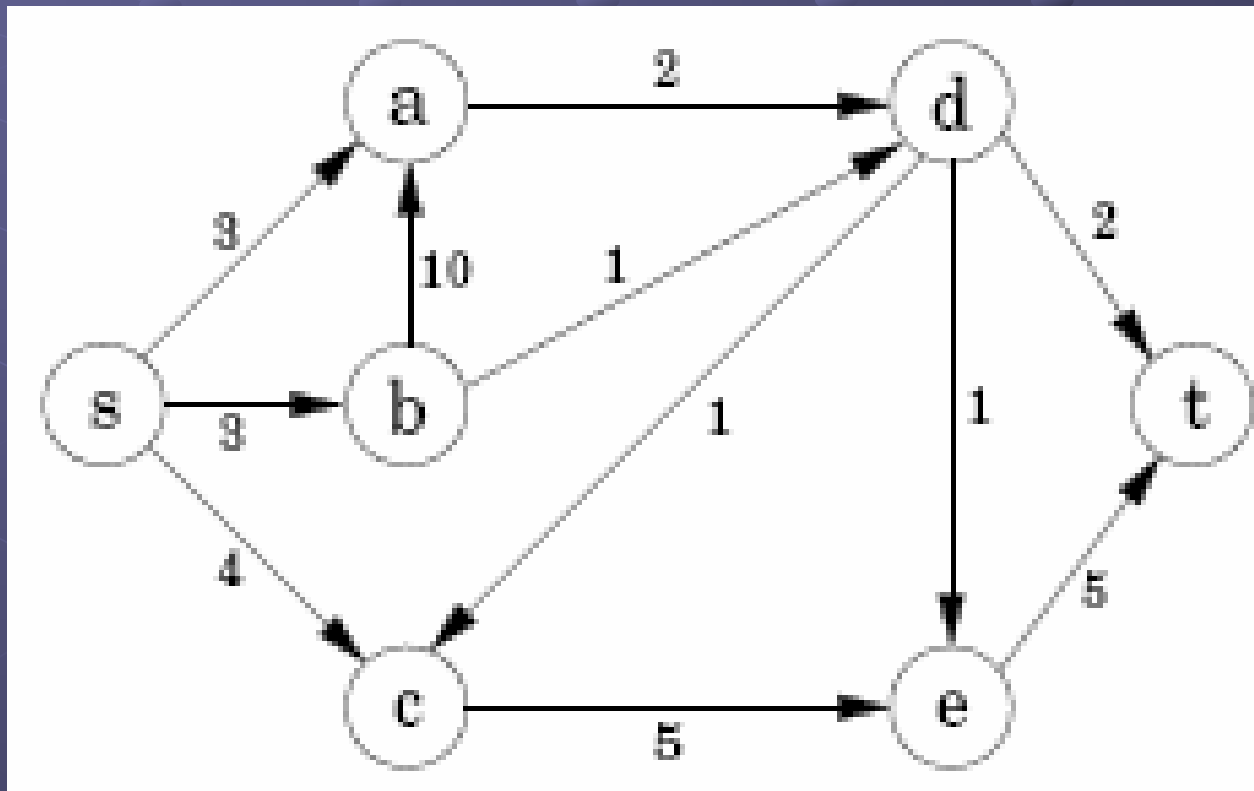
Dijkstra's algorithm



www.combinatorica.com

More Applications

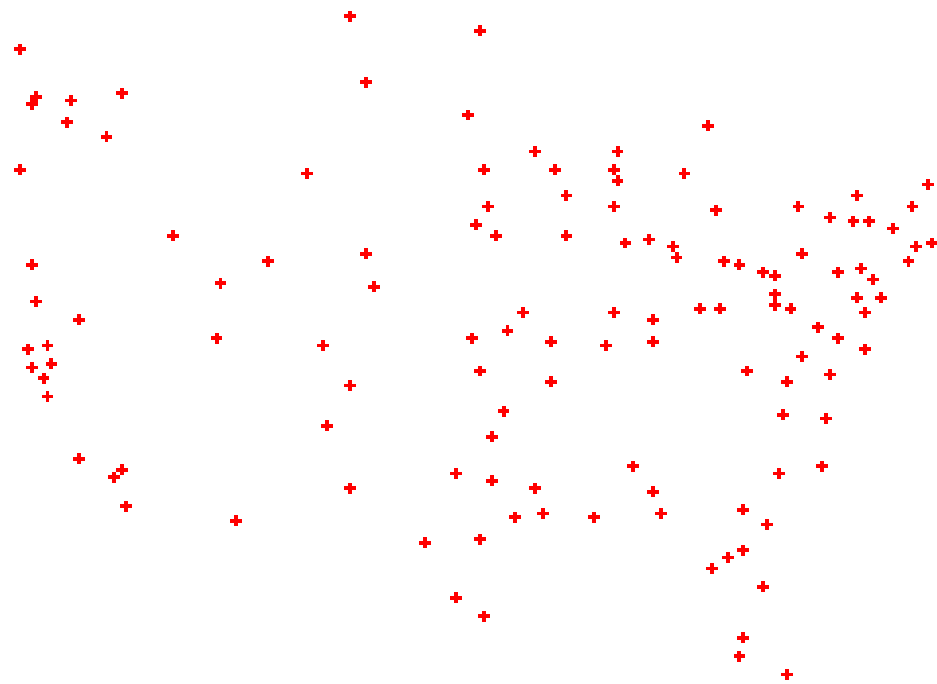
- Plumbing, electricity, phone, cable, and internet wiring
- Network Flow Modeling



Minimum Spanning Tree

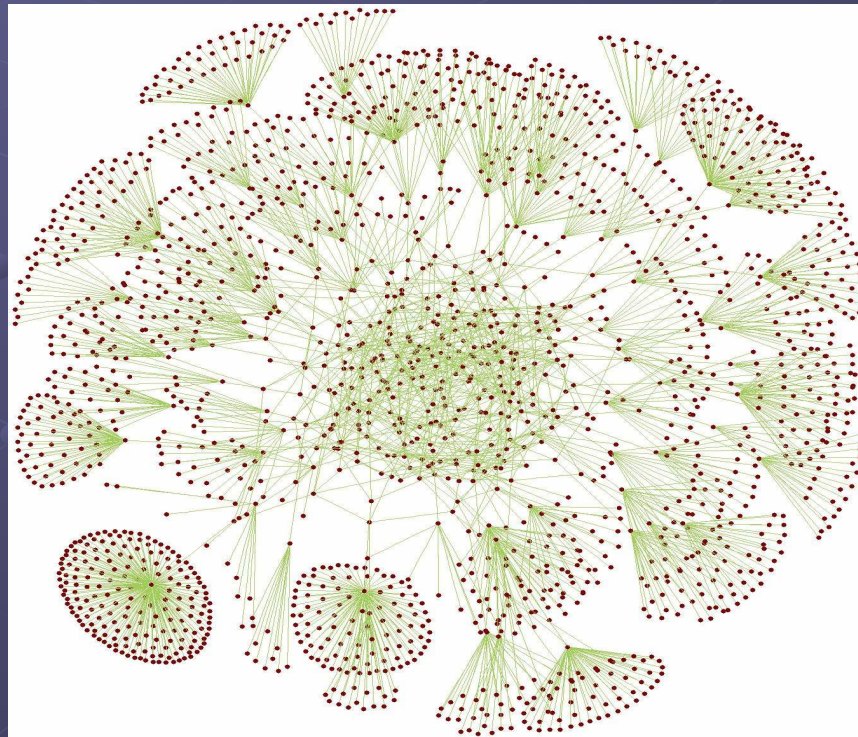
- Shortest distance to connect all nodes
- Kruskal's Algorithm

Minimum Spanning Tree



Graphing the Internet

- Useful to study security and other topics
- Random generated graphs used
- How much does the internet weigh?



Thank You

A mathematician is a device for
turning coffee into theorems.

-Paul Erdős

Works Cited

- Minimum Spanning Tree animation
<http://www.cs.sunysb.edu/~skiena/combinatorica/animations/mst.html>
- Dijkstra's Algorithm animation
<http://www.cs.sunysb.edu/~skiena/combinatorica/animations/dijkstra.html>
- Google answers
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- Graph Theory
http://en.wikipedia.org/wiki/Graph_theory