Graphs and Networks

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Graphs and Networks

Graph: Set of vertices $V$
Set of edges $E$ – pairs of vertices
Sometimes directed/ordered pairs
Sometimes with weights

Network = Graph
Graphs and Networks
Graphs and Networks

Social networks:
\[ V = \text{people}, \]
\[ E = \text{pairs who know each other/are friends} \]

Web graph:
\[ V = \text{web pages}, \]
\[ \text{edge } (u,v) \text{ if page } u \text{ links to page } v \]
The Social Structure of “Countryside” School District

From James Moody’s page: http://www.sociology.ohio-state.edu/jwm/adol_soc_net.htm
Graphs and Networks

Protein interaction networks
V = proteins
edges: proteins that “interact”
weight by strength of interaction

Neural networks

Technological networks
internet hardware
communication networks
Graphs and Networks

Scientific Applications
Graphs and Networks

Scientific Applications

image processing example (l1img.m)
Geometric Graph: vertices connected if distance less than $r$
Course outline

1. What graphs look like
   empirical studies
   mathematical models
   sampling bias

healthy skepticism
Course outline

2. Processes on graphs

- diffusion / contagion
- random walks
- gossip
- traffic flow
- electrical flow
- coordination / agreement / percolation

- evolution of graphs
Diffusion
Diffusion
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Diffusion
Diffusion
Course outline

2. Processes on graphs

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3. Analysis of graphs

importance / ranking / centrality
similarity / distance measures
community detection
learning
link prediction
de-noising?
Course outline

3. Analysis of graphs

validate by:
- theoretical justification
- axiomatic justification
- experiments and prediction
Mechanics

Problem sets
  theorems / proofs
  some experiments

Final Project (optional)
  can substitute for some problem sets

No tests or exams

Future research projects