Graphs and Networks

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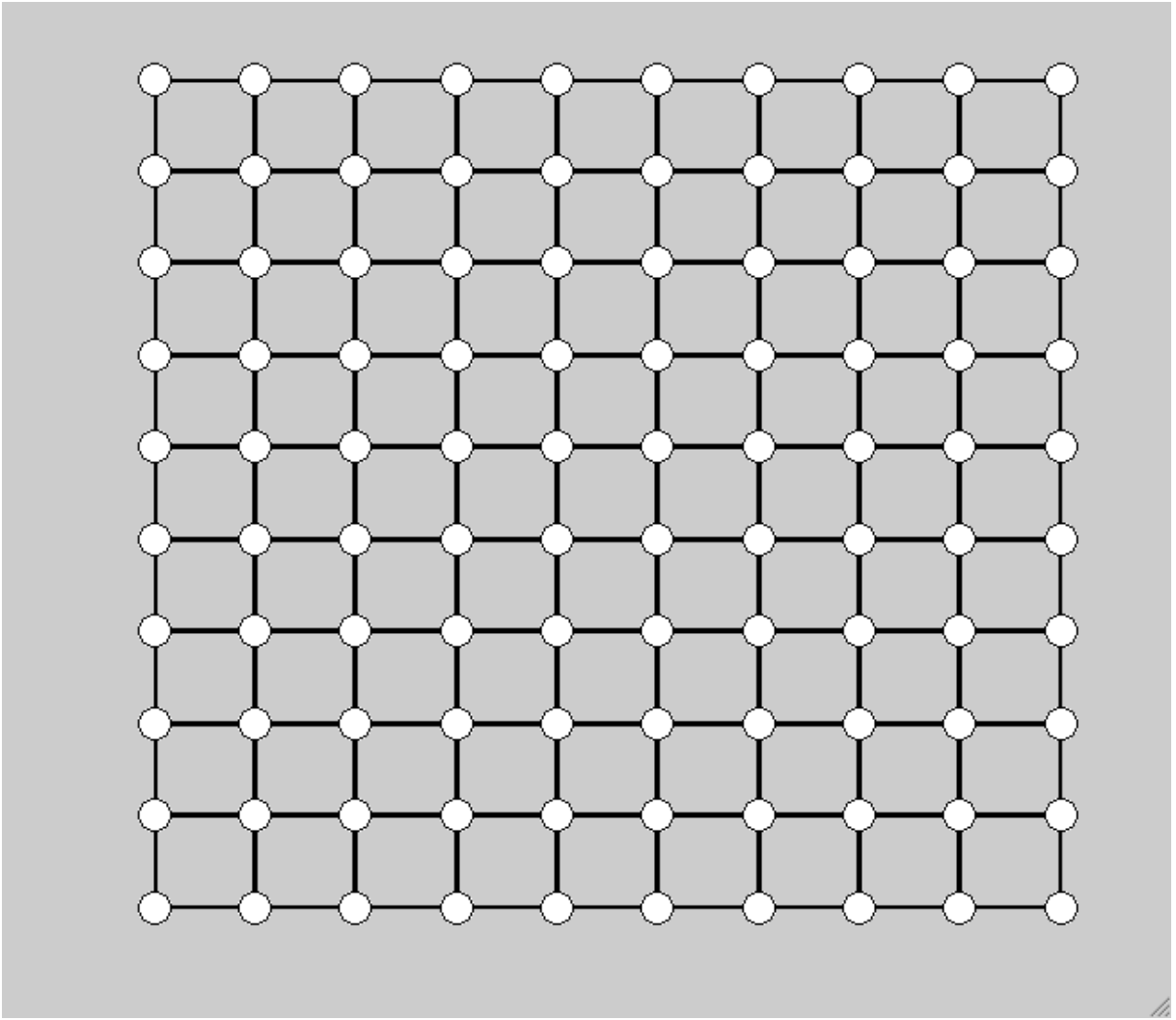
Graphs and Networks

Graph: Set of vertices V
Set of edges E – pairs of vertices

Sometimes directed/ordered pairs
Sometimes with weights

Network = Graph

Graphs and Networks

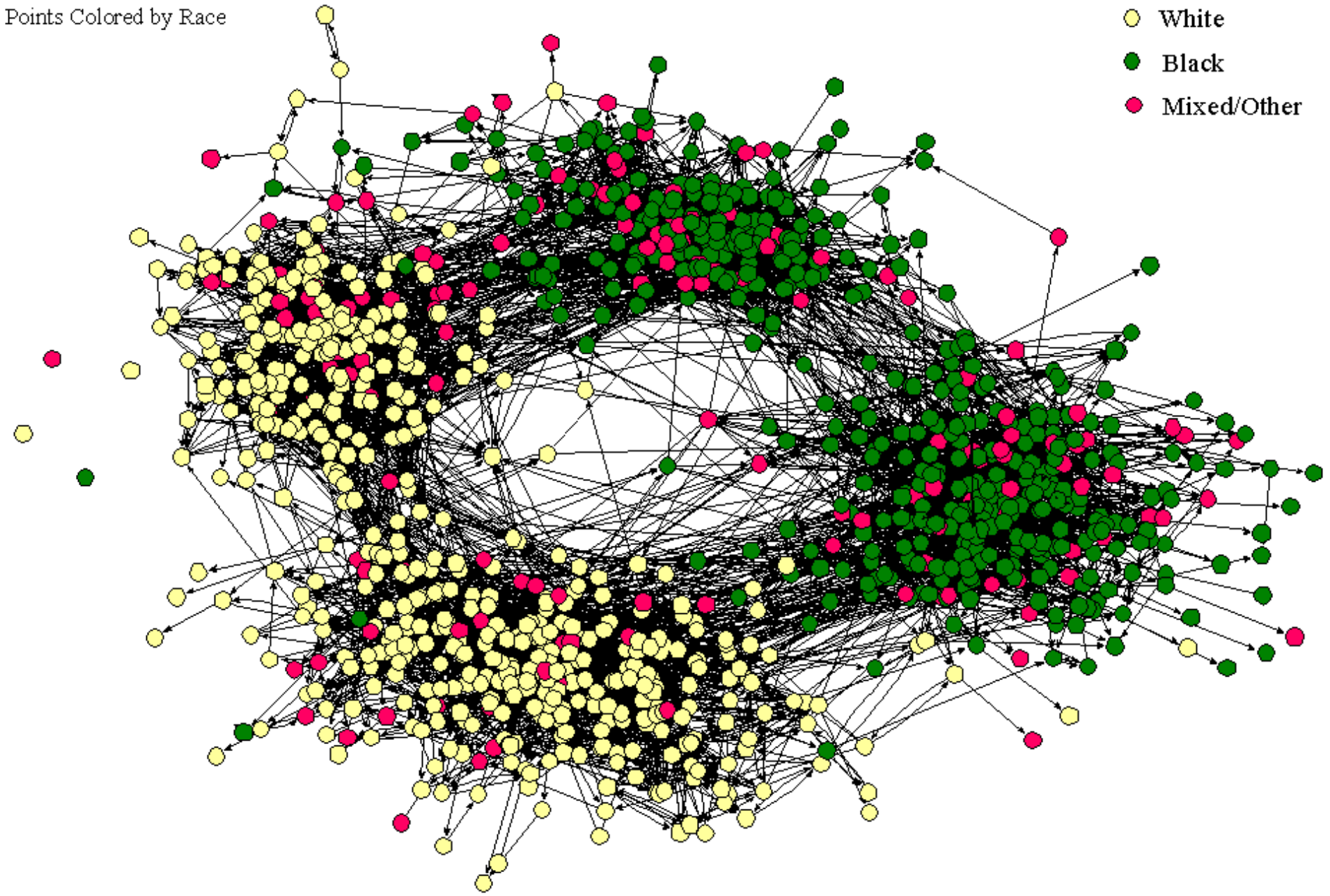


Graphs and Networks

Social networks:
V = people,
E = pairs who know each other/are friends

Web graph:
V = web pages,
edge (u,v) if page u 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

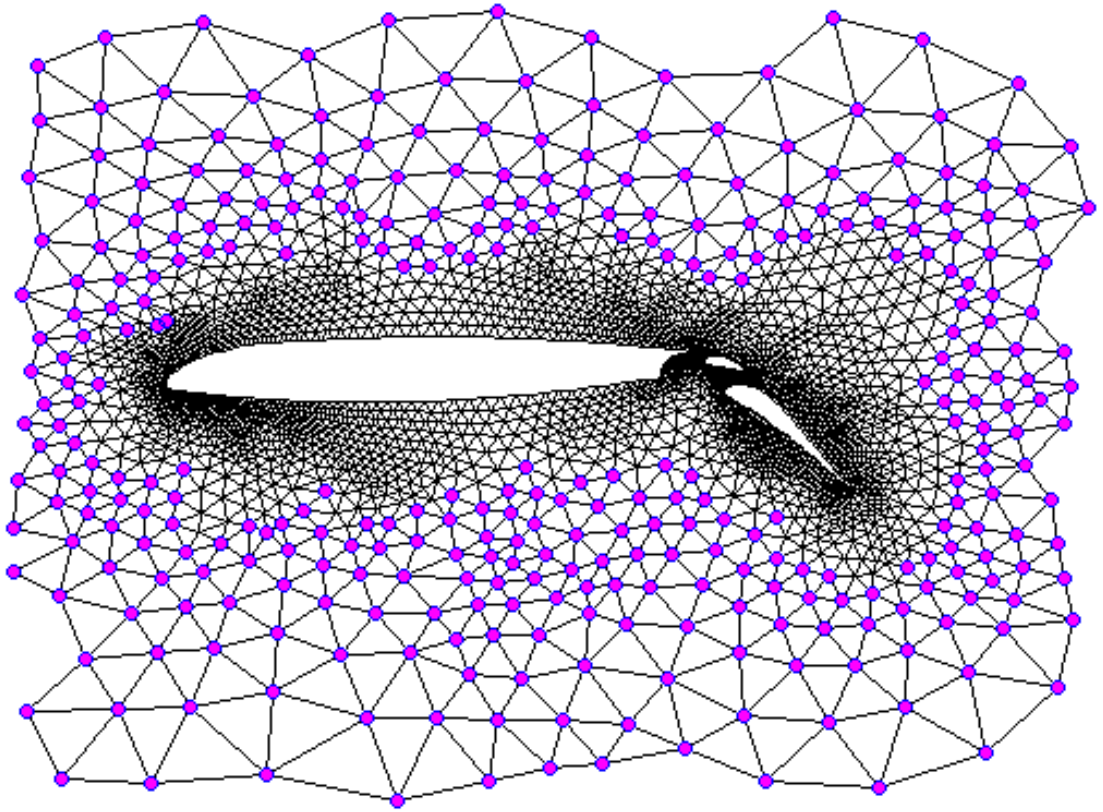
Protein interaction networks
- V = proteins
- edges: proteins that “interact”
  - weight by strength of interaction

Neural networks

Technological networks
- internet hardware
- communication networks

Graphs and Networks

Scientific Applications

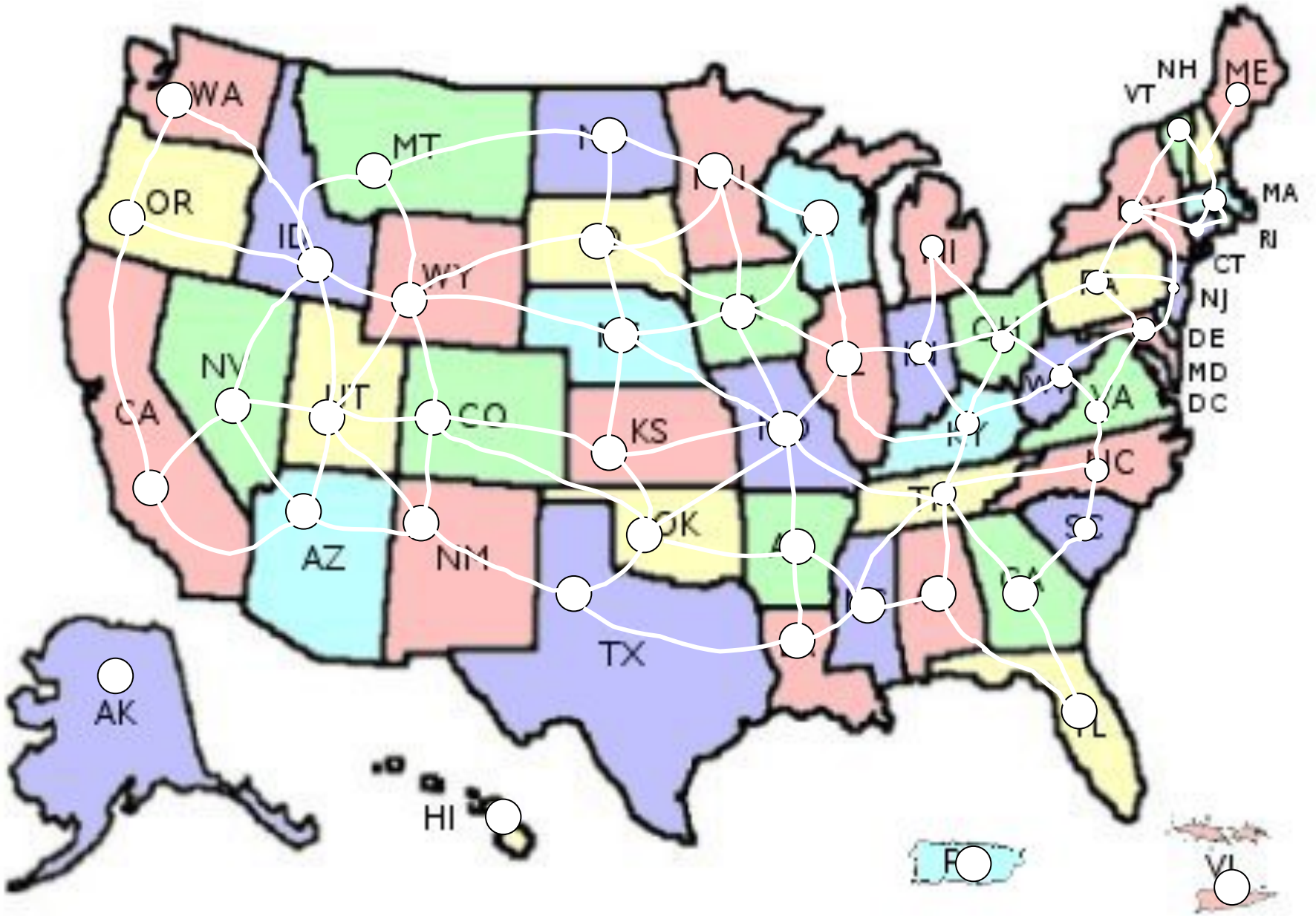


Graphs and Networks

Scientific Applications

image processing example
(l1img.m)

from: http://nrc.uchsc.edu/STATES/united-states-map.jpg



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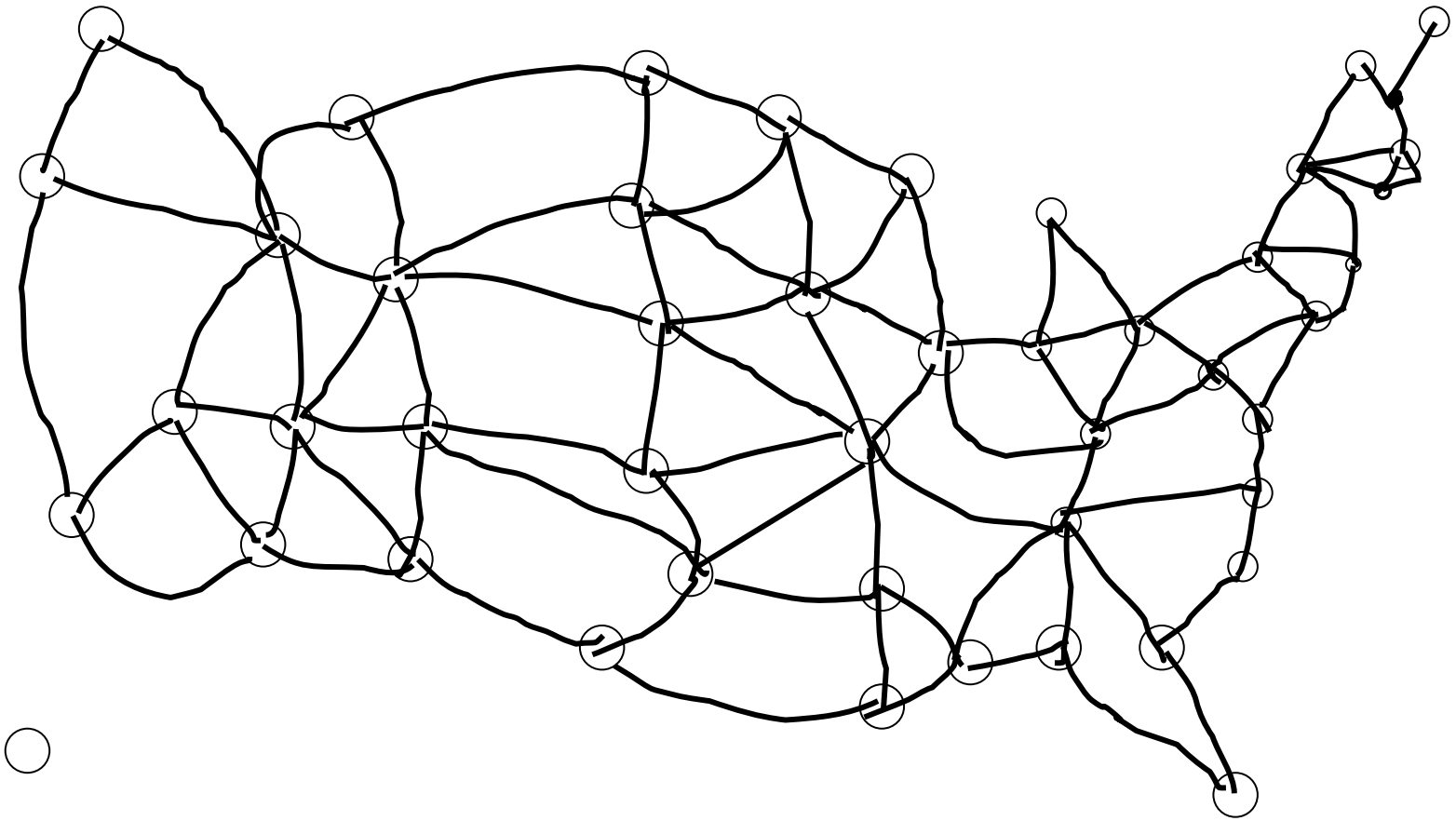
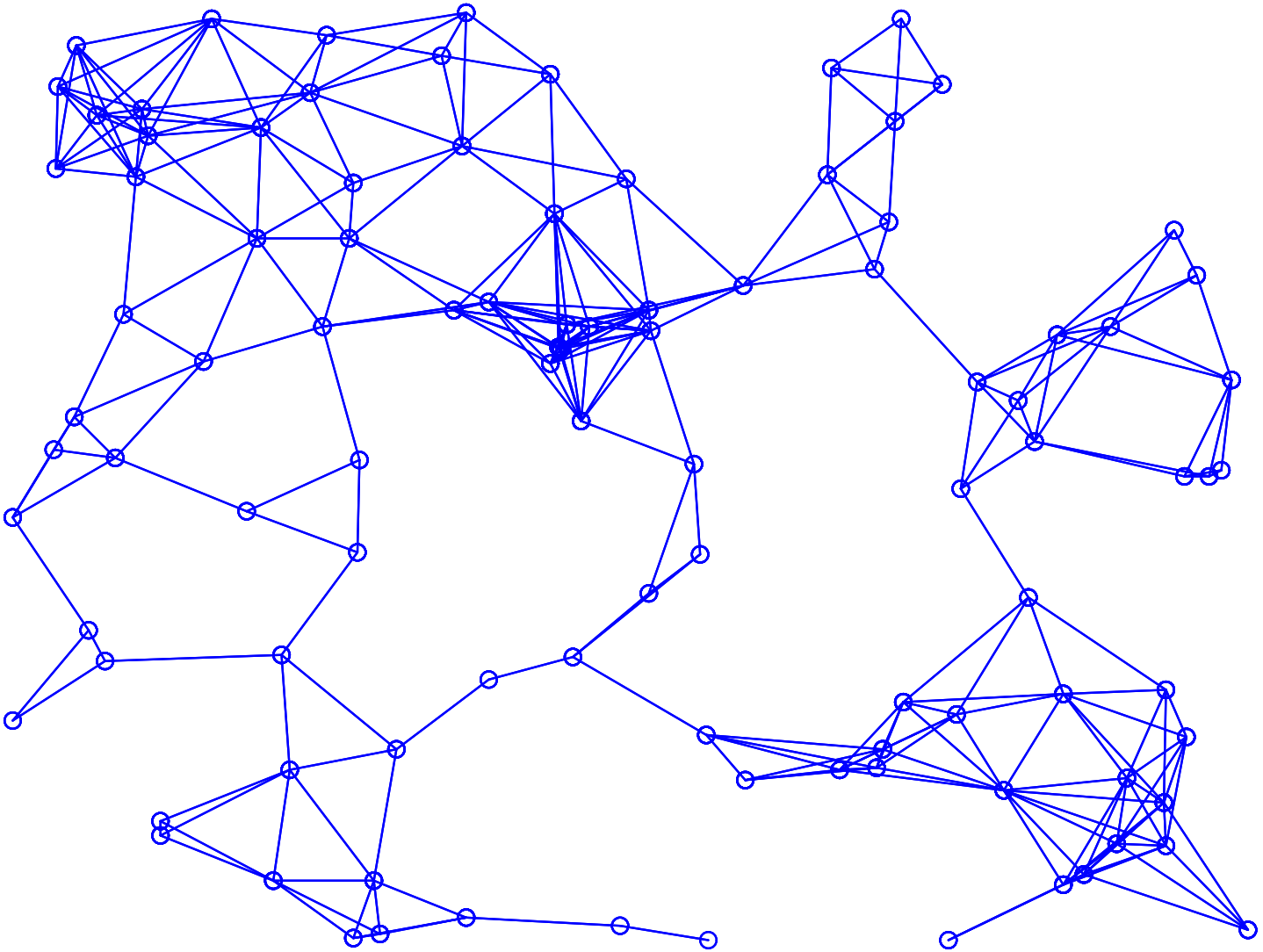


Geometric Graph: vertices connected if distance less than r



Course outline

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

   healthy skepticism

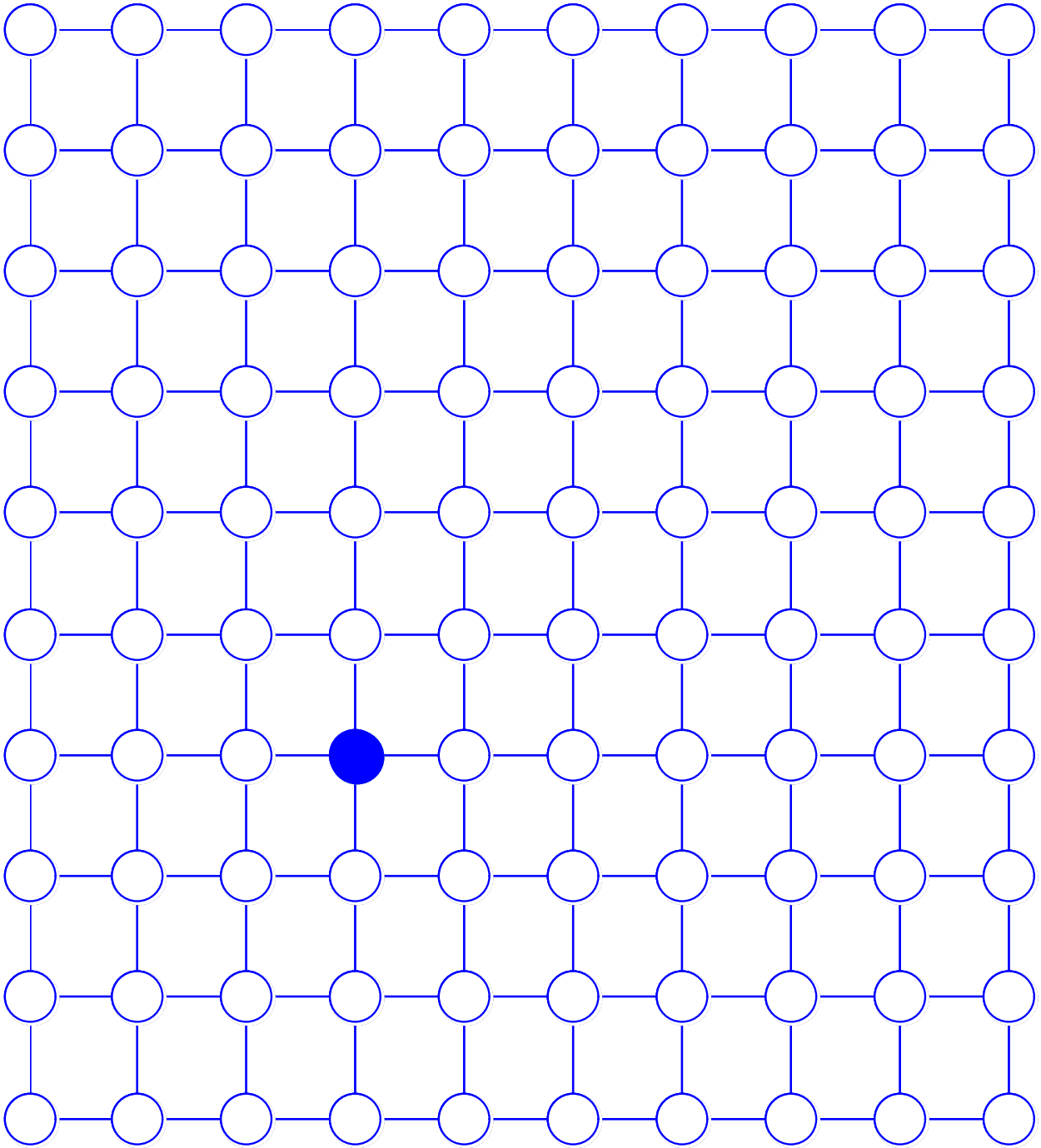
Course outline

2. Processes on graphs

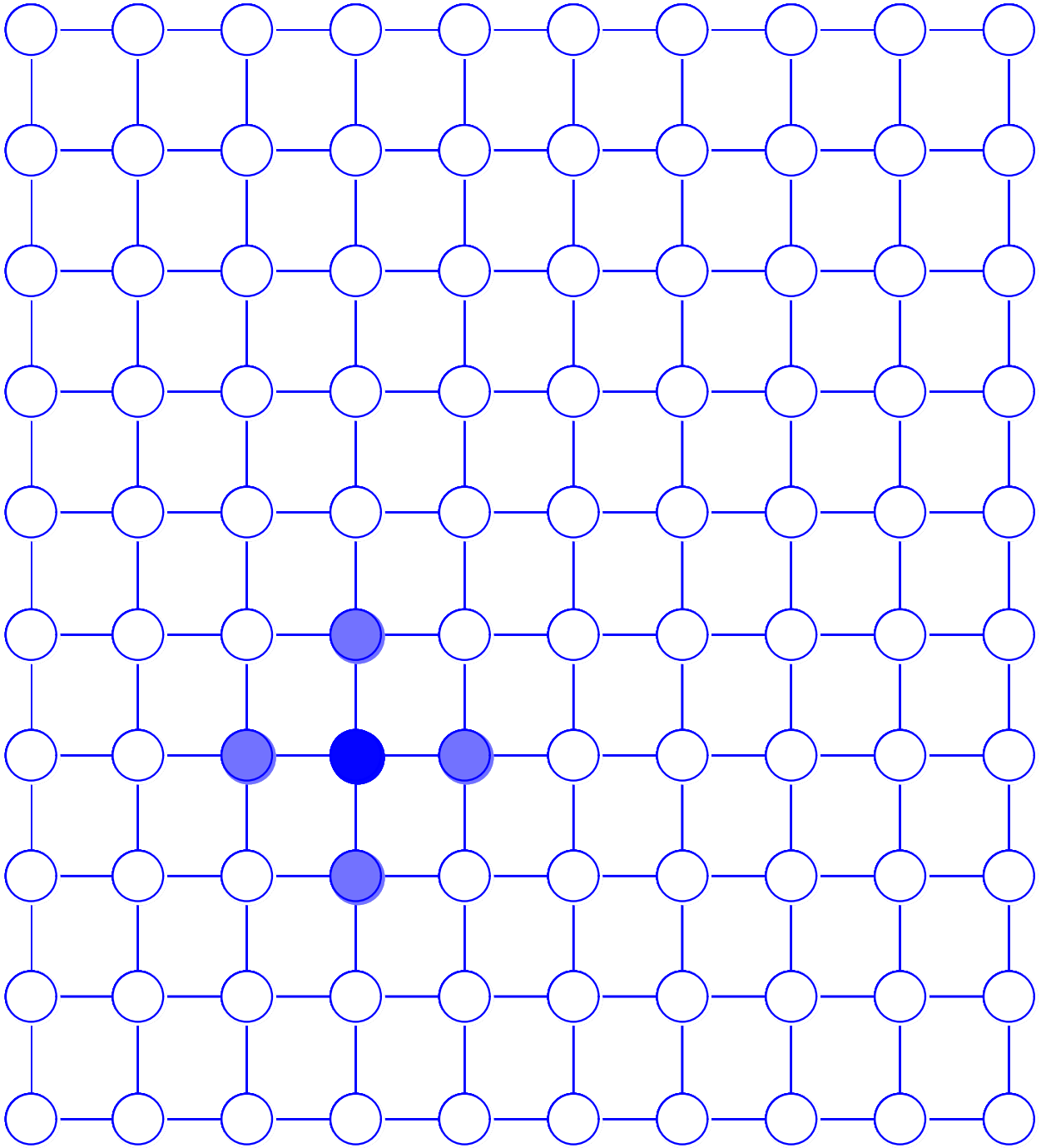
   diffusion / contagion
   random walks
   gossip
   traffic flow
   electrical flow
   coordination / agreement / percolation

   evolution of graphs

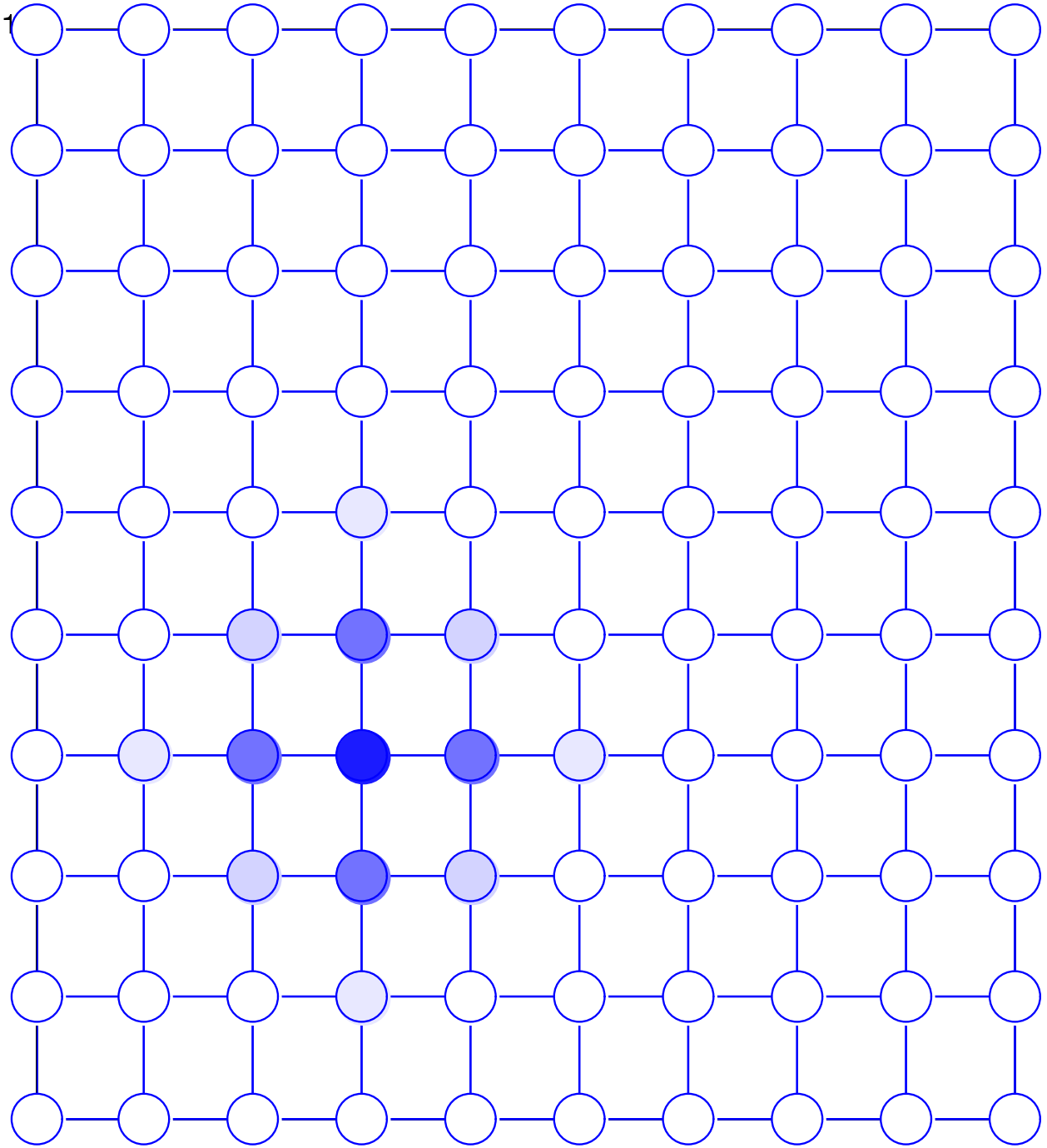
Diffusion



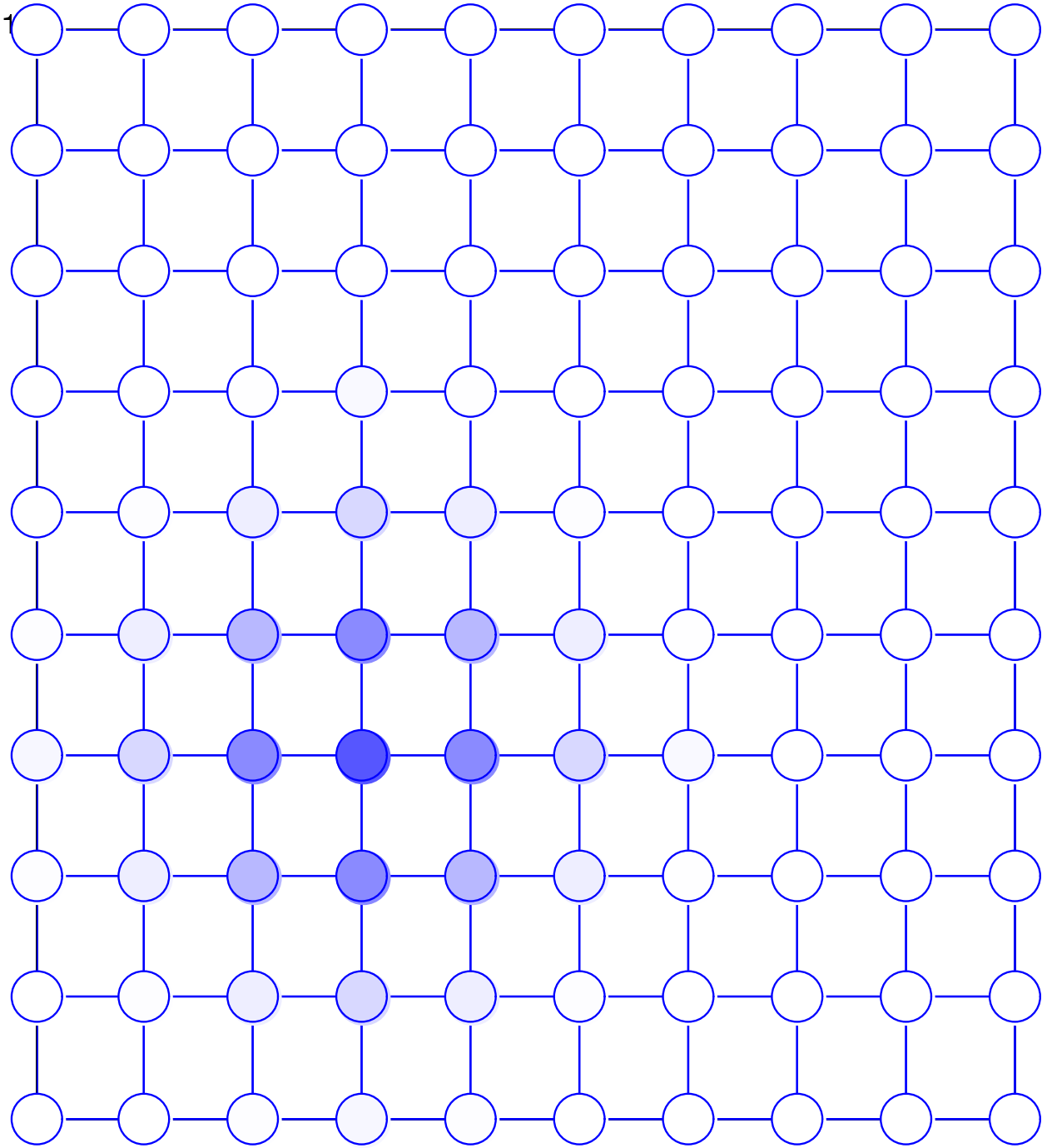
Diffusion



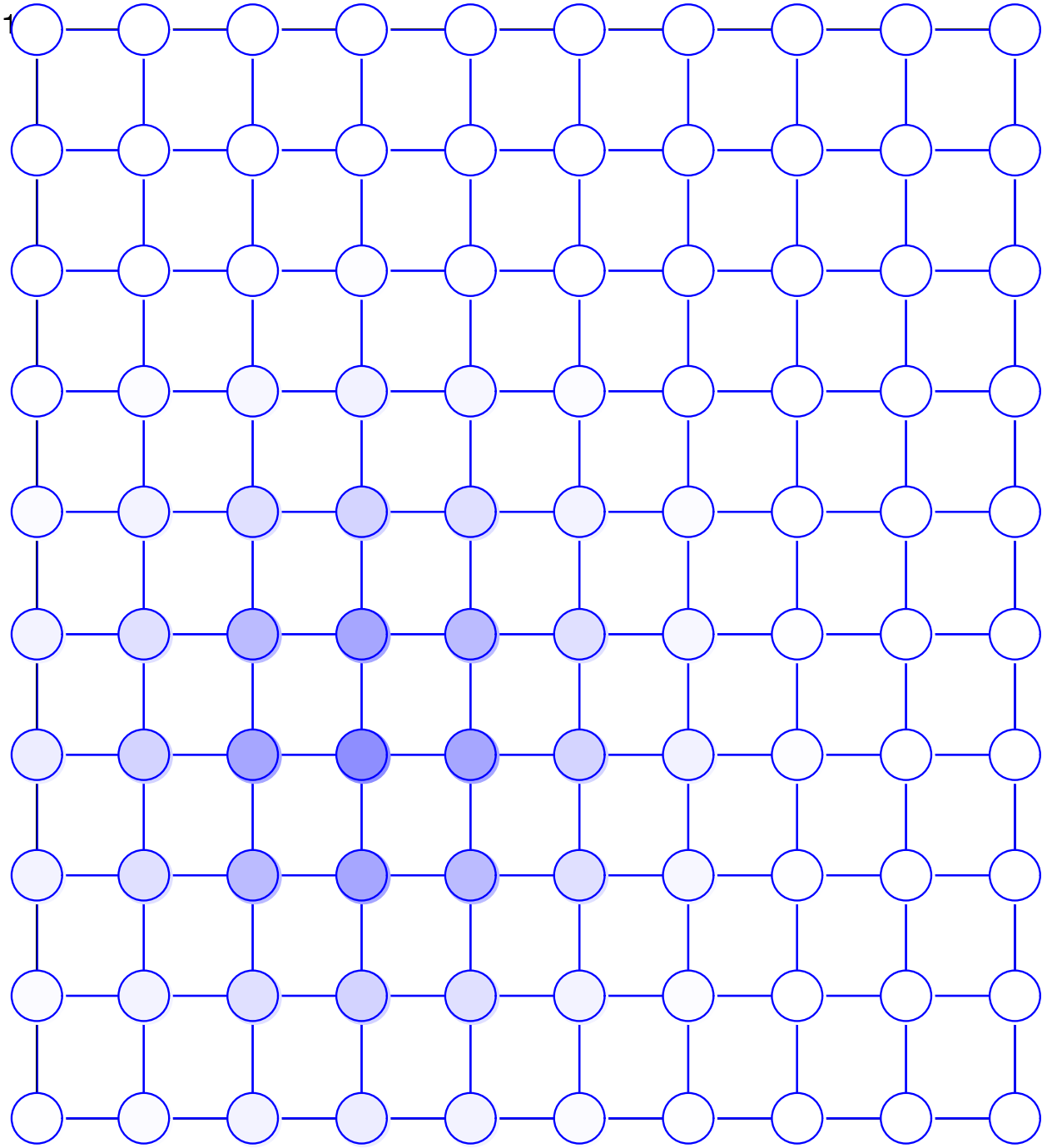
Diffusion



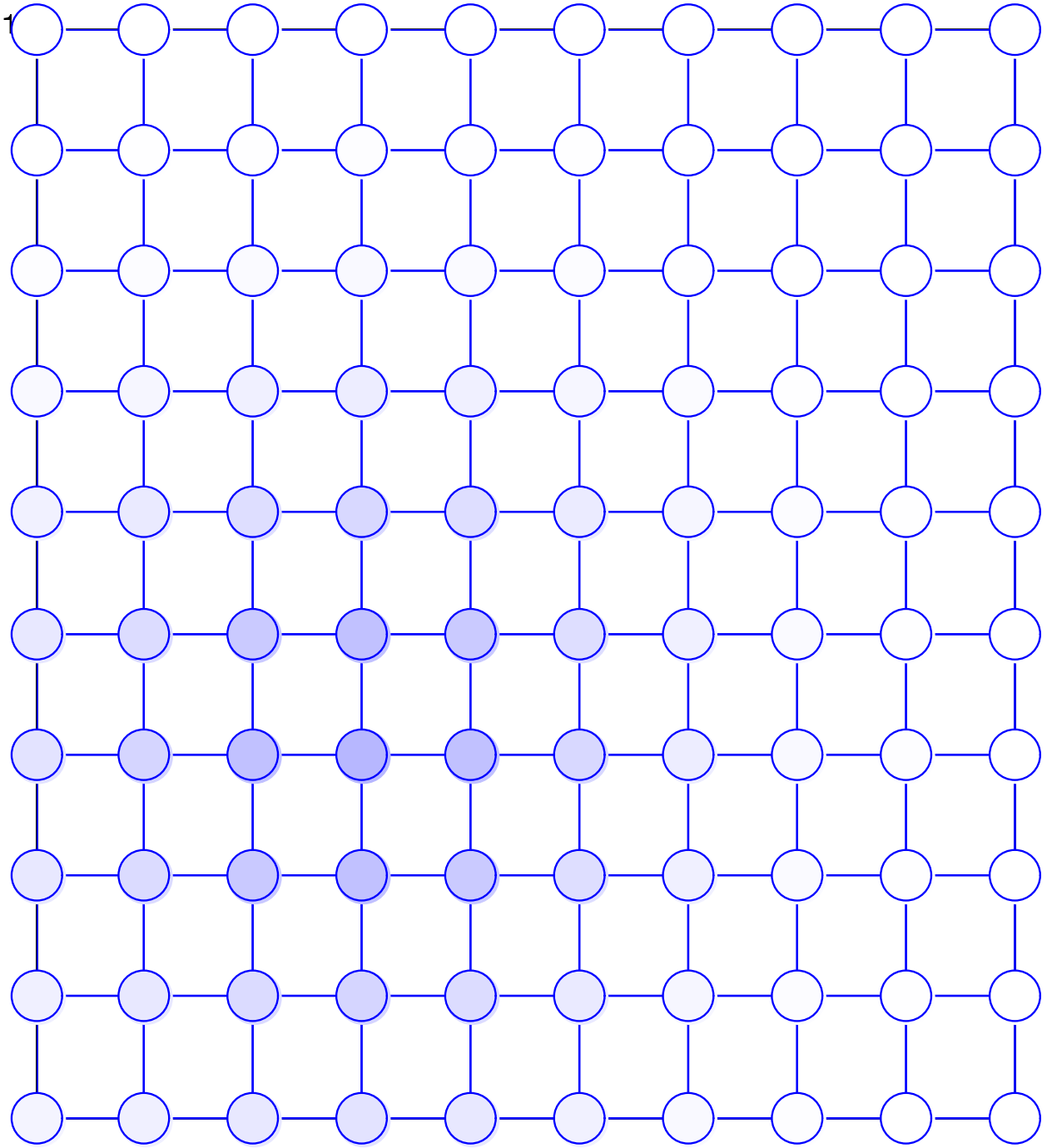
Diffusion



Diffusion



Diffusion



Course outline

2. Processes on graphs

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

   evolution of graphs

Course outline

2. Processes on graphs

   diffusion / contagion
   random walks
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   traffic flow
   electrical flow
   coordination / agreement / **percolation**

   evolution of graphs

Course outline

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