Neworks, Crowds and Markets

The assumption is that you have access to the text of the book.

We need to agree on some things:

- Meeting time instead of 11 May
- How to divide the work? Groups?
- Who will take care of preparing for which meetings?
- Grading for the course

We now proceed to going through Part I of the book.
Chapter 1

Connectedness: Structure (graph theory) and Behavior (game theory)

Graph theory: Strong and week ties in social network

Game theory

Auctions: strategy and equilibrium

Example of web searches: people react to how the ranking is done ⇒ not static environment

Population effects: following a crowd, rich get richer feedback mechanism

Structural effects: behavior of neighbors in the network is important

Aggregate behavior: Markets as aggregators of beliefs about probabilities of future events

Voting systems aggregates behavior across a population
Chapter 2

Networks: Communication network, social network, information network (such as web pages)

Basic terminology: path, cycle, connectivity, components, breadth-first search

p. 30-35 description of the famous small-world phenomenon = six degrees of separation phenomenon: nice to read

Giant component: one predominant big component of social networks

Chapter 3.1

p. 44 Triadic Closure: If A has a link to B and to C, there is a link between B and C. Motivation: A’s friends are likely to become friends between themselves

p. 45 Clustering Coefficient (A) = fraction of A’s friends that are connected to each other

Chapter 3.2

Bridge: deleting the edge would break the network into different components, see Figure 3.3

Local bridge: deleting the edge would increase the distance to > 2, see Figure 3.4
p. 48 Distinguishing between strong ties ("friends") and weak ties ("acquaintances")

p. 49 Strong Triadic Closure: If A has a strong tie to B and to C, there is a strong or weak tie between B and C

**Chapter 3.3**

p. 52 Neighborhood Overlap = \( \frac{\text{nr of nodes which are neighbors of } A \text{ AND } B}{\text{nr of nodes which are neighbors of } A \text{ OR } B \text{(not counting } A,B \text{ themselves)}} \)

**Chapter 3.4**

(p. 54-58 About Facebook and Twitter)

p. 58-59 Embeddedness of an edge = nr of common neighbors shared by endpoints, the numerator in neighborhood overlap

Local bridge = embeddedness is zero

**Chapter 3.5**

In Fig 3.11 B is a structural hole, gatekeeper

p. 61-62 Discussion about social capital: nice to read

**Chapter 3.6**

p. 62-74 Advanced material ("betweenness" and graph partitioning): read
Chapter 4.1

Homophily: tend to be friends with similar people

p. 80-81 Homophily test (for binary value case): read

Chapter 4.2

The similarity comes both from similar people getting together (selection) and by people being together becoming similar (socialization or social influence)

Chapter 4.3

Representation of activities as bipartite graphs with people on one side and foci on the other, see Figure 4.4

Chapter 4.4

Social-affiliation network: including links between people too (not bipartite any more), see Figure 4.8

See the graphs in Chapter 4.4 for comparison between empiria of triadic closure and a simple model (given on page 91)

Figure 4.13 displays empirical results for selection vs. social influence for Wikipedia editing
Chapter 4.5 Shelling model for separation.

Grid with X, O or empty. Neighbors include diagonal neighbors (i.e., each nonboundary cell has 8 neighbors). If the agent has $< t$ same type neighbors, it moves to a new cell. There are different ways of moving, e.g., randomly. Figures 4.14 and 4.19 good examples (white and black people living)

Chapter 5.1

Not only friends, but also taking into account negative relationships $\Rightarrow +$ and $-$ edges

First approach: complete graph

Structural Balance: For every set of three nodes, there are 1 or 3 $+$ edges (see Figure 5.1 and motivation on p. 109)

Chapter 5.2

p. 111 Easy to prove "Balance Theorem": A complete graph is balanced iff
(1) either all nodes are friends, or
(2) the nodes can be divided into groups $X$ and $Y$, so that all within a group are mutual friends, and everyone in $X$ is enemy of everyone in $Y$

See Figure 5.3
Chapter 5.3

Application of balance theory: over time groups of countries tend to form two blocks

Chapter 5.4

Weak Structural Balance: For every set of three nodes, there are 0, 1, or 3 + edges (see motivation on p. 115-116)

This results in a similar characterization as the Balance Theorem, but now there can be more than two cliques of friends (see Figure 5.6)

Chapter 5.5

Generalizing this to noncomplete graphs (links can be missing)

Now balance can mean that
(1) we could fill in the missing links with + or − getting a balanced graph, or
(2) we could group the nodes into $X$ and $Y$ (internally friends, enemies between $X$ and $Y$)

These definitions are equivalent!
Algorithm to detect if graph is balanced:
1. Reduce any clique of friends to a supernode
2. The graph is balanced iff the reduced graph is bipartite

(Note: step 2 can be done as follows: run breadth-first search on the reduced graph to find cycles; the graph is balanced iff all cycles have an even number of edges)

Relaxing the balancing property (so that *almost* all triangles are balanced): read p. 128-132

**Summary of what to read**

- (p. 30-35, 5 pages)
- (p. 61-62, 2 pages)
- p. 62-74 Chapter 3.6 (12 pages)
- p. 80-81 (1.5 pages)
- p. 128-132 (5 pages)

**Exercises**
2.3., 3.2, 4.4. and 5.4