

Mathematical Modeling of Social Phenomena

Agent-based modeling / Networks

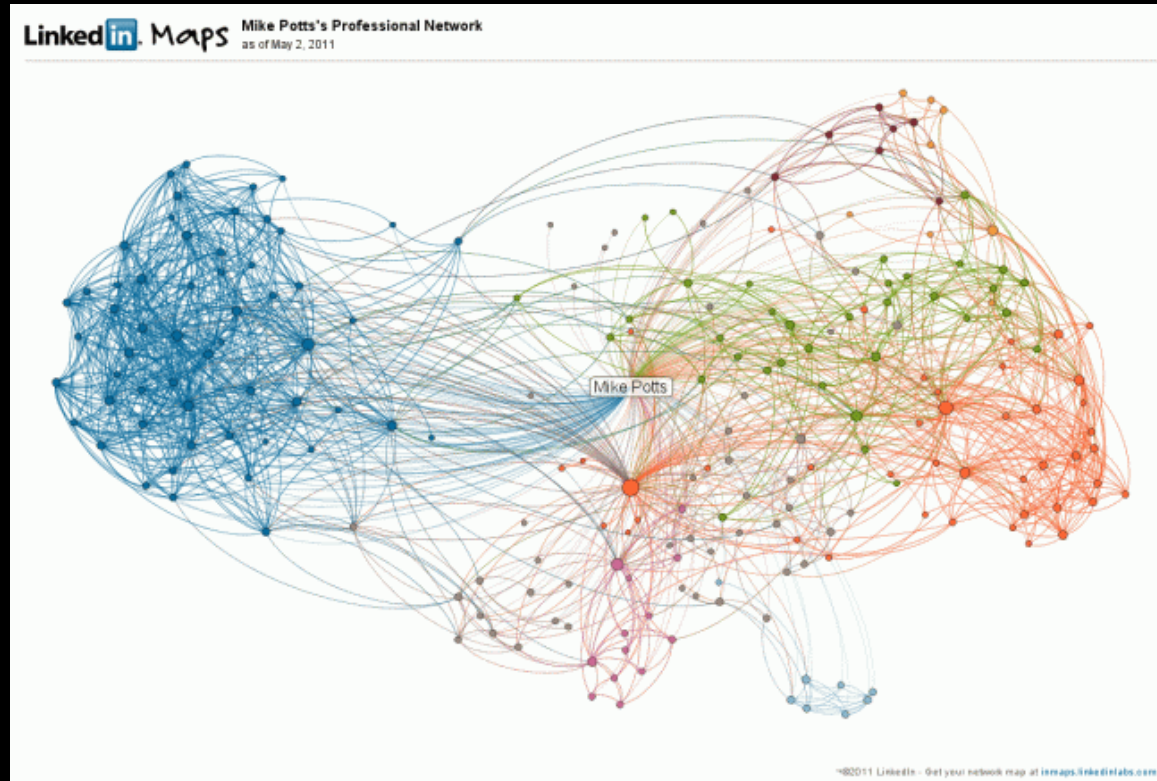
Class Layout

- Simulations, why, why not?
- Agent-based modeling
- Networks
- Epidemiology

Simulations: Why, why not?

- Powerful, flexible and quick
- Black box dynamics
- Implicit specification
 - stopping problem
 - communication
- Huge space of possibilities
 - external validity

Example: Networks



Social networks

- Graphs
 - Nodes
 - Edges
 - Attributes
- Digraphs
 - with directed edges

Social networks: Properties

- Size
- Density / Degree (n of edges per node)
- Reachability / Connectedness
- Distance / Path-length

Example: Graph

Laura has two friends, Franscesco and Tony

Tony has two friends, Tony and Ernesto

Ernesto has one friend, Tony

Degree: Average degree

Theorem: The average degree of a neighbor will be at least as large as the degree of the network.

Social capital

How connected are we?

How fast will information, or ebola, travel?

Other examples?

Path-length

Number of edges to get from node A to node B

For a graph, it is its average number.

Number of flights needed

Social distances

Other examples?

Cluster coefficient

Percentages of triples of nodes with edges

Social capital, again

Innovation capacity

Norm adoption

Connectedness

Is there edges connecting all subgraphs of the graph?

Information spreading?

Ebola spreading?

Network formation

Random

Small world

Preferential attachment

Small world phenomena

- Six degrees of separation
 - Exponential growth, 100^n , but cliques
- Erdős number
- Erdős-Bacon-Sabbath number
- Hank Aaron (Erdős number: 1):

$$714 = 2 \times 3 \times 7 \times 17, 715 = 5 \times 11 \times 13, \text{ and } 2 + 3 + 7 + 17 = 5 + 11 + 13 = 29$$

Ego networks

- Centrality
- Power
- Distance
- Celebrities

Adding networks

- Schelling's segregation model
- Granovetter's threshold model
- Akerlof's market for lemons

Adding networks

What role could they play in your papers?

Philosophically

Does it chime with,

Mäki?

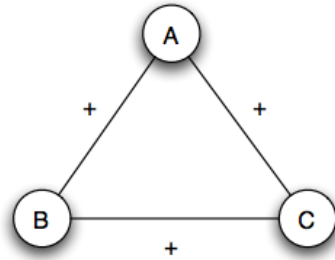
McCloskey?

Friedman?

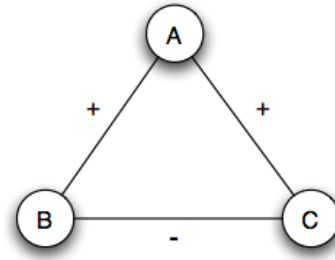
Cascading through networks

Threshold model

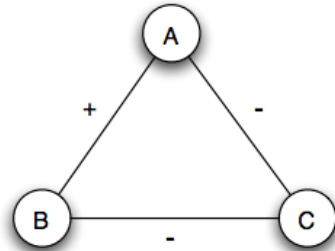
Structural balance graph



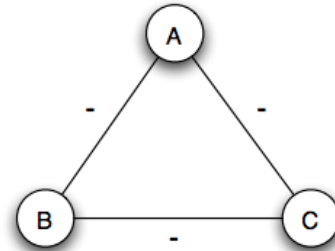
(a) *A, B, and C are mutual friends: balanced.*



(b) *A is friends with B and C, but they don't get along with each other: not balanced.*

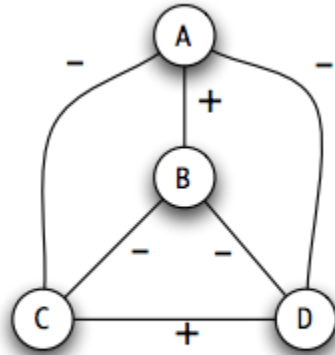


(c) *A and B are friends with C as a mutual enemy: balanced.*

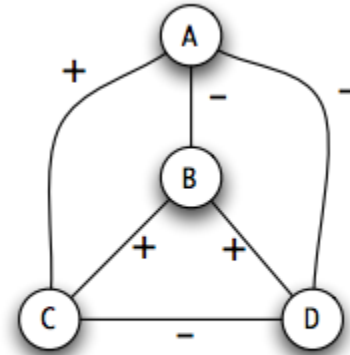


(d) *A, B, and C are mutual enemies: not balanced.*

Structural balance graph



balanced



not balanced

Abolishing social norms

Actually, just go to the paper.

Strong and weak ties