# Mathematical Modeling of Social Phenomena

Agent-based modeling / Networks

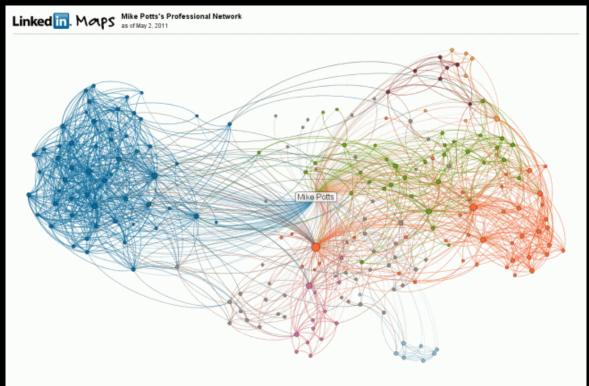
# **Class Layout**

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

# Simulations: Why, why not?

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

# **Example: Networks**



### Social networks

#### • Graphs

- $\circ$  Nodes
- $\circ$  Edges
- Attributes
- Digraphs
  - $\circ$  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<sup>n</sup>, but cliques
- Erdős number
- Erdős-Bacon-Sabbath number
- Hank Aaron (Erdős number: 1):

714 = 2 × 3 × 7 × 17, 715 = 5 × 11 × 13, 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

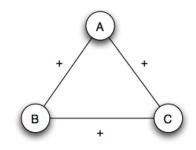
Does it chime with,

Mäki? McCloskey? Friedman?

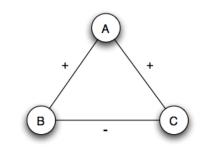
### Cascading through networks

Threshold model

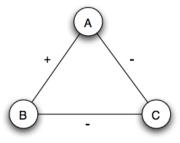
#### Structural balance graph



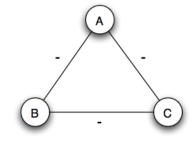
(a) A, B, and C are mutual friends: balanced.



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

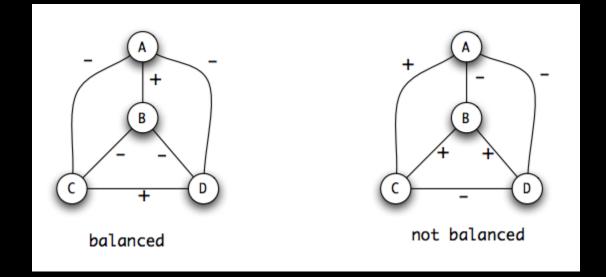


(c) A and B are friends with C as a mutual enemy: balanced.



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

# Structural balance graph



# **Abolishing social norms**

Actually, just go to the paper.

# Strong and weak ties