Information and Network

Wenhao Wu
wuwh2@shanghaitech.edu.cn

SEM, ShanghaiTech U

2025 Spring

上海科技大学
ShanghaiTech University

Outline

Outline

Cascade Model

Example

- A sequence of players 1, . . . , N.
- There is one project. The quality of project could be *good* (50%), or bad (50%).
- One by one, players decide to *accept* or *reject* the project.
  - If he accepts, cost = 0.5, benefit = 1 (good) or 0 (bad).
  - If he rejects, cost = 0, benefit = 0.
- Suppose each of them maximizes his *expected* payoff.

Private Signals

Before making decisions, each player is able to observe previous actions of other players and one **private signal** about the true quality of the project.

Each signal may take on two values *high* and *low*.
$Pr(high|good) = p > 0.5$ and $Pr(high|bad) = 1 - p$.

What is his updated belief after receiving two conflicting signals?

Herding Effect

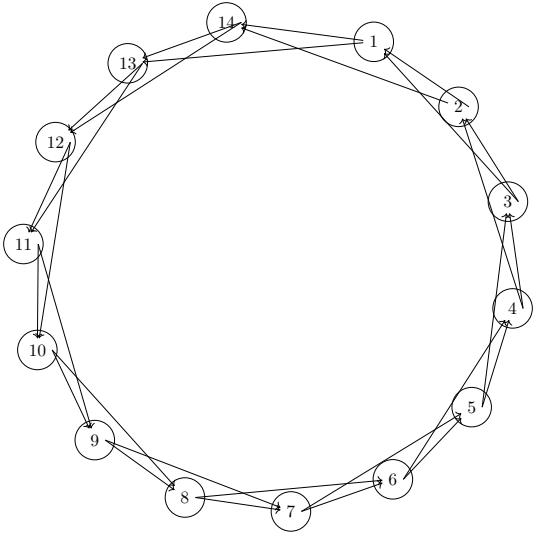
If Players follows predecessors when indifferent, what happens next?

- Player 1:
- Player 2:
- Player 3:
- So on and so forth.

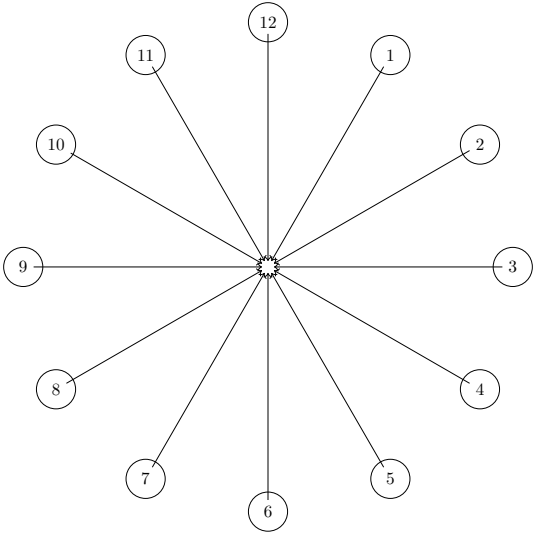
If Players follows his own signal when indifferent, what happens next?

Outline

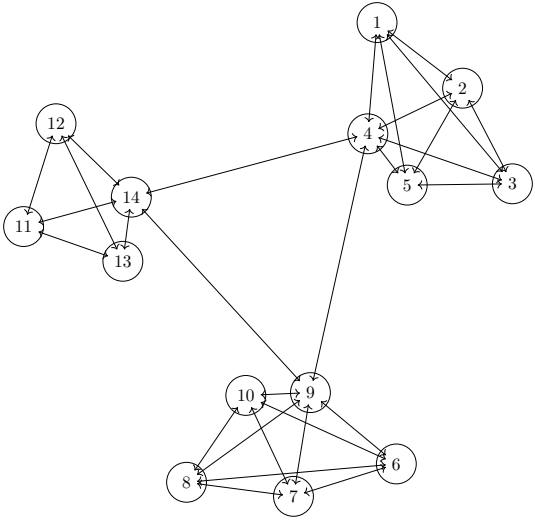
Erdos-Renyi



Royal Family



Stochastic Block



Outline

Social Network Affects the Formation of Opinions and Behavior

Environment

1. Individuals receive noisy signals about the true state of the world and try to make their guesses to match the true state.
2. They also observe the *guesses* of their neighbors, which causes **information flow across paths of the social network**.

Research Question

- How the network shapes the long-run process of information dissemination.
- What updating rule is used by human subjects.

Model

- A set of individuals $N = \{1, \ldots, n\}$
- States of the world, $\omega \in \{0, 1\}$, equally likely
- Noisy signal s_i for individual i
- Probability of correct signal $p \in (0.5, 1]$
- Individual i makes a guess $a_i \in \{0, 1\}$, receives 1 if $a_i = \omega$, receive 0 otherwise.
- A network g, with $g_{ij} \in \{0, 1\}$.
- If $g_{ij} = 1$, then individual i observes the guesses of individual j.
- Neighbors of individual i is $N_i(g) = \{j | g_{ij} = 1\}$.
- Updated belief about the likelihood of $\omega = 1$, μ_i.

An Updating Process for Simulation

DeGroot updating

Update belief based on previous information from neighbors,

$$\mu_i = \frac{1}{|N_i(g)|+1}\{\sum_{j=1}^{n} a_{j,t-1} \cdot g_{ij} + a_{i,t-1}\}$$

Follow the majority guess of his neighbors during the periods $t = 1, 2, \ldots$.

$$a_{i,t} = \begin{cases} 1 & \text{if } \mu_{i,t} > \frac{1}{2}, \\ 0 & \text{if } \mu_{i,t} < \frac{1}{2}, \\ \{0,1\} & \text{if } \mu_{i,t} = \frac{1}{2} \end{cases}$$

Features of Three Types of Networks

Erdos-Renyi Network

- Connections among homogeneous individuals
- Decentralized information sharing and learning

Royal Family Network

- There exist "influential individuals"
- Inequality in informational effects of signals

Stochastic Block Network

- Divided into subgroups of highly connected individuals
- Reflect network **homophily** (tendency of people with similar traits to form links with each other)

Three Hypotheses

Hypothesis 1 Individual guesses converge to a limit guess in all networks.

Hypothesis 2 The breakdown of consensus is more likely in the SB network as compared with the ER and RF network.

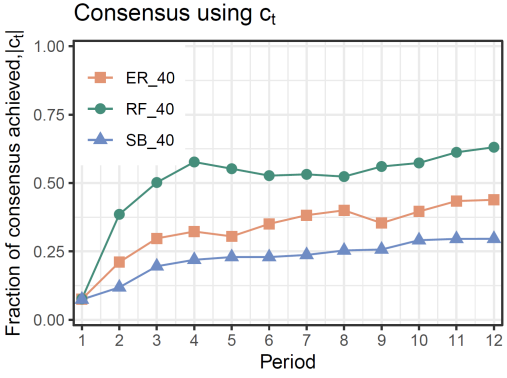
Hypothesis 3 Incorrect consensus is more likely in the RF network as compared with the ER and SB network.

Are these hypotheses verified in our class?

Lab Experiment Results

Experiments at University of Valencia

- 480 participants, randomized to one of three networks.
- 40 people in each session, 12 sessions, 4 sessions for each network.



Network Effects on Consensus