Truth Learning in a Social Setting

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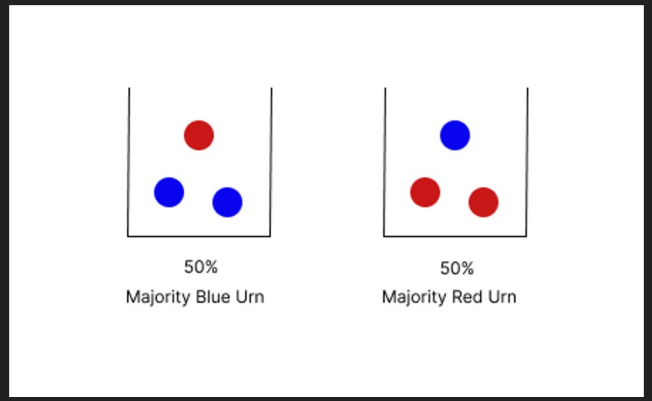
Social Interactions and Information Dissemination

- People make choices often weighing their own private information and the public actions of those around them
- Theoretically, there is a hidden correct truth people are trying to answer
- There is some order in which people make decisions

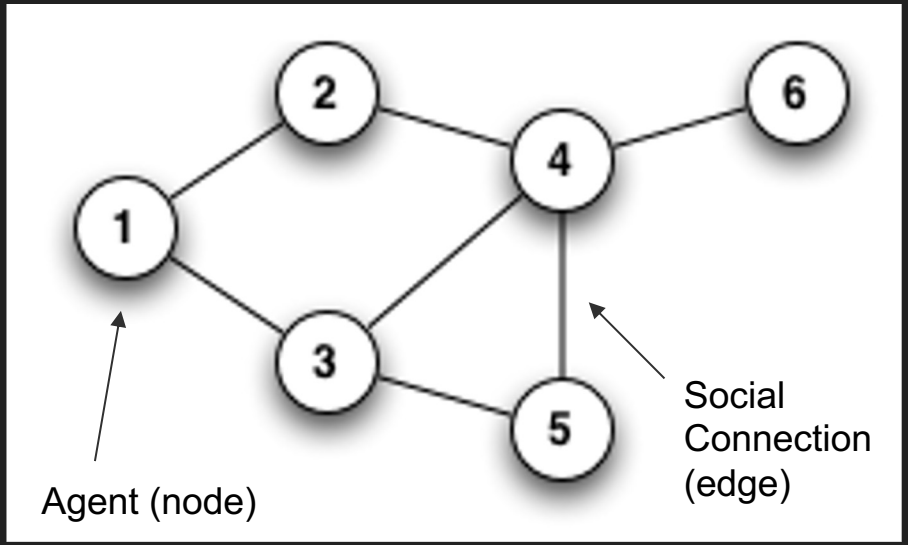
Herding/Information cascades

- In a social network, it is possible for people to be influenced by the actions of others in both beneficial and harmful ways
- A simple experiment:



Using Graphs as a Model

- Idea: Nodes are people (agents) and edges are connections in a social network
- Model ingredients:
  - Hidden ground truth
  - Private signal/measurement
  - Actions
  - Payoffs



Formulation

Network: $G = (V, E)$

Realized Network: $G_T = (V, E_T)$ s.t. $E_i = \{vu \in E : t_u < t_v\}$

Signals: $s_v \in \{0, 1\}$; $Pr[s_v = \theta] = p$ and $Pr[s_v \neq \theta] = 1 - p$

Ground Truth: $\theta \sim bernoulli(\frac{1}{2})$

Actions: $a_v \in \{0, 1\}$

Payoff:

$$P(a_v) = \begin{cases} 1 & \text{if } a_v = \theta \\ \\ 0 & \text{if } a_v \neq \theta \end{cases}$$

Measuring Learning

- Learning quality: The probability that an agent learns successfully

Learning quality for an agent: $l(v) = \mathbb{P}(a_v = \theta)$ where $\mathbb{P}$ is the probability given randomness in the problem and v is some agent in the network

Learning quality for the network: $L(G) = \frac{1}{|V|} \sum_{v \in V} l(v)$

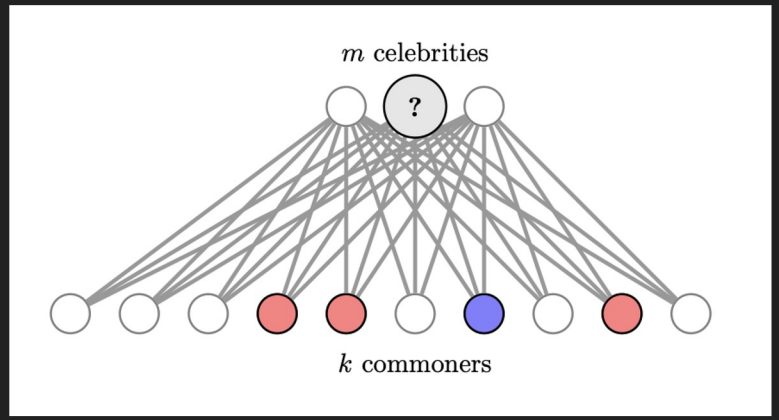
- Robust learning: The ability for the network to correctly aggregate information even with random agent orderings or adversarial agent orderings

Leading Questions

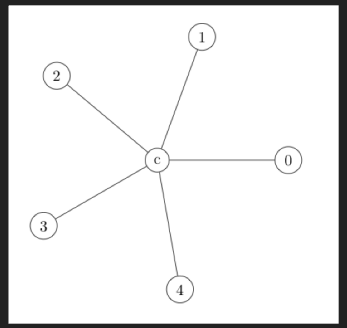
- Node Ordering
  - Does there exist a “best” ordering and can you find it in polynomial time? or an approximation of the best ordering?
- Model Selection
  - Which model/family of graphs is most conducive to learning?
  - Run simulations on different graph/network models
  - Compare the success rate of learning of different models
- Robust learning
  - What other models satisfy the robust learning property?

Examples

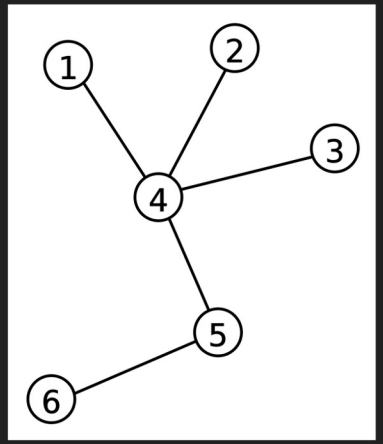
- n-cliques (everybody connected to everybody)
  - (1-p)^2 chance of everyone choosing the wrong choice
  - Information Cascades
- Bipartite “Celebrity” Graph
  - on average independent observations, aggregation, and dissemination of information generally lead to successful learning



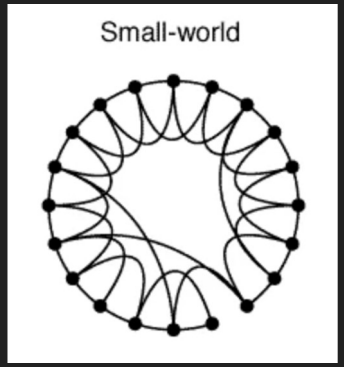
More Examples



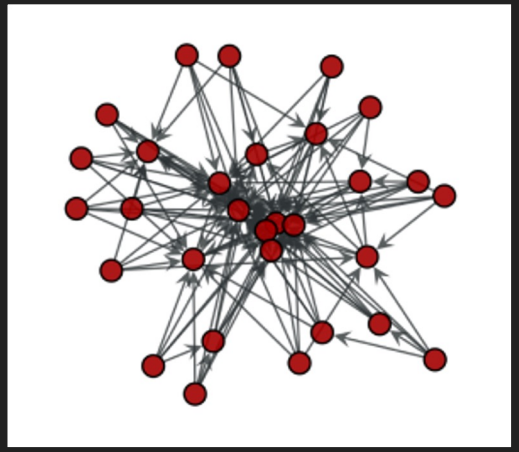
Stars



Trees



Watts-Strogatz



Preferential Attachment

Sources

- “On social networks that support learning” by Arieli et al.
- “Multi-issue social learning” by Bahar et al.
- *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* by David Easley and Jon Kleinberg
- *Network Science* by Albert-Laszlo Barabasi

Acknowledgements

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