INFLUENTIALS AND THE SPREAD OF INNOVATIONS

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Abstract. This report explores the *influential hypothesis* - a minority of individuals, called influentials, who can spread innovations to an exceptional number of peers are important to the spread of ideas/innovations. We explore this idea by performing computer simulations modelling the interpersonal influence process under various conditions. It was found that the importance of influentials in the spread of influence depended on the degree distribution of the network which suggests a reexamination of the *influential hypothesis*.

1. Introduction

The spread of influence is a well studied phenomena in social science and diffusion research that looks to understand how influence is spread and what factors contribute to large cascades of influence within a population. This phenomena can be found in many domains such as the circulation of news by the media, the adoption of new technologies, and the promotion of products by social media influencers. One hypothesis on how innovations are spread is called the *influential hypothesis*[1], which suggests that a minority of individuals called *influentials* are able to spread ideas/innovations to an exceptional number of peers. However, this model does not explain the characteristics of influentials or precisely how responsible they are in the cascade of influence on the (non-influential) population.

In this report, we argue that it is unclear what characteristics underpin influentials and whether they can be attributed to the adoption of social changes, new technologies, cultural fads and other diffusion processes. By performing a series of computer simulations of various network models, it was found that there are instances where influentials show greater responsibility in the spread of influences. However, under other conditions it was found that influentials are only marginally more important than the average individual. Although our models are simplifications of the complexities of reality, our results highlights the importance of population interconnectedness in dictating the responsibility of influentials in the cascade of influence.

2. Interpersonal Influence Model

For our model of the spread of influence, we assume that every individual makes a binary decision on an innovation X. Moreover, we assume that the innovation exhibits *positive externalities* meaning the probability of an individual choosing B over A increases with the number of people choosing B. While this model is not fully general, as it excludes negative externality behaviours and innovations with multiple decisions, it is a reasonable general case to consider. For example, in marketing and diffusion research, positive externalities arise in many areas of research such as *network effects*, *learning from others*, and conformity pressures [1].

2.1. Threshold Model. A simple model to capture the aforementioned behaviour is to represent each individual i by a node, which can be in one of two discrete states $\{0, 1\}$, with a *threshold rule* ϕ_i. An individual in state 1 is said to be `influenced` by an innovation while an individual in state 0 is uninfluenced by an innovation. Defining p_i to be the proportion of i's neighbours who are influenced (in state 1), then the probability of i being influenced (in stat 1) is given by

$$P[\text{Node } i \text{ in state } 1] = \begin{cases} 1 & p_i \geq \phi_i \\ 0 & p_i < \phi_i \end{cases}$$

where $\phi_i \in [0, 1]$ refers to the minimum proportion of i's neighbours that need to be influenced for i to be influenced. Intuitively, ϕ_i refers to i's willingness to be influenced. For simplicity, we assume every node can be influenced by the same threshold rule, meaning for every node i we have $\phi_i = \phi$ for some fixed ϕ.

2.2. Influence Networks. Alongside the rule describing how individuals are able to influence each other, we also need to describe who influences whom. However, social networks are not yet fully understood in terms of their network properties. Consequently, we make the following assumptions about our influence network for computer simulation. We assume that every individual i in a population of size N has n_i neighbours, where n_i is drawn from an *influence distribution* $p(n)$ with known average n_{avg} that is much less than the population size $n_{avg} \ll N$. Of note is that n_i refers not to the number of individual that i knows but the number of other individuals they can influence due different factors such as their character, expertise, and community. Additionally, we explore the scenario where individual influence is unidirectional, meaning an individual i can influence its neighbour j but j cannot influence i, and bidirectional, meaning if i can influence its neighbour j then j can influence i. This is to represent scenarios where an individual follows other individuals, such as Instagram influencers, and influence is spread in one direction and when individuals influence each other such as within a family.

To describe the *influence distribution*, we use two common random graph models which contain properties similar to real social networks called Scale-Free Networks and Poisson Random Graphs.

2.2.1. *Poisson Random Graph.*

2.2.2. *Scale-Free Networks.*

2.3. Influentials. What are influentials and how we define them. Pagerank.

2.4. Influence Dynamics.

- Threshold Model
- Scale-Free network
- Poisson Random Graph Model
- Percolation

3. Results

4. Conclusion

References

[1] Duncan J. Watts and Peter Sheridan Dodds. Influentials, networks, and public opinion formation. *Journal of Consumer Research*, 34:441–458, 2007.

5. Main Points

- Influentials - a minority within a population who exert influence on an exceptional number of their peers.
- Motivation - We want to understand whether influentials play a significant role in the spread of influence.
- How - What factors within a network contribute to the spread of innovations and does it affect the influence of influentials
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Background

- What are influentials
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- Poisson Random Graph - If a cascade can occur, anyone can start it

6. Introduction

6.1. The Influentials Hypothesis.

`Influentials` are a minority of individuals who influence an exceptional number of their peers.

The **hypothesis** was that influentials were mediators between the source of innovation and the majority of society. The model, called the `two-step flow` of communication.

6.2. Questions of Interest.

- What does the two-step model say about influentials?
- How do influentials exert influence over the larger population?
- Are influentials responsible for the spread/diffusion of innovation?

6.3. General Results.

- Under certain (rare) conditions, influentials appear responsible for initiating cascades of influence and are important.
- Under most conditions, most cascades are driven by easily influenced individuals influencing other easily influenced individuals.
- Model: Two-way influence model with influentials acting as a middle-man.

- Simulations suggest that under certain conditions, influentials promote cascading effects but these conditions are rare.
- Computer simulation models

Simulations

Threshold Model

- Each individual i in a population of N influence n_i random individuals.
- Early adopters are individuals who adopt an innovation when a single neighbour has innovated.