



# Networked individuals predict a community wide outcome from their local information

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## ABSTRACT

The term 'viral' is used to describe a phenomenon that tends to be shared by those who encounter it. This paper considers the act of responding positively to a phenomenon by sharing it with others, something exemplified by the online social media acts of choosing to 'like' on Facebook, 'retweet' on Twitter, or by a similar mechanism on websites such as LinkedIn, Flickr or Pinterest. Using a threshold model of influence, simulations are run on four network structures where a critical mass chooses to share a phenomenon that eventually either goes viral or does not. The data collected are examined to determine whether an individual node can make an accurate prediction about the state of the entire network just from information on the behavior of their neighbors. The intention is to study what it is in terms of network structure that makes an individual good at sensing the *zeitgeist*, or 'spirit of the age'.

Findings show that those best placed to predict are 'important' as measured by network centrality, and members of numerous communities. The characteristics of the critical mass are important in determining the spread of a phenomenon and it is possible for an individual node to predict an outcome as well as an observer who has access to the state of every node in the network.

Potential applications might be found in monitoring the success of marketing campaigns, or in organizations wishing to keep abreast of current trends in a situation where data on network structure is available but data on the activity of network members is limited.

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## 1. Introduction

The Mona Lisa, Harry Potter and the Philosopher's Stone, the Bat Out Of Hell album, grunge music group Nirvana and the horror film Saw, all have one thing in common: they were not expected to be popular yet they each achieved immense cultural significance. Analyzing them to identify the source of their huge success would be unproductive. The intrinsic quality of each could be examined, but this would not reveal why it became so phenomenal. All of them had some or even many contemporary 'competitors' of similar quality that did not—to use the social contagion terminology—*go viral*.

'Going viral' is an ill defined term but can be taken to mean the tendency of a phenomenon to be shared by those who encounter it [29]. This sharing could happen in a physical sense (as in "take this CD and listen to it") or it could be the sharing of an idea ("that music group is worth listening to"). With the use of social media such as Facebook, Twitter and LinkedIn, it is even simpler that these — information in any format can be shared with friends by a single mouse click, or it can even be set to happen automatically (examples are given in Section 2).

Whether a phenomenon will go viral cannot be predicted by examining the characteristics of that phenomenon: going viral is a network effect.<sup>1</sup> Watts [64, Chapter 3] gives a good account of this argument. There would however be enormous value in being able to predict which ideas—or songs, books, products, adverts etc.—are going viral [2,1,3,61,30] and social media services already sell related information to businesses (see for example <http://datasift.com>). At the point of creation success cannot be predicted; by the time something has gone viral, everyone knows that it is a success. This paper examines making a prediction between these two points, limiting it to be based on what one member of a social network can see in the behavior of his or her neighbors. In a simulation study the paper considers the network characteristics of individuals who are successful at making a prediction, characteristics of early adopters, and the impact of network structure on the ability to predict. The intention is to study what it is in terms of network structure that makes an individual good at sensing the *zeitgeist*, or 'spirit of the age'.

<sup>1</sup> The Complete Works of William Shakespeare, the Sony Walkman, the Rubik's Cube and the Qwerty keyboard could also have been used as examples, although these are more complicated as their competitors were (initially at least) inferior or came afterwards. Many other examples exist. In each case the argument is that *phenomenal* success is a network effect.

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The screenshot shows a user profile for 'Thomas' with 33 friends, 32 ratings, and 0 'Want to Sees'. Below the profile is a section titled 'Movies' with two sub-sections: 'TOP BOX OFFICE' and 'OPENING'. The 'TOP BOX OFFICE' section lists movies with their Rotten Tomatoes scores and box office earnings. The 'OPENING' section lists movies with their opening dates. Below these is a 'COMING SOON' section. To the right of the movie lists is a large movie poster for 'The Woman in Black' with a trailer. Below the poster is a 'Friend Activity' section showing three friends who have liked movies: Linzie Cobain likes 'Bicycle Dreams', Ken Chisholm likes 'The Jungle Book', and Chris Lindsay likes 'Blue Velvet'.

| TOP BOX OFFICE |                           |       |
|----------------|---------------------------|-------|
| 92%            | Arthur Christmas          | £1.9M |
| 41%            | Happy Feet Two            | £1.7M |
| 26%            | Twilight Saga: Breakin... | £1.7M |
| 94%            | Hugo                      | £1.2M |
| 36%            | The Thing                 | £0.5M |
| 83%            | My Week with Marilyn      | £0.5M |
| 84%            | The Adventures of Tintin  | £0.3M |
| 93%            | 50/50                     | £0.2M |
| 36%            | Immortals                 | £0.2M |
| 7%             | Dream House               | £0.1M |

In Theaters | Top 50

| OPENING |                          |       |
|---------|--------------------------|-------|
| 81%     | Puss in Boots            | 09/12 |
| 6%      | New Year's Eve           | 09/12 |
| 72%     | A Very Harold & Kumar... | 09/12 |
| 65%     | Another Earth            | 09/12 |
| —       | La Fille Du Puisatier    | 09/12 |
| —       | Magic to Win             | 16/12 |
| 83%     | Mysteries of Lisbon      | 09/12 |

More...

| COMING SOON |                          |       |
|-------------|--------------------------|-------|
| —           | Sherlock Holmes: A Ga... | 16/12 |
| —           | Alvin and the Chipmun... | 16/12 |

Fig. 1. Screen shot from the Rotten Tomatoes website showing a list of films that Facebook friends have chosen to like.

The application of this research question may not be immediately apparent. Sargut and McGrath [53] discuss a concept they refer to as the 'hyperconnected world', a place characterized by complexity. They describe the difference between operating in a complicated environment and a complex environment as being the presence of unpredictable interactions between connected elements which mean simple actions can produce unintended consequences. In a hyperconnected world, an understanding of each element that makes up an environment does not produce an understanding of the behavior of the environment as a whole [45]. As an example of this hyperconnection, members of the online social network Facebook have recently noticed information about (or perhaps 'information from' — this point is debatable) their friends appearing on so called 'trusted partner' websites [31]. One instance of this can be found on the movie review site Rotten Tomatoes where visitors to the site who are also members of Facebook, are presented with their 'Friend Activity' (Fig. 1). This activity is a list of films their friends have selected (on Facebook) to 'like'. Similar features can be found on travel websites, video sharing sites and many others.<sup>2</sup>

This is seen as a very significant development [53,18] which creates decision points where an individual knows something of what his or her friends have done given the same choice. This is not new

<sup>2</sup> The 'like' feature is well known but for any who have not come across it Facebook explain: "Like is a way to give positive feedback or to connect with things you care about on Facebook. Clicking Like under something you or a friend posts on Facebook is an easy way to let someone know that you enjoy it, without leaving a comment." See: <http://www.facebook.com/help/?page=103918613033301>. Also note that the appearance of Friend Activity depends on web browser privacy settings.

in itself — friends have always discussed such things. What is new is the availability of explicit data, without requesting it, from perhaps a large number of friends at the time an individual is making a decision. Such decision points are likely to become more common and it is not unrealistic to think that future developments will include not only what films/holidays/etc. a friend liked, but also what films and holidays they disliked. It has been argued [53] that knowing what friends think of a product or service will have a huge impact on the decision to adopt that product or service. Even product reviews from complete strangers on sites such as Amazon or eBay, or word of mouth reviews are known to affect an individual's purchase decision [51,70,22,46].

## 2. Social networks and social contagion

### 2.1. Social contagion

This paper considers the act of responding positively to something which causes it to be shared with others. The scenario studied is exemplified by the Facebook app of the music sharing service Spotify. This app automatically shares with friends (although it can be turned off) a list of songs that individuals have listened to. Imagine I see that three of my friends have listened to a song. This alone causes me to listen to the song. Facebook shares this fact with my friends, which causes more of them to listen to it too. That everyone involved may have hated the song does not come into it. Several other examples are presented in Fig. 2.

There are two salient features of this scenario that set it apart from most examples of information diffusion. Firstly, an individual does not

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