



# Is this the end for Facebook? A mathematical analysis



Anthony DeLegge\*, Hannah Wangler

Benedictine University, 5700 College Rd, Lisle, IL 60532, USA

## ARTICLE INFO

### Keywords:

Facebook  
SIR model  
Online social network

## ABSTRACT

Since the early 2000s, one of the most popular uses of the Internet has been for online social networking. Since 2009, the most popular online social network has been Facebook; roughly 80% of Internet users worldwide have a Facebook account as of the end of 2014. However, in early 2014, Princeton University graduate students Cannarella and Spechler released a manuscript which claimed that Facebook would decline in popularity to essential “death” by the end of 2017. This claim was based on results obtained from an adaptation of the classic *SIR* epidemic model. In this paper, we will explore a modified version of this model to take into account a changing population size and the possibility of people leaving the social network, but later returning, and compare this model and its results to those of the original model to either confirm or deny the result that Facebook will fade to obscurity by the end of 2017.

© 2017 Elsevier Inc. All rights reserved.

## 1. Introduction

In early 2014, an interesting manuscript appeared on arXiv entitled “Epidemiological Modeling of Online Social Networks”, written by two Princeton University graduate students, Cannarella and Spechler. Using a mathematical model inspired by the classic *SIR* epidemic model, originally proposed by Kermack and McKendrick in 1927 [14], along with search data gathered from Google Trends, they demonstrated that Facebook, a popular online social network, has not only reached the peak of its popularity, but will decrease steadily in popularity over the next few years, eventually becoming essentially irrelevant by the end of 2017 [2]. Their model, called the *irSIR* model, was demonstrated to be a better fit to the search data than the original *SIR* model, helping to support this claim [2,21]. This was a shocking revelation, garnering significant attention from online media [8,18], traditional media [7], and even Facebook itself, which posted rebuttals showing that, not only was Facebook *increasing* in popularity worldwide, but that the author’s methodology was flawed, humorously showing that the methods could also imply that Princeton University would eventually become irrelevant and that the world was doomed because air was declining [4,5].

Facebook is not only a popular online social network, but is currently one of the most popular websites in the world, with an estimated 80% of Internet users worldwide having a Facebook account in 2014, the most recent year where comprehensive data existed as of this writing, and 40% of Internet users worldwide being *active* Facebook users, or logging in to the site at least once per month during the year [3]. This dominance has continued since then; as of April 2016, there are an estimated 1.59 billion active Facebook users worldwide [3]. Looking at this data, it is sometimes hard to believe that Facebook has only existed since February 2004, when five Harvard University students, most notably Mark Zuckerberg, launched the site. Originally known as “Thefacebook”, the site was created to provide an online social network for the founders and

\* Corresponding author.

E-mail addresses: [adelegge@ben.edu](mailto:adelegge@ben.edu) (A. DeLegge), [hannahwangler343@gmail.com](mailto:hannahwangler343@gmail.com) (H. Wangler).

their fellow Harvard University students [20]. Not more than a few months after its launch, the site expanded to allow most students attending colleges and universities in the U.S. to join, and then, in September 2006, the site allowed anyone with a valid e-mail address worldwide to join [20].

Since this expansion to the general public, Facebook has continued to grow both in active users and site visits. In 2009, Facebook became the top online social networking site in the world, overtaking Myspace, and has not relinquished its spot since. As a comparison, in 2014, the second-most popular social networking site, Twitter, had about a little over 50% of all Internet users worldwide with an account, but only 20% of Internet users being active Twitter users [3]. As of April 2016, Twitter has about 320 million active users, which is about a fifth of Facebook's active users [3]. It should be noted that Google+ and YouTube actually have a higher reach, with about 60% of all Internet users worldwide having accounts on each in 2014, but have much less active users than Twitter. This can be partly attributed to people automatically being signed up for accounts when they sign up for GMail, Google's popular personal e-mail server [3]. As a company, Facebook became so valuable that, in February 2012, Facebook filed to be listed as a public company, with an IPO (initial public offering) valuing the company at \$104 billion, which was the highest IPO in American history [23]. Shortly after, in April 2012, Facebook also acquired the popular photo-sharing social network Instagram for \$1 billion, giving it even more of a stronghold in the social networking world [23].

Facebook, however, is not the only success story with online social networking sites. Its arguably closest competitor, Twitter, which launched in March 2006, has also seen a fairly steady increase in both active users and site visits since its launch. Interestingly, unlike Facebook, which changed its focus from a college-centered social network to a general public one, Twitter has always been available to the general public. Due to Twitter's success, it, too, became a publicly-traded company in November 2013, with an IPO of \$1.82 billion [22]. In 2014, Twitter saw a 10% increase in new users and a 7% increase in active users worldwide, continuing a trend it has been on since its founding [3].

Of course, when talking about successful online social networks, it is important to remember the first wildly popular network, Myspace. Launched in August 2003, it paved the way for features that current Facebook and other social network users may take for granted: customizable pages, photo sharing, music sharing, and online games [9]. From shortly after its launch to 2009, it was the world's most popular online social network, ceding its spot to Facebook when it could not compete with Facebook's easier-to-use interface and not having a prevalence of obtrusive ads on users' pages [9]. This caused Myspace's popularity to fall so suddenly that, by 2011, it was sold by its owners, NewsCorp, for \$35 million to a group of investors that included musician Justin Timberlake, who then rebranded the site as a music-sharing platform. This was a staggering loss, given NewsCorp originally bought Myspace in 2005 for \$580 million [9,19].

With the rapid decline of Myspace, it is certainly reasonable to wonder: could the same kind of decline happen to Facebook and/or Twitter? Cannarella and Spechler argued Facebook would suffer such a decline, and user data at that time was in partial agreement; in 2014, Facebook saw a 9% decline in its active user base [3]. However, their *irSIR* model could be considered greatly simplified for a long-term study, as it assumed a static population size and no potential for those who may leave the network to ever come back. These assumptions force the number of users to eventually decline to 0. Two more recent works have attempted to correct this by creating the *irSIRS* model with births and deaths, which allows for a changing population, as well as a potential regaining of susceptibility after leaving the network [16,24]. Both of these works show that it is possible for online social networks, including Facebook, to continually thrive under certain conditions, which is a stark contrast to Cannarella and Spechler's work.

The purpose of this work is twofold: to modify the improved *irSIRS* model, specifically with how births are introduced into the model, to ensure that the population never grows infinitely large in the long-term, and to analyze the model to see if a different conclusion is reached than what Cannarella and Spechler reached; namely, is the "end" of Facebook inevitable? Our model, called the *birSIRS* model, is defined in Section 2, with theoretical analysis following in Section 3. The numerical analysis of the model using the Google Trends search data for Facebook, Twitter, and Myspace, along with a comparison of how the model describes the data compared to the *irSIR* model, is in Section 4. Finally, we discuss an extension of the *birSIRS* model that divides the user group into "active" and "passive" users and investigates more closely what is needed to keep an online social network thriving in Section 5.

## 2. The *birSIRS* model

To formulate our model for a specific online social network, we will assume that our population can be divided into three distinct groups: Susceptible (*S*), Infected (*I*), and Removed (*R*). Those who are susceptible are not currently members of the network, but are open to joining, while those who are infected are currently members of the network and can recruit susceptibles to join as well. Those who are removed are not currently members of the network and are not open to joining, likely due to disinterest, but also possibly due to lack of a way to join (e.g., no Internet access). Unlike the standard *SIR* epidemic model, however, removed individuals can recruit infected individuals to become removed as well. This is assumed because a social network can only thrive if it has active members; specifically, the more people who are not on the network and have no interest in joining, the more likely it will be those who are on the network can be convinced to leave.

We will also assume that those who are removed may, over time, be open to joining or rejoining the network, and hence may regain susceptibility. This can be due to more of one's friends joining the network, someone moving away who now wishes to keep in contact with his/her friends from home, etc. Thus, the typical flow of individuals in this model from one

Download English Version:

<https://daneshyari.com/en/article/5775902>

Download Persian Version:

<https://daneshyari.com/article/5775902>

[Daneshyari.com](https://daneshyari.com)