

Sentiment Propagation in Social Networks: A Case Study in LiveJournal

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Abstract. Social networking websites have facilitated a new style of communication through blogs, instant messaging, and various other techniques. Through collaboration, millions of users participate in millions of discussions every day. However, it is still difficult to determine the extent to which such discussions affect the emotions of the participants. We surmise that emotionally-oriented discussions may affect a given user's general emotional bent and be reflected in other discussions he or she may initiate or participate in. It is in this way that emotion (or sentiment) may propagate through a network. In this paper, we analyze sentiment propagation in social networks, review the importance and challenges of such a study, and provide methodologies for measuring this kind of propagation. A case study has been conducted on a large dataset gathered from the LiveJournal social network. Experimental results are promising in revealing some aspects of the sentiment propagation taking place in social networks.

1 Introduction

Social networks have become popular with the pervasive use of the World Wide Web. With the paradigm shift in the usage of the Web from information consumption to information production and sharing ("Web 2.0"), numerous social media services have emerged. Individuals use different social media services for various purposes and exhibit diverse behaviors. We use Flickr to share pictures with friends, Twitter to update our "status", MySpace to keep in touch with friends, and Blogs to express our interests, opinions, and thoughts. According to recent statistics¹, more than 10 billion photos exist on Facebook, 20 hours of video is uploaded on YouTube every minute, and around 38,400 photos are uploaded every hour on Flickr. With the massive amount of data published every day on these networks, we no longer have a shortage of experimental data; our challenge now is to make sense of the data. That said, the quantity of data gives us the opportunity to analyze the various behaviors of users in social networks and how they differ from their "real-world" social lives. Analogs of some

¹ <http://www.labnol.org/internet/data-storage-for-user-generated-content/9656/>

real-world behaviors have been studied in the context of online social networks. For example, in [1], the authors introduce a technique to measure the degree of influence users in the Blogosphere have on other users in order to identify the most influential bloggers. In this study we focus on a different problem. Does the amount of [emotional] content users are exposed to on a daily basis in the online social world influence their emotions? And if it does, how can we observe this phenomenon? We aim to develop methodologies and find answers to these questions. In this paper, we present a case study with the following contributions:

- Formally define and study the propagation of sentiment in social networks,
- Quantify and predict the occurrence of a sentiment propagation, and
- Identify salient features that result in a sentiment propagation.

The rest of the paper is organized as follows: Section 2 describes the motivation behind this study. Section 3 presents the problem statement. Section 4 discusses a case study in LiveJournal, the approach used to analyze sentiment propagation in social networks, and experimental results. Section 5 summarizes the related research. Section 6 concludes with future work.

2 Motivations

The following five items describe the basic motivation behind our study.

- **How do individuals influence each other in social networks?** There is growing interest in the community to determine the extent to which participants can influence each other in terms of thoughts and behaviors via social networks.
- **Does sentiment propagate?** There has been extensive research on information diffusion in social networks. However, to the best of our knowledge this is the first study of its kind to consider sentiments as information entities to analyze the propagation thereof.
- **How does sentiment propagate?** Assuming there is a propagation effect, there are many questions that arise in this area. For example, how rapidly does sentiment propagate? What parameters influence the propagation rate? How do propagation speed variations correspond to real world events?
- **What different roles do individuals play in propagation?** It is important to analyze the actors involved in the propagation to understand these roles. For example, the users who initiate the propagation, those who relay the propagation (hubs), and those who block or enhance the propagation, are of interest in our a study.
- **How useful are sentiment analysis tools for sentiment propagation analysis?** It is interesting to find out how effective current sentiment analysis techniques are for analyzing sentiment propagation. For example, we used Normalized Google Distance (NGD) as measure of semantic distance in this study, and it is interesting to analyze how it affected our experimental results.