Modeling Online Collective Emotions

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ABSTRACT

A common phenomenon on the Internet is the appearance of collective emotions, in which many users share an emotional state. Online communities allow users to emotionally interact with large amounts of other users, creating collective states faster than in offline interaction. We present our modeling framework for collective emotions in online communities. This framework allows the analysis and design of agent-based models, including the dynamics of psychological states under emotional interaction. We illustrate the applications of our framework through an overview of two different models. Based on this framework, our first model of emotions in product reviews communities reproduces the empirical distribution of emotions towards products in Amazon. The second model within our framework reproduces the emergence of emotional persistence at the individual and collective level. This persistence pattern is similar to the one revealed by our statistical analysis of IRC chatrooms. Further applications of our framework aim at reproducing collective features of emotions in a variety of online communities.

Categories and Subject Descriptors

J.4 [**Computer Applications**]: Social and behavioral sciences—*Psychology, Sociology*; H.1.2 [**Information Systems**]: Models and principles —*User/machine Systems*

Keywords

Internet, agent-based modeling, emotion

1. COLLECTIVE EMOTIONS FRAMEWORK

The increasing importance of online communication not only changes the way people interact everyday, but also offers a great chance to retrieve and analyze large amounts of data on human behavior. The unprecedented size of these datasets allows the quantitative testing of previous theories and hypotheses formulated in the social sciences. Fur-

thermore, sentiment mining techniques [9] allow the analysis of the emotions expressed through the Internet. Applying these tools to single users and messages heavily depends on the tool's accuracy, but when applied to large sets of texts, sentiment analysis provides useful insights on the emotions of the collective. For example, the emotional content of millions of `Twitter` messages has been used to study the daily patterns of mood [5], and the assortativity of happiness in social networks [1]. Massive datasets of annotated messages allow the study of collective emotions, i.e. transient collective states in which a large amount of users share an emotion. These collective emotions can be triggered by an external event, or can emerge from the interaction of many users in the online community, which is the case of viral videos and heated forum discussions [2].

In this article, we present our approach to understanding the emergence of collective emotional states in online communities. Our framework for collective emotions [8] allows the creation of agent-based models of emotional interaction. These models are designed to reproduce the features of collective emotions in online communities. Our framework, based in psychological states and emotional communication, provides a link between the macroscopic behavior of the community and the behavior of individual agents. The assumptions of models within our framework can be tested in psychological experiments. We aim at a complete view of collective emotions, bridging the macro and the micro level in a quantitative, testable way.
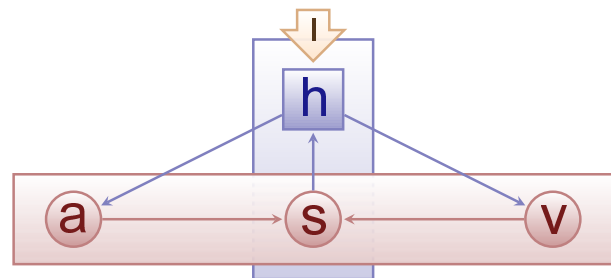

Figure 1: An agent's psychological state is composed of the internal variables valence v, and arousal a. Agent expression s is communicated through the field h, influencing the emotions of other agents [8].

We apply the concept of Brownian agents to model users of an online community. Following Russell's model of core affect [7], the emotional state of an agent is composed of

two variables: valence v and arousal a. Valence is defined as the pleasure or displeasure associated with the emotion, and arousal is the degree of activity induced by the emotion. These two internal variables determine the value of s, which is the external emotional expression of the agent. The properties of this expression vary between models, depending on the information provided by sentiment analysis of empirical data. The emotional interaction between agents is aggregated in a communication field h, which can also be influenced by external events I. This field changes the emotional state of other users following the communication mechanisms of the online community. For example, a forum discussion would be modeled by a common field that can be perceived by all the agents. The interaction in social networking sites would be represented by a field divided in different components, aggregating emotional information in user walls. Fig. 1 summarizes the relation between the components of our framework.

The analytical tractability of our framework allows the application of techniques from statistical physics. Our first analytical results [8] showed how this framework is able to reproduce the spontaneous emergence of collective emotional states. We analyzed the role of each parameter of the model and found the conditions for the emergence of high emotional activity and polarization. The values of these parameters can be estimated from empirical data of individual emotions in controlled setups. For example, psychological studies shed light on some dynamics of our framework, such as the relaxation of emotions and its heterogeneity among humans [6].

2. APPLICATIONS OF THE FRAMEWORK

The first empirical application of our model focused on the patterns of emotional expression in product reviews communities [4]. We retrieved a dataset composed of more than 1.7 million reviews from Amazon.com. Then we processed the text of each review with SentiStrength [9], obtaining two scores of negative and positive emotional content. Analysis of these emotional scores revealed certain statistical regularities, in particular on the distributions of positive and negative emotional expression. We applied our framework to design an agent-based model of the emotional interaction through product reviews, with the aim of reproducing the patterns of emotional expression found in the data. Simulations of our model show that the distribution of emotions are similar in our model as in the empirical data. Fig. 2 shows an example of the distribution of emotions in the reviews of *Twilight* versus the emotions in a simulation of our model. Our model, only based on testable assumptions of emotional dynamics, is able to reproduce the bias towards positive expression in product reviews, while negative expression is more uniformly distributed.

Our recent study of emotions in chatroom discussions [3] also uses our modeling framework. Our dataset contains 2.5 million messages from publicly available discussions in IRC chats, over which we performed sentiment analysis. For each user and channel, we calculated persistence, which is a quantitative measure of the tendency to deviate from the average emotional expression. Our model for chatroom communication reproduces the emergence of persistence at the discussion and individual level, as users influence the emotional expression of other users.

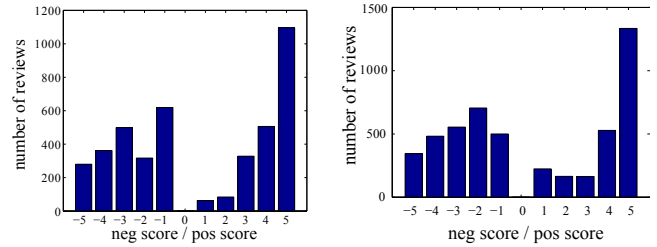Ongoing works within our framework aim at explaining

Figure 2: Distribution of emotional expression in the product reviews for *Twilight* (left), and in a simulation of our model (right) [4].

the cascades of emotional expression in the social network MySpace, and in trust networks of product reviews communities. We also plan to apply our models to study the relation between emotional expression, and developer activity in Open Source Software communities. In addition, our framework is currently applied to data-driven simulations of avatar emotions in virtual human platforms. The results of our models have special importance for future prediction of collective emotions, as well as for mechanism design to enhance the emotional experience of the members of online communities.

3. ACKNOWLEDGMENTS

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