Understanding the Algorithmic Nature of Human Behavior by Analyzing Interactions in Wikipedia

Lei (Nico) Zheng
Stevens Institute of Technology
Hoboken, NJ 07030, USA
lzheng9@stevens.edu

Jeffery V. Nickerson
Stevens Institute of Technology
Hoboken, NJ 07030, USA
jnickerson@stevens.edu

Abstract
Macroscopic phenomena emerge from local interactions in many natural and social systems. In these systems, individual actors interact in algorithmic ways. The dynamic of interactions creates collective behavior. Drawing on theories from biology, we consider Wikipedia articles as systems that evolve and self-organize, continuously shaped and reshaped by interactions with the text made by editors. We further discuss a model to analyze the interaction dynamics in Wikipedia.

Author Keywords
collective behavior; interactions; Wikipedia; social network; dynamic two-mode network model.

ACM Classification Keywords
H.1.2. User/Machine Systems.

Introduction
In the field of statistical physics, biology and social epidemiology, studies show that macroscopic phenomena arise from local interactions. Such processes play a fundamental role in both natural and human systems that include herding [16], task allocation [8], segregation [15], spreading of news and

opinions [14], knowledge diffusion [11] and fire evacuation [10]. In these systems, the individual actors respond following algorithmic laws, and it is the dynamic of interactions that lead to collective behavior. Similar influence processes are exhibited when we receive a comment from our friends, when we react to posts in Reddit or when we respond to a new edit in a Wikipedia article. Because of the algorithmic nature of responses, a better understanding of individual interactions can not only help us understand collective behavior but also suggest changes in the design of online platforms.

In this paper, we find supportive evidence that macroscopic phenomena also emerge from interactions in Wikipedia. We further discuss a dynamic two-mode network model that can be used to study human interactions. We apply this to Wikipedia data.

We draw theories from the collective behavior in biology. Biologists have identified many systems in which the frequency of brief chemical or tactile contacts regulates the individuals' choice of activities and these, in turn, affect collective task allocation [5, 8]. For example, in harvester ants, an outgoing forager's decision about whether to leave the nest on its next trip depends on the rate at which it meets foragers returning with food [5, 13]. Although no ant can assess food availability, this process provides feedback based on food availability -- the more food is available, the more quickly foragers return, and the more ants go out -- which results in high group productivity.

A Wikipedia article can also be a dynamical system that evolves and self-organizes, continuously shaped and reshaped by its editors. Like ant colonies, global characteristics of articles, such as information quality, productivity, and diffusion of ideas can be regulated by spatial and temporal interactions. Figure 1 shows patterns of edits with respect to time and with respect to editors. In contrast with the Poisson distribution, the nearly straight line in the log-log plot indicate the distributions of both inter-edit time intervals and editors' user edits follow a Power-law distribution. The emergence of Power-law shows edits influence each other in the scale of both time and people.

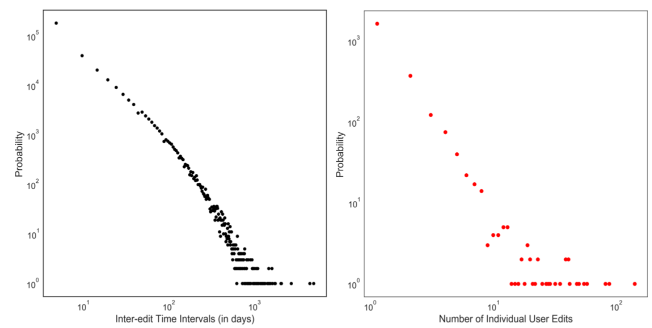

Figure 1: The inter-edit time distribution (left) and the distribution of edits per editor (right).

Interactions in Wikipedia

Previous studies have identified two kinds of interactions in Wikipedia: *explicit* and *implicit* [12]. *Explicit interaction* refers to user talks in the article discussion page, or in each other's user talk page. The discussion usually relates to changes to the article [17]. *Implicit interaction* refers to users adding or deleting content based on each other's edits. Such an interaction mechanism has been related to the concept of stigmergy [4, 9] and has attracted attention in the information systems literature [2, 3]. Hence, interactions happening on a page can be illustrated through a dynamic two-mode network composed of content and editors. For example, Figure 2 shows a two-mode network with article sections as circles and editors as squares. In this network, editors interact with each other by modifying the same sections in an article or the article's talk page. The two-mode network can be plotted for different instants in time, creating a set of temporally related graphs, of which certain graph characteristics explain the evolvement of the editors' community.

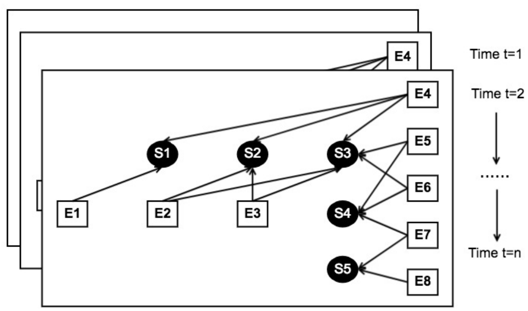

Figure 2: A dynamic two-mode network of interactions in a Wikipedia article, where editors (squares) interact through modifying the same sections (dots).

By representing interactions as a dynamic network, we can build models based on a time sequence of network characteristics. For example, it may be that the frequency of edits on a certain section has an effect on the quality of the section. These models can help us understand the interaction dynamics in various ways. First, we may be able to predict whether certain kinds of interaction patterns will lead to convergence or divergence. This might help us head off a potential conflict, improving both quality and productivity. Second, we can better understand how groups react to external events, such as worm-attacks or sudden traffic increases. Third, we can study the roles bots play in such systems, and, in particular, how human editors interact with bots.

Algorithmic systems can fail in multiple ways [1, 6, 7]. Some failures are inherited from identifiable mathematical flaws in algorithms, and consequently can be addressed directly. By contrast, some failures may be the result of complex interactions, the result of feedback loops in collective human behavior. To fix such problems, we need a deep understanding of human interactions through models that capture their complexity. Studying interactions using dynamic two-mode networks can be a starting point for understanding such collective behavior in online communities.

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