Is Reinvention of Information a Catalyst for Critical Mass Formation?

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Abstract

Critical mass is a socio-dynamic term used to describe the existence of sufficient momentum in a social system such that it becomes self sustaining and fuels further growth. The current study focuses on factors which are crucial for the development of a critical mass needed for the diffusion of new information in online social networks. Critical mass will be discussed by linking concepts from the Diffusion of Innovation theory and Critical Mass theory, This linkage provides us with the ability to view critical mass in accordance with its occurrence at a certain point in time and the process leading towards that point. We offer a study of critical mass dynamic formation using the process approach offered by the Critical Mass theory. From the Diffusion of Innovation theory we suggest the concept of reinvention as a catalyst for critical mass formation. Specifically, we propose that reinvention of information that is integral to learning processes, is crucial for the diffusion of information. Understanding the role of reinvention in critical mass formation during the diffusion of information will expand the understanding of formal and informal learning communities.

Keywords: critical mass, diffusion of information, social networks, reinvention

Introduction

Critical mass as a concept and theoretical approach has been described in terms of a threshold and in terms of resources needed in order to reach beyond a certain level of output. The current study focuses on factors which are crucial for the development of a critical mass and on the tension between factors and processes contributing to its development. We propose that information will reach critical mass faster when adding the factor of reinvention to the process of information exchange. Reinvention is defined as the degree to which an innovation is modified by a user in the process of adoption and implementation (Rogers, 1995). In this study, we research the contribution of reinvention of information in a social network to reaching critical mass of participants. This extended abstract lays the theoretical basis, research questions and proposed method which will be followed by empirical work.

In social sciences, "Critical Mass" is a socio-dynamic term used to describe the existence of sufficient momentum in a social system such that it becomes self sustaining and fuels further growth (Ball, 2004). Attaining social critical mass may be influenced by factors such as the number of participants, their interrelatedness and level of communication.

Research about the diffusion of innovations uses the term critical mass to describe a certain ***point in time*** in which the rate of the adoption rate (the acceleration of adoption) is fastest i.e the increase in the number of new adopters increases most rapidly. This point is referred to as the increasing second order inflection point, and it occurs early in the diffusion process, when

about 16% of the individuals have adopted the innovation (Rogers, 1962). What causes the initial group of receivers of new information to pass it on, thus initiating the diffusion process? We offer to view this process from the perspective of Critical Mass Theory (Oliver et. al., 1985).

Critical Mass Theory

The Critical Mass Theory (CMT) aims to predict the probability, extent and effectiveness of group actions in pursuit of a collective good. Oliver et.al (1985) define critical mass as "the small segment of the population that chooses to make big contributions to the collective action, while the majority does little or nothing". In other words, the minority of the population (the critical mass), through their early contribution to the collective good enhances the probability of success of collective action. This creates conditions for the majority to join leading to the achievement of the collective good.

Communication scholars have adopted and applied CMT, recognizing information as a type of public good, and that different structures for sharing information have different properties that affect people's willingness to participate in information sharing, thus affecting its diffusion (Oliver & Marwell, 2001).

Viewing information as a public good allows us to apply CMT to the diffusion process of new information. According to CMT, In a given group, individuals exhibit different levels of interest on a given topic and have different levels of resources to contribute to its realization. - This **heterogeneity** in interest and resource levels was found to be a main predictor to the existence of a critical mass (Marwell & Oliver, 1993). Individuals in the group are mobilized towards a collective action through sequential interdependence, namely, they make independent decisions one at a time, but past decisions of others are known to them and thus the total amount of prior contributions provided by the group influences subsequent contributions. Sequential interdependence is visualized in a graph plotting the collective output of a group [p(r)] against the resources contributed by the group (r). Two main graphs are obtained. The first, describes situations in which the earliest contributors have the greatest effect on achieving the public good, and subsequent contributors have progressively less effect. This situation is referred to as a **decelerating production function**. In the second situation, initial contributors have only negligible effects on achieving the collective good, and subsequent contributors yield the greatest effect. This situation is referred to as an **accelerating production function**.

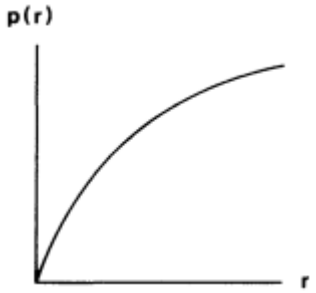

Figure 1: Decelerating PF

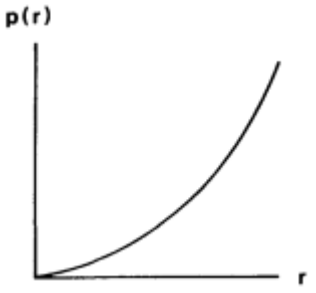

Figure 2: Accelerating PF

In both types of production function (PF) greater contribution will produce greater probabilities of obtaining the collective good. The difference is whether the marginal returns are increasing or decreasing. Differences in PF are associated with different social dynamics and with different

probabilities of actually providing the collective e good (Marwell & Oliver, 1993; Oliver et.al., 1985).

The "critical mass" in a decelerating PF constitute a set of individuals whose interest in the collective good is high enough relative to the slope of the production function, that they are willing to contribute in that region. Ironically, the collective good is rarely fully achieved in this scenario due to the decreasing marginal rates of return seen by later contributors.

In an accelerating PF, a pool of highly resourceful and interested individuals willing to contribute in the initial region of low returns may become the "critical mass" creating the conditions for additional widespread contributions. If such a group exists, they may begin a process in which continuously increasing numbers of group members find that contributions made by others have changed the situation to one which they too, wish to contribute. For this process to start, the initiators must have an extremely high interest in the collective good – up to 100 times greater than necessary to initiate action in a decreasing production function (Marwell & Oliver, 1993). When the PF is accelerating it is difficult to initiate collective action because the benefits to early contributors remain largely contingent on the subsequent contributions of others, and only after a long start up stage the accumulated benefit becomes evident and invites subsequent contributions (increasing marginal returns). Although contributions in this type of production functions are hard to start, once these contributions get started they generally accelerate rapidly, with the critical mass filling the role associated with the nuclear metaphor – a small core of highly interested and resourceful individuals can begin contributions that will draw subsequent contributions until "explosion" – the event carried out to its maximum potential.

Table 1: Main characteristics of decelerating and accelerating PF

	Decelerating PF	Accelerating PF
Marginal return	diminishing	Increasing
Interdependence	Negative: each contribution lowers the value of the next one	Positive: each contribution increases the value of the next one
Central problem	Free riding	High start-up costs
Solution to central problem	order effect – initial contributors with lower interest levels	initial contributors with high interest and resources
Collective action	Tends to be self limiting	Tends to be self reinforcing
The critical mass	A set of individuals whose interest in the collective good is high enough relative to the slope of the PF	A set of highly resourceful and interested individuals willing to contribute in the initial region of low return
Example	lobbying	voting

Critical Mass in Online Social Networks

Understanding the factors that contribute to attracting a critical mass of adopters to new information thus propelling its diffusion throughout the network is of great interest. Some researchers focused on attributes of content (Berger & Milkman, 2010; Berger & Heath, 2005), some on its usefulness (Wojnicki & Godes, 2008), others disregard content and focus on structural attributes of the network such as centrality (Bolland, 1988; Bonacich, 1987; Borgatti et. al., 1992); network centrality betweenness and closeness (Freeman, 1979; Kitsak et. al., 2011), Eigenvector Centrality (Canright & Engo-Mosen, 2005); and density (Gould, 1993; Prahl

et. al., 1991; Watts & Dodds, 2007). Others emphasize the strength of certain ties (Granovetter, 1973; Goldenberg et. al., 2001) and the role of the source of information – whether it be influential individuals in the network (Goldenberg et. al., 2009; Kempe et. al., 2003) or active individuals, i.e., those that post information more extensively than others (Stephen et. al, 2010).

Online social networks are characterized by a participatory culture built on their members' inclination to express their personal thoughts, locus of interest and creativity. Members of social networks are inclined to contribute resources as they "believe their contributions matter and feel some degree of social connection with one another" (Jenkins, 2006). In the diffusion of digitized information, after initial exposure to new information, individuals decide whether to pass it on to others. Explicit retransmissions are critical for information to be shared over social networks and to spread widely. We suggest the factor of reinvention of information in the process of sharing as influencing the attainment of critical mass of new information in these networks.

Diffusion of Innovation Theory (DOI) and Reinvention

In the DOI, diffusion is described as the process by which an innovation is communicated through certain channels over time among members of a social system. As such, diffusion is a special type of communication concerned with the spread of messages that are perceived as new ideas.

The DOI theory describes five stages: knowledge, persuasion, decision, implementation and decision (Rogers, 2003).

The concept of reinvention was introduced in the Diffusion of Innovation theory (DOI) in the 1970's (Rogers, 1995) and is defined as the degree to which an innovation is modified by a user in the process of adoption and implementation. Thus, reinvention widens the choices available to potential adopters. Instead of either adoption or rejection, modification of the innovation or selective rejection of some components of the innovation may also occur (Rogers, 1995). Most research on the topic of reinvention was done in the fourth stage of the diffusion process – in the implementation stage (Rogers, 1995).

In the context of our work, new information diffuses in a network by being passed on to others. Information may be passed on as is, or in modified form. Reinvention of information occurs when individuals in a network modify it thus expressing their creativity and sense of ownership over it.

This study focuses on reinvention in critical mass formation early in the innovation-decision process, in the "knowing" stage, where potential adopters first encounter awareness and knowledge of the innovation. Understanding reinvention in this informational stage promises to extend the theory of critical mass in an aspect which is crucial for the online environment.
This leads to the following research questions:

Research questions

RQ1: will critical mass around new information be reached faster when reinvention occurs?
RQ2: will reinvention manifest an accelerating or decelerating production function?

Variables

Critical mass will be determined by observing an inflection point in the process of the diffusion of information.

Production functions will be determined by plotting the relationship between the resources contributed by the group and the collective output of that group. The number of nodes the information is passed to is the collective outcome, and the resources contributed are of three types: not passing the information, passing information on, and passing information with reinvention.

For RQ1:
Dependent variable: number of participants, time
Independent variable: reinvention (yes/no), tie type (strong/weak), interest & resource level

For RQ2:
Dependent variable: the number of nodes the information reaches in the network
Independent variable: receiver's activity (not pass it on, pass as is, pass +RI)

Method

Cellular automata (CA), a mathematical modeling technique for complex systems, will be used. CA simulates aggregate consequences based on local interactions between individual members of the population thus contributing to the understanding of how micro level activities govern macro level effects (Goldenberg et.al., 2001).

The model typically consists of a framework in which interactions occur between various types of individuals. In CA models, each individual's behavior is dictated by a predefined scheme of response probabilities and is a function of the state of other individuals with whom he interacts. The solution of such models consists of tracking the changing state of each individual over time. The model consists of a finite number of virtual individuals in a given simulated social system, each of whom is able to receive information and pass it on during consecutive, discrete periods.

In order to address the research questions, a model will be built based upon probabilities known in the literature regarding interest and resource levels, the number of ties each node has, the strength of these ties and inclination to share information. By performing simulations we will be able to differentiate between situations in which information was either not passed on to others, passed as is, or passed after being modified. In addition, we will be able to track the spread of information in each of the three situations thus allowing us to test RQ1. Subsequently, we will be able to determine whether the critical mass point in the spread of information was reached in an accelerating or a decelerating production function, thus allowing us to test RQ2.

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