New Evolutionary Adoption Model for Innovation Diffusion

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ABSTRACT

The study of innovation diffusion offers an insight into its adoption by a particular community, which has attracted the attention of many researchers. However, most of proposed models do not take all the fundamental elements for simulating the diffusion process into account. The main contribution of this article is proposing an original model founded on the evolutionary algorithm. The model simulates the adoption decision as a process of gradual acceptance and focuses on the representation of (1) the innovation features (2) the individuals’ heterogeneity, (3) the social network (4) the communication influence. For this purpose, different simulation scenarios were carried out using a probabilistic foundation. The results validated the model’s ability to determine the earlier adopters and therefore, demonstrated an explicit diffusion pattern without the need of historical data.

KEYWORDS
Communication, Evolutionary Algorithm, Gradual Acceptance, Individuals’ Heterogeneity, Innovation Characteristics, Innovation Diffusion, Social Network

INTRODUCTION

New advantageous ideas, activities, and products take time to be adopted and sometimes they are rejected. Innovation diffusion research aims at understanding this social phenomenon. Organizations and companies seek to predict the success or failure of an innovation. They also hope to accelerate and to facilitate its dissemination at a lower cost. Rogers (1962) developed a general diffusion theory to explain human behavior. He defined the innovation diffusion as “…the process by which an innovation is communicated through certain channels over time among the members of a social system…” (Rogers, 2003, p. 11). He also identified five qualities that determine the success of an innovation and the rapidity of its adoption in society: relative advantage, simplicity, compatibility, observability, and trialability. This theory gained a wide popularity and has been applied in different fields such as: medicine (Dearing, 2009; Fennell & Warnecke, 1988; Greenhalgh, Robert, Bate, Macfarlane, 

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& Kyriakidou, 2005; Rogers & Peterson, 2008; Zhang, Yu, Yan, & Spil, 2015), agriculture (Simin & Janković, 2014), sociology (Kohles, Bligh, & Carsten, 2013; Valente & Davis, 1999), marketing (Wu, Hu, & Zhang, 2013), economics (Aizstrasuata, Gintersa, & Erolesb, 2015), and epidemiology (Valente, Dyal, Chu, Wipflf, & Fujimoto, 2015). There are four categories of innovation diffusion models that consider different elements of the dissemination process. These elements are: (1) the innovation itself, (2) communication channels, (3) time and (4) the social system (Rogers, 2003).

The threshold models category concentrates on the influence of the social structure, where the individual’s decision depends on the behavior of others in the personal network or the social system (Granovetter, 1978; Valente, 2005). However, these models do not consider the absence of communication between members of the social system.

The impact of communication channels between the social system members was the focus of epidemiology approach in which the diffusion is treated as an epidemic disease that is transmitted by a direct contact between the community members (Easley & Kleinberg, 2010). Similarly, the cascade models category considers both components: the social system and the communication channel, where the members follow the crowd. This herding assumption presumes that the individual overlooks its private information by imitating the behavior of others (Akrouf, Laifa, Belayadi, & Mouhoub, 2013). A remarkable limitation in these models is that they eliminate personal choices. They rely on social pressure instead of affording a clear reason to adopt the innovation (Young, 2009).

Mathematical models showed specific interest on the rate of adopters, making assumptions of homophilous individuals, or highly connected social networks (Mahajan & Peterson, 1985; Valente, 1993; Valente, 2005). A particular case of these macro-models is Bass model (1969) where the individuals are restricted as two groups: innovators or imitators. However, in real scenarios, potential adopters are not similar and do not always interact with everyone else in the network.

While most of the existing models support the heterogeneity by classifying the potential adopters in different groups or by adding probability distributions, they ignore the innovation features and consider that all innovations are at the same level of estimation (Chikouche, Bouziane, Bouhouita-Guermech, Mostefai, & Gouffi, 2018). To some extent, the innovation features can mainly change its future adoption (Rogers, 1995). Therefore, the innovation features are critical for diffusion model conceptualization in order to reflect a real process.

On the other hand, selecting early adopters and determining the initial adoption rate are a main concern for many diffusion models. For example, the more the early adopters are, the sooner the spread of information will be noted (Rogers, 1995). Many researchers rely on historical data to determine the initial rate. In case of lacking data, a predictive threshold will be used, and a set of adopters will be stochastically chosen.

The separation of the innovation important elements and studying every concept independently from the others may subsequently diminish the model description and may considerably reduce the result accuracy.

The proposed model in this paper aims at bridging up the gap widened by a shortage of studies available in the literature that addresses these drawbacks. It implicitly solves the early adopters’ selecting problem by inserting usual conditions for their generation. Moreover, this work focuses on modeling the innovation qualities, the four elements of the diffusion, the heterogeneity of individuals, the social pressure, and the influence of communication channels in the same model.

Furthermore, despite the extensive diffusion literature, a little of it applied techniques based on the evolutionary algorithm (O’Mahoney, 2007; Sampaio, Varajão, Pires, & Oliveira, 2013). The novelty and the contribution that this research is likely to initiate is to bring to the surface the application of the evolutionary algorithm to simulate the innovation diffusion as a gradual acceptance process, which can be affected by personal choices of adopting neighbors or by the value of the innovation itself.

The rest of this paper is organized as follows. Section 2 addresses fundamental conceptions in innovation diffusion theory to attain a better understanding of the background. Literary reviews that tackle the subject matter are provided in section 3. Next, Section 4 introduces the proposed model
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