Why Do Diffusion Data Not Fit the Logistic Model? A Note on Network Discreteness, Heterogeneity and Anisotropy

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Abstract Diffusion of innovations and knowledge is in most cases accounted for by the logistic model. Fieldwork research however constantly report that empirical data utterly deviate from this mathematical function. This chapter scrutinizes network forcing of diffusion process. The departure of empirical data from the logistic function is explained by social network discreteness, heterogeneity and anisotropy. New indices are proposed. Results are illustrated by empirical data from an original study of knowledge diffusion in the medieval academic network.

Introduction

Diffusion of innovations is the process by which an innovation is communicated through certain channels over time among the members of a social system [27, p. 5]. Diffusion of knowledge may be defined in the same manner, replacing what should be in the previous definition. Social network analysis is in its early stages of application to diffusion issues.

Compared with other aspects of diffusion research, there have been relatively few studies of how the social or communication structure affects the diffusion and adoption of innovations in a system [27, p. 25].

So speaks Everett M. Rogers, the outstanding promoter of diffusion studies, about the way they are connected to network analysis. In the 1970’s, according to a content analysis of 1,084 empirical publications, diffusion networks represented less than one percent of diffusion research. Ten years ago, a book especially dedicated to network analysis has the same diagnosis:

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Only few material coupling a diffusion study with network analysis is available [8, p. 189]. The authors consequently content themselves with classical studies in the field. The fact that different authors interested in the diffusion of innovations vs. network analysis have detected the same lack of research, vouches for a promising fieldwork.

1 A Brief Historical Sketch

Despite the fact that the first paper explicitly dedicated to network diffusion was written in 1979 by Everett M. Rogers [26], the concern is much more ancient. For instance, in the course of his studies on the cholera, in 1884, Etienne-Jules Marey already applied network perspective to diffusion data. He had the insight that the topology of social network determines the form of the diffusion process. Marey says: “Closed institutions: prisons, boarding schools, convents, asylums, etc., usually escape to cholera; but if it gets into, it takes a terrible toll of victims” [20, p. 670]. Cliques (i.e. closed communities) exhibit atypical behaviour: they are resistant to the disease or completely devastated by the epidemic. The “clique effect” was independently rediscovered in 1973 by Mark S. Granovetter [12]; “weak ties” favour diffusion, “strong ties” protect the members from a tentative adoption: either they all adopt, or they all reject.

The first book approaching the diffusion of innovations through network analysis came out in 1995 by a student of Rogers: Thomas W. Valente [35]. His scope was to compare three classical datasets: the adoption of tetracycline by 130 physicians of the Middle West [6]; the diffusion of innovations among 692 Brazilian farmers [28]; the diffusion of family planning in 24 Korean villages [29]. Held with fifteen years of hindsight, the book appears a little disappointing for seven chapters out of nine are in fact dedicated to apply thresholds and critical mass models to diffusion issues. Network analysis occupies thirty pages [35, p. 31-61], where classical measures of density, centrality and equivalence are processed out on the three datasets.

In the past decades, diffusion process have been simulated either within deterministic or probabilistic models [1, 19, 16, 5, 9, 17]. Researchers have explored a full range of simulations, including Monte Carlo, Ising, Potts, Krause-Hegselmann and Deffuant models [16, 10, 32, 34, 4]. However, more often than not, models presuppose the population to be homogeneous. Simulations are implemented on regular bi-dimensional lattices. Modeling rarely assumes the topology in which the diffusion occurs, and it is only in the 2000s that sociologists, economists and physicists addressed the point [7, 15, 30, 31, 18, 2]. The network-based approach of diffusion is full of consequences, some of which are still developing.