Noname manuscript No.
(will be inserted by the editor)

Analysing the Social Network Evolution and Parametrization in Diffusion Models

Samer Hassan · Juan Pavón · Candelaria Sansores

the date of receipt and acceptance should be inserted later

Keywords agent-based modeling and simulation, data-driven, social network

1 Introduction

Many of the models introduced for the study of diffusion phenomena in societies assume that a local threshold in the fraction of active neighbours must be overcome for the diffusion process to occur [1]. That is the case for the diffusion of innovation, rumours, news or epidemics. However, this assumption raises several questions: Which threshold to consider? How should it be fixed? If it is not homogeneous for all the population, how to divide it in types, each one with a threshold? How many groups, in which percentage, and how to justify the assigned threshold for each one? In general, how to avoid the arbitrary decisions concerning such threshold?

On the other hand, several questions can appear referring to that 'fraction of active neighbours': Which neighbours to include? For an individual in a social network this is related to the topology of the network: Which neighbours are connected to the individual? Which are not and why they are not? Should each linked neighbour have the same weight in the individual decision? If there is a link strength, should it be static or evolve over time? Should the internal state of the individual affect the topology in any way? In general, how to define the dynamics concerning the network topology?

This paper attempts to contribute to this discussion from a methodological approach. First, by considering the construction of the social network. For this purpose, it proposes a data-driven approach for the parametrisation of the agent-based simulation (and thus, the questioned threshold). Second, encouraging the increase of complexity in diffusion models, considering the use of adaptive networks with dynamic link strength. This will be illustrated with a specific case study on friendship evolution.

S. Hassan · J. Pavón
Facultad de Informática, Universidad Complutense Madrid, 28040 Madrid, Spain
E-mail: {samer, jpavon}@fdi.ucm.es
Candelaria Sansores
Complex Systems Simulation Lab, Universidad del Caribe, 77528 Cancún, México
E-mail: csansores@ucaribe.edu.mx

2 Data-driven ABS parametrisation

It is frequent that diffusion models keep a high level of abstraction and a low use of empirical data. In those models, interesting dynamics can be studied through the sensitivity analysis of the different parameters. However, with some recent exceptions such as [2], the diffusion models deal with a wide number of arbitrary decisions, especially referring to the first set of questions in section 1.

Even though it is not advised for every model, it is useful to consider the possibility of introducing empirical data (e.g., survey data) into the agent-based model in order to fix some of its parameters. Thus, an exploration of the available research studies in the area would allow to limit the range of possible values that the thresholds can have. For instance, regardless the emergence of friendship or the difussion of a rumour, those thresholds can be fixed (or limited) when considering the means found in empirical sociological studies.

3 Adaptive networks, homophily

A full-linked social network with constant link strengths would be the simplest solution to the second set of questions of section 1. But it is possible to consider higher degrees of complexity, even if not every model may be benefit from it. Concerning the social network, it is interesting to study the use of adaptive networks [1], with coevolution of the topology and the agent internal states. In such networks, changes in those internal states would trigger modifications on the topology. For instance, build a new link with an agent considered similar enough. Also, changes in the topology may trigger changes in the internal states. For example, losing a specific link may trigger changes in the agent behaviour.

On the other hand, concerning the link strength, the possibility of using heterogeneous linkage can be taken into account. For instance, homophily dynamics may influence the appearance of links but also their strengthening over time. In such context, two 'friends' would increase their friendship degree over time if their similarity is high enough [3].

In the extended article, a more throughout analysis of those questions in the context of a case study on friendship dynamics will be presented.

Acknowledgements This work has been performed in the context of the project *Simulation of Complex Social Systems (SiCoSSys)*, supported by Spanish Council for Science and Innovation, with grant TIN2008-06464-C03-01. We also thank the support from the *Programa de Creación y Consolidación de Grupos de Investigación UCM-BSCH, GR58/08*

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