Master Internship proposal

Title : Coevolving higher order opinions dynamics models

Research project:

The formation and diffusion of opinions in a society, a typical object of study of social sciences, attracts the interest of physicists, mathematicians and computer scientists as it can be formulated in terms of complex dynamical systems [1]. From this perspective, the objective of such studies is to address questions concerning large scale properties that are observed in many different real systems instead of understanding particular cases.

Several models have been proposed, which aim at understanding how the different observed regularities, like consensus, polarization or fragmentation, emerge from a dynamics governed by the interactions among social actors. These models are stylized simplified versions of real societies which integrate, in general, the most widespread properties of human interactions considered by researchers in social human sciences [2].

In the last decade, the generalization of the usage of social networks, allowed for large scale phenomenological studies of the outcomes of these dynamical processes, leading to a wide collection of observations that, though limited to the users of these platforms, provide a widespread view in terms of geographical location, language and cultural aspects of the involved social actors.

Most studied models consider pairwise relations between agents which can naturally be represented by networks [1]. However, pairwise interactions do not describe all possible ways of discussion in real life, and the particularities of group discussion and decision making are still a matter of discussion in Social Psychology [3,4]. This necessity of going beyond pairwise interactions has been first addressed by generalizing previous models to the case of group interactions mainly in the form of an aggregation rule that averages the opinion of the neighbours of the active agent, as in the Hegselmann-Krause model [5].
The interest in multi-agent interactions, that cannot be decomposed into pairwise ones to model group dynamics at a large scale did rise sharply and several studies were published in the context of opinion dynamics, (social) contagion and other dynamical processes, which modeled the topology of interactions by hypergraphs [6]. In this line we have studied the generalization of the Deffuant- Weisbuch model [7], a model which implements homophily and social influence by a threshold rule: only agents whose opinions lie within a confidence range may interact, to the case of group interactions. We have shown that this modification transforms the sharp transition between polarization and consensus observed in the pairwise model into a soft crossover [8]. In this study the groups that can potentially interact do not change in time as they are constrained by the underlying topology.

The project proposed here aims at understanding the co-evolution of opinions and hyper-edges, in particular we ask whether the observed effects would still hold if we release the constraint on the groups by considering a model that introduces a realistic dynamic for them, by granting the agents the ability to leave groups and join another group. The departure could be triggered by some measure of the frustration of not being able to reach consensus within a group.

This internship is open in the framework of the OpLaDyn project *(Understanding Opinion and Language Dynamics using massive data)* *http://project.u-cergy.fr/~opladyn/* , winner of the TransAtlantic Digging into Data Challenge grant: https://diggingintodata.org/awards/2016/news/winners-round-four-t-ap-digging-data-challenge. This is international project brings together researchers in Data Science, Physics, Linguistics,

Communications, Philosophy and Law with the goal of studying problems in Human Social Sciences developing an interdisciplinary view of the relation between information patterns in Big Data and the dynamics of social actions, bridging the gap between Social and Natural Sciences.

Applicant's profile:
The candidate should be a M2 student preferably in Physics or Applied Mathematics, motivated by the interdisciplinary applications of her/his discipline. She/he should have very good programming skills. Knowledge of Network Theory, Phase Transitions and Dynamical Systems will be appreciated.

Working place:
The selected candidate will work under the supervision of Dr Laura Hernández, Associate Professor at Laboratoire de Physique Théorique et Modélisation (LPTM), UMR8089 CNRS-CY-Cergy Paris University, https://www.cyu.fr/laboratoire-de-physique-theorique-et-modelisation. She/he will benefit from the working environment of the LPTM and the computer center of CY and will participate in the activities of the OpLaDyn team.

Application procedure
Interested candidates should send by email (contact below) a detailed CV, with full list of marks of previous years (and eventually the partial marks of the current year), and two reference letters.

Funding and duration: Funded internship (French internship allowance rate), starting February/March 2022 for a period of 4 to 6 months.

Contact: Laura.Hernandez@cyu.fr

References:
[1] C. Castellano, S. Fortunato, and V. Loreto, *Statistical physics of social dynamics*, Rev. Mod. Phys. 81, 591 (2009).
[2] J. Scott, *Social network analysis: developments, advances, and prospects*, Social network analysis and mining 1, 21 (2011).
[3] Matthew S Levendusky, James N Druckman, and Audrey McLain. *"How group discussions create strong attitudes and strong partisans".* In: Research & Politics 3.2 (2016), https://doi.org/10.1177/2053168016645137
[4]Dana M Binder and Martin J Bourgeois. "*Direct and indirect effects of group discussion on consensus"*. In: Social Influence 1.4 (2006), pp. 249-264.[5] R. Hegselmann and U. Krause, *Opinion dynamics and bounded confidence models, analysis, and simulation*, Journal of Artifcial Societies and Social Simulation 5 (2002).
[6] Renaud Lambiotte, Martin Rosvall, and Ingo Scholtes. *"From networks to optimal higher-order models of complex systems"*. In: Nature physics 15.4 (2019), pp. 313-320. doi: 10.1038/s41567-019-0459-y.
[7] G. Deffuant, D. Neau, F. Amblard, and G. Weisbuch, *Mixing beliefs among interacting agents*, Advances in Complex Systems 03, 87 (2000).
[8] H. Schawe and L. Hernández, *Higher order interactions destroy phase transitions in Deffuant opinion dynamics model,* to appear in Comm. Phys (2022). arXiv:2111.12165