Master Internship proposal

Title : Opinion dynamics in multi-layered societies

Research project:
The formation and diffusion of opinions in a society, a typical object of study of social sciences, is also of interest for physicists and mathematicians as it can be formulated in terms of complex dynamical systems [1]. From this perspective, the objective of such studies is not to understand the opinion formation in a particular case, but to address questions concerning large scale properties that are observed in many different real systems instead.

Several models have been proposed, which aim at understanding how these 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.

Among the theoretical studies, bounded confidence models [3,4], address the fact that social actors are rarely influenced by every other one they encounter. Instead, humans have a tendency to be influenced only by those others holding an opinion that is not so different from their own, while ignoring the opinion of those with whom they strongly disagree. This aspect, along with the fact that they also have the tendency to conform to the opinion of these close contacts, are considered as basic ingredient of social interaction, known as *homophily* and *social influence*.

The HK is a synchronous model where, at each time step, each agent adopts the average opinion of its own group, defined as the set of agents whose opinion differs from its own in less than a parameter ε, called *confidence*. Several variants have been studied, in particular we have recently studied the heterogeneous version of the HK model, where each agent has its own confidence value ε_i [5] reflecting the fact that some agents are more open minded than others. We have also considered the case where changing the opinion bears a cost for the agent [6] and also the situation where the interactions are additionally constrained by a network of contacts, which takes into account the fact that each agent is not potentially in contact with all the other members of the society [7].

The project proposed in this internship is the natural continuation of these works. In particular, it concerns the study of the HK model taking into account that in the real world, an individual holds different types of contacts, according to the considered context and the role she/he plays in it (family, working environment, friends, sports, etc). From the mathematical point of view this implies modeling the interactions by the means of a multiplex network.

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 good programming skills. Knowledge of Netwtork 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: Six months funded internship (French internship allowance rate), starting February 2021.

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] G. Deffuant, D. Neau, F. Amblard, and G. Weisbuch, *Mixing beliefs among interacting agents*, Advances in Complex Systems 03, 87 (2000).
[4] R. Hegselmann and U. Krause, *Opinion dynamics and bounded confidence models, analysis, and simulation*, Journal of Artifcial Societies and Social Simulation 5 (2002).
[5] H. Schawe and L. Hernández, *When open mindedness hinders consensus*, Scientific Reports 10, 1 (2020).
[6] H. Schawe and L. Hernández, *Collective effects of the cost of opinion change*, Scientific Reports 10, 1 (2020).
[7] H. Schawe, Sylvain Fontaine and L. Hernández, *The bridges to consensus: new results in opinion formation on networked societies,* (in preparation)