



## Stage M2 / 5<sup>e</sup> année ingénieur

### **RESEARCH SUBJECT TITLE: Complex contagion in social networks: economic games played on networks**

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**Lab Language:** english

**Minimum language level required:**

- English: required
- French:
- Other:

#### **Abstract:**

Social networks play a crucial role in learning and informal transmission of information across society. There is a need for understanding formation of, and spread of information in, social networks at different levels, connecting computational principles at the individual level, the brain system level and the level of collective behavior. How do the structures of social networks affect the computations underlying learning of social norms and, in turn, how do specific brain regions influence neurocomputational processes required to build social structures and to make collective decisions? This project seeks to answer these fundamental questions by developing a unified mechanistic account of how social networks are formed, that bridges the gap between the individual and the collective levels. Experimental economics research of games played in networks allows us to investigate how networks form and evolve when individuals create links between each other, and then investigate how different treatments, (e.g. effect of network size) lead to different outcomes at the collective level (e.g. number of links, investment/effort, payoffs...). How do humans build social networks, learn from social interactions, make decisions in which one's immediate self-interest often competes against collective interest, or decide to spread information or other resources to others?

Convincing people to conform to new social norms, such as adopting more sustainable behavior is a type of complex contagion, which requires confirmation from respected peers in order for people to find a new or uncomfortable behavior acceptable (Centola, 2020; Guibeault, 2021; Iacopini, 2021). Complex contagion is the phenomenon in social networks in which multiple sources of exposure are required before an individual adopts the change of behavior. It differs from simple contagion in that unlike a disease, it may not be possible for the innovation to spread after only one contact with a neighbor (i.e. only one connection in the network). Thus, a contagion is complex if its transmission requires an individual to have contact with two or more sources of activation, i.e. if a contact with a single active neighbor is not enough to trigger adoption. Complex contagion can hence be broadly defined as a process in which exposure to



multiple sources presenting the same stimulus is needed for the contagion to occur. Empirical evidence that contagion processes including multiple exposure can be needed to describe social contagion has been provided in various contexts and experiments. Complex social contagion phenomena concern a wide number of problems, such as the adoption of norms, behaviors or the diffusion of rumors or fads. Also simple epidemic-like contagion can suffice to describe some cases, such as easily convincing rumors or domino effects. In many other situations, however, they do not provide a satisfactory description, especially in those cases where more complex dynamics of peer influence and reinforcement mechanisms are at work.

Social networks allow members to be socially influenced through their connections. For example, people can observe their peers' behavior and learn social norms in their communities. This process of complex social contagion can have positive consequences, as it may help spread prosocial behavior through social imitation. In a first study, we will use a behavioral economics approach and a modeling approach to consider games played on networks. We will investigate the role of social influence on sustainable behavior and the way complex social contagion spreads in networks depending on neighbors' influence. The key impact of this research will be to determine what structures of social networks create the most appropriate environment for social influence and promote prosocial behavior. Such prosocial behavior will be studied in the context of public good provision. We will use of real-time online technologies with inter-connected behavioral economics labs to investigate the effects of social structure on the diffusion of sustainable behavior. We will study both theoretically and experimentally how pressure towards conformism within local networks is expected to facilitate social influence, especially within clustered communities, which can boost cooperative behavior across the network.

#### References:

- Centola D. Considering network interventions. Proc Natl Acad Sci U S A. 2020 Dec 29;117(52):32833-32835. doi: 10.1073/pnas.2022584118. Epub 2020 Dec 21. PMID: 33376213; PMCID: PMC7776602.
- Guilbeault D, Centola D. Topological measures for identifying and predicting the spread of complex contagions. Nat Commun. 2021 Jul 20;12(1):4430. doi: 10.1038/s41467-021-24704-6. PMID: 34285206; PMCID: PMC8292353.
- Iacopini I, Petri G, Barrat A, Latora V. Simplicial models of social contagion. Nat Commun. 2019 Jun 6;10(1):2485. doi: 10.1038/s41467-019-10431-6. PMID: 31171784; PMCID: PMC6554271.
- K Khalvati, S A. Park, R Philippe, M Sestito, **J-C Dreher\***, and Rajesh P. N. Rao\*. Bayesian Inference of Other Minds Explains Human Decisions in a Group Decision Making Task, **Science Advances**, Vol. 5, no. 11, eaax8783, DOI: 10.1126/sciadv.aax8783 \*: co-last author (contributed equally), 2019
- S.A. Park, M Sestito, E D. Boorman and **J-C Dreher**. Neural computations underlying strategic social decision-making in groups, **Nature Communications**, 10:5287, 2019