Topics for internships-2018/2019

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1- **Innovation dynamics for the green revolution.**
The adoption of innovations in a population may be described as a dynamics over a network. Depending on the applications, researchers have looked into epidemic models (eg. SI), threshold models, or more complex game-theoretic models (eg http://www.pnas.org/content/107/47/20196).The task of the project would be to identify tractable models that are suitable to describe adoption phenomena in the context of the green energy transition and propose an analysis by means of both simulations and analytical methods. This research will focus on models for the market penetration of electric vehicles in collaboration with Mara Tanelli (Politecnico di Milano)

2- **Games of influence in social networks**.
Influence in social networks can be approximated by a linear diffusion process, where the sources are the influencers (Chap 5 in https://www.springer.com/it/book/9783319680217). Depending on the topology of the network, some nodes are more effective than others as influencers. When two opposite views are competing for influence over the network, a number of game-theoretic questions arise regarding, for instance, the optimal placement of sources. The task of the project would be to single out and address some of these questions.

3- **Transfer learning in multi-agent systems.**
Even though it may appear to belong nowadays to the realm of computer science, “learning” is among the core words of our control-theoretic heritage. For instance, in multi-robot systems, researchers have asked the question of how much a robotic learner can benefit from its fellow learners’ past experiences. The task of the project would be to revisit this literature, in the perspective of approaching the general problem of the sensitivity (to noise, to parameter uncertainties) of the answers that are obtained by learning techniques (https://onlinelibrary.wiley.com/doi/abs/10.1002/asjc.398, https://ieeexplore.ieee.org/abstract/document/8206342).

4- **Graphons: from data models to control systems for large-scale networks.**
Graphs provide a natural mathematical abstraction for the analysis of networks. However, as uncertainty permeates data-acquisition methods, and the size of the networks of interest continues to grow, traditional graph-based approaches are increasingly replaced by more flexible modeling paradigms. A promising framework in this regard is that of graphons, suitable continuous objects that are suitable mathematical limits of families of graphs. While the theory of graphons themselves is already well developed (http://web.cs.elte.hu/~lovasz/bookxx/hombook-almost.final.pdf), the study of “dynamics over graphons” (akin to the dynamics over graphs that have been studied by the control community in the last decade) is in its infancy. The goal of the project would be to translate known dynamics over graphs, such as averaging, network flows, or epidemics, into dynamics over graphons and thereby gain better insights on how to control them.

5- **Online closed-loop learning for optimal recommendations**.
Online platforms, such as Amazon, Facebook, Twitter, or YouTube, rely on recommender systems to provide their users with interesting and engaging contents. The appropriateness of this selection depends on the interests of the user, who is in turn influenced by the received recommendations (https://arxiv.org/abs/1809.04644). Despite the abundant literature on recommender systems, the design of an optimal recommender system *in this closed-loop dynamics* is an open problem, which this project intends to address.