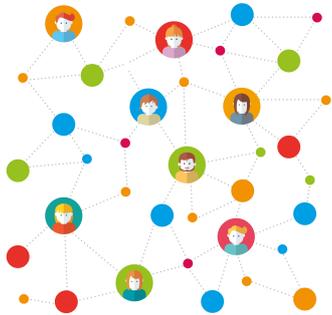


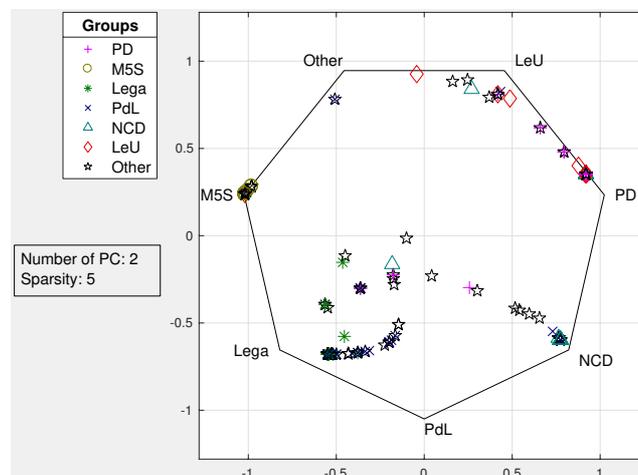
Thesis proposals on Social Dynamical Networks



In the last decades, the interest on the study of opinion formation in social networks and belief systems has constantly grown in various disciplines, including computer science, mathematics, physics, engineering science, economics, and social sciences. In fact, individual behaviors is often influenced by social relations with others and the understanding of these relations is the key to predict, analyze and control social systems. Mathematically, the arising complex networks can be represented by a graph, consisting in a set of nodes (agents) and a set of connections that reflect the dependency, influence or similarity relations. Each agent is endowed with a state, which evolves in discrete time can represent its belief or opinion. This evolution can be described by a dynamical system that takes into accounts the network structure.

❖ Thesis 1: Data-driven Identification of Influence in Social Networks

Goal of the thesis is to estimate the network structure and the strength of the relations and trust among agents starting from the observation of preferences. In particular, the thesis will focus on the analysis of the roll-call data in the Italian Senate. A recent thesis mined the key voting records of the Italian Senate during the XVII legislature in order to extract the hidden information about the closeness of senators to political parties, based on a parsimonious feature extraction method that selects the most relevant bills, and derived an information theoretic measure, which we refer to as *Political Data-analytic Affinity (Political DNA)*. The concept of **Political Map** was also introduced.

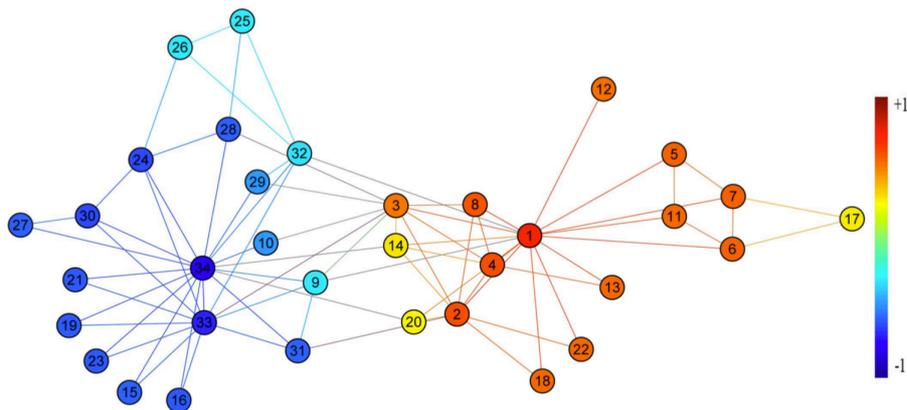


SENATORS	NOMINAL POLITICAL GROUP	Political DNA		
FRAVEZZI Vittorio	Per le Autonomie	0.8593		0.1204
CAMPANELLA Francesco	LeU	0.9926		
BRUNI Francesco	Noi con L'Italia	0.9046		0.0954
MARINO Ignazio Roberto Maria	PD	0.2215	0.3554	0.4231

In this thesis, the student will apply graph-based techniques to model and possibly predict the affinity between Senators. The goal is to obtain a representation of the network of influences of the Senators.

❖ **Thesis 2: Optimal Control of Dynamics over Networks**

The thesis focuses on a dynamical network model in presence of multiple competitors with different states and regular agents that adjust its state according to a distributed consensus protocol. The main goal of work is to design parsimonious controllers, acting on few nodes/edges only, in order to lead (a) the dynamics towards a desired pattern (b) qualitative changes to the limit profile (e.g., merge clusters together) (c) quantitative changes to some observable (e.g., average opinion, target nodes).



Bibliography:

- C. Ravazzi, R. Tempo, F. Dabbene, "Learning Political DNA in the Italian Senate", submitted.
- C. Castellano, S. Fortunato, V. Loreto, "Statistical physics of social dynamics"
- A. Proskurnikov, R. Tempo, "A Tutorial on Modeling and Analysis of Dynamic Social Networks. Part I"

- Additional material will be provided to complete the background.

Skills: Good mathematical background, Mathematical modeling, Basic signal processing, Convex optimization, Basic coding skills (MATLAB is enough).

Keywords: Compressed Sensing, System Identification, Systems Theory, Opinion dynamics, Social Networks, Sparse representation

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Advisors and Stage: The two thesis will be carried out under the supervision of the staff of the System and Modeling Control Group at the Institute of Electronics, Computer and Telecommunication Engineering of National Research Council of Italy (IEIT-CNR), in collaboration with Prof. Giuseppe Calafiore, Dept. of Electronic Engineering, Politecnico di Torino, and the association OpenPolis (www.openpolis.it).

National Research Council of Italy



Institute of Electronics,
Computer and
Telecommunication Engineering

