Centrality, influence, consensus, polarization in network models

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Lecture 1: Centrality, influence, consensus in network models: the global effect of local specifications.

Lecture 2: From opinion dynamics to randomized network algorithms.

Lecture 3: Fragility and resilience in centrality and consensus models.

Lecture 4: When consensus breaks down: influential nodes, dissensus, polarization.

Abstract: How can we measure the relevance of a single node or a family of nodes in a network? This issue has been much debated in the last years, due to the relevance that networks have acquired, not only in science and technology but also in everyday life. In these lectures, we will carry out a rigorous analysis of one of the most popular centrality measures in a network, which was first proposed by Bonacich and is now the basis for the popular web page rank measure. This measure lends itself to two natural dynamic interpretations. On the one hand, it corresponds to the weight values that determine the consensus point of linear average dynamics. On the other hand, it represents the fraction of time spent in a node by a random walker along the network. In this short course, we will review all the basic concepts related to centrality measures, average consensus and random walk on graphs. We will consider a variety of average dynamical models, both in the context of opinion dynamics (DeGroot model) and of sensor/computer networks (cooperative inferential algorithms such as average gossip and broadcasting). We will investigate how the centrality measure and the average dynamic models are affected by perturbations in the network, both of stochastic and deterministic nature. We will devote particular attention to how the modification of a local part of the network affects its overall behavior. Finally, we will consider models with influential units (as media or leaders in social networks) whose dynamics is exogenously determined. We will review recent results that show how, in these models, phase transition phenomena happen in situations of quasi-consensus as well as when opinions are highly polarized. A concept of resilience of a large-scale network to local (but possibly not small) perturbations will finally emerge and complete the picture.

A short bibliography of the author on the content of these four lectures:

1. D. Acemoglu, G. Como, F. Fagnani, and A. Ozdaglar, "Opinion fluctuations and disagreement in social networks", Math. Oper. Res., vol. 38, no. 1, pp. 1-27, 2013.

2. G. Como, F. Fagnani, "From local averaging to emergent global behaviors: The fundamental role of network interconnections", Systems and Control Letters, vol. 95, pp. 70-76, 2016.

3. G. Como, F. Fagnani, "Robustness of large scale stochastic matrices to localized perturbations", IEEE Trans. of Network Science and engineering, vol. 2 (2), pp. 53-64, 2015.

4. F. Fagnani, J.-C. Delvenne, "The robustness of democratic consensus", Automatica, vol. 52, pp. 232-241, 2015.

5. F. Fagnani, S. Zampieri, "Randomized consensus algorithms over large scale networks", IEEE J. Selected areas in communications, vol. 26, pp. 634-649, 2008.