

Centrality in interconnected multilayer networks: mathematical formulation of node versatility and its applications

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The determination of the most central agents in complex networks is important because they are responsible for a faster propagation of information, epidemics, failures and congestion, among others. A challenging problem is to identify them in networked systems characterized by different types of interactions, forming interconnected multilayer networks. Here we describe a mathematical framework that allows us to calculate centrality in such networks and rank nodes accordingly, finding the ones that play the most central roles in the cohesion of the whole structure, bridging together different types of relations. These nodes are the most versatile in the multilayer network.

We then present two applications. First, we propose a method based on the analysis of bipartite interconnected multilayer networks of citations and disciplines, to assess scholars, institutions and countries interdisciplinary importance. Using data about physics publications and US patents, we show that our method allows to reward, using a quantitative approach, scholars and institutions that have carried out interdisciplinary work and have had an impact in different scientific areas.

Second, we investigate the diffusion of microfinance within rural India villages accounting for the whole multilayer structure of the underlying social networks. We define a new measure of node centrality on multilayer networks, diffusion versatility, and show that this is a better predictor of microfinance participation rate than previously introduced measures defined on aggregated single-layer social networks. Moreover, we untangle the role played by each social dimension and find that the most prominent role is played by the nodes that are central on the layer representing medical help ties, shedding new light on the key triggers of the diffusion of microfinance.

References

- [1] M. De Domenico, A. Solé-Ribalta, E. Omodei, S. Gómez, and A. Arenas. "Ranking in interconnected multilayer networks reveals versatile nodes." *Nature communications*, 6, 6868 (2015)
- [2] E. Omodei, M. De Domenico, and A. Arenas. "Evaluating the impact of interdisciplinary research: a multilayer network approach." arXiv:1601.06075 (2016)
- [3] E. Omodei and A. Arenas. "Untangling the role of diverse social dimensions in the diffusion of microfinance." *Under review*.