

Multilayer networks: from disease spreading to ecosystems

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Multilayer networks are a new paradigm in the study of complex interconnected systems, as they allow to cast into a single framework the complex topological and dynamical interdependencies between different networked systems. In this talk, we first provide a brief overview of what is the state-of-the-art in network science, paying special attention to multilayer networks. Then, in order to discuss some specific case studies, we show that the recently developed framework of multilayer networks allows to tackle many of the existing challenges in the study of multi-scale diseases [1, 2], ranging from interacting diseases to new phenomena like disease localization, see Fig. 1. Finally, we discuss ecological networks and abandon the mean field hypothesis to show, through a dynamical population model and numerical simulations, that viewing mutualistic systems as a multilayer network unravels, as seen in Fig. 2, an intricate relation between competition and mutualism[3].

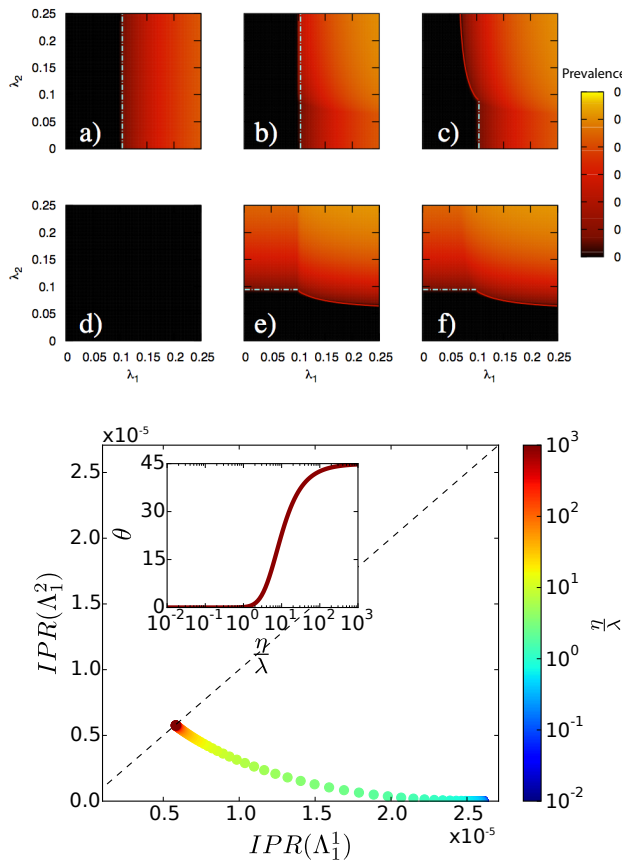


Figure 1: (Top) Phase diagram of the incidence of two interacting diseases for the case of homogeneous networks and (bottom) localization effect in the spreading of diseases in multilayer networks.

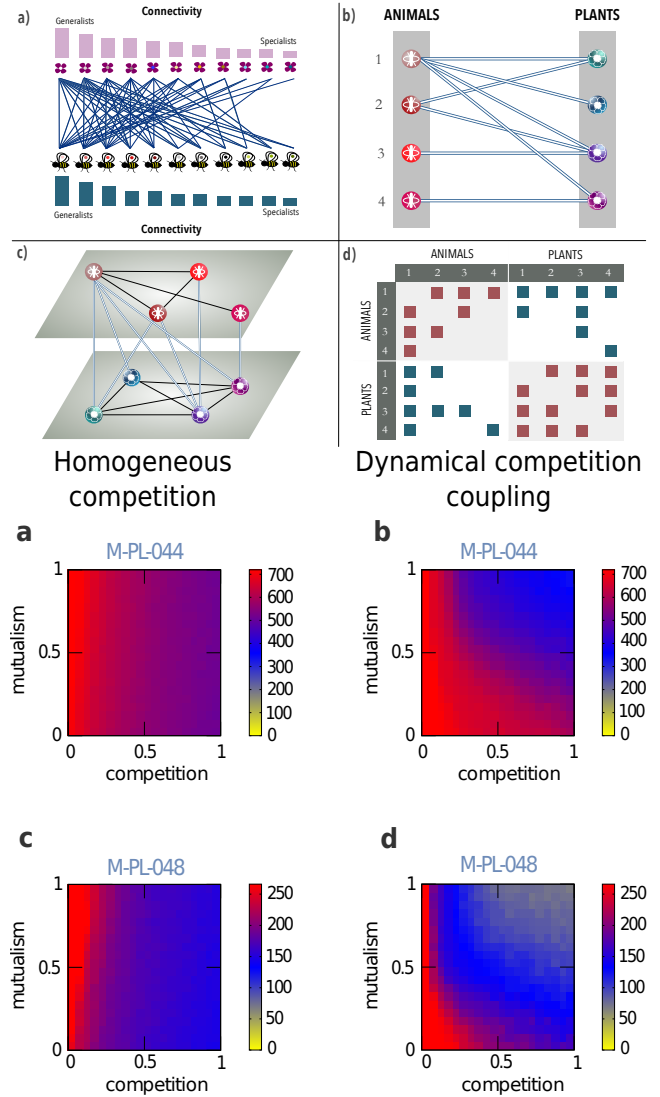


Figure 2: (Top) Representation of Mutualistic Systems as Multilayer Networks and (bottom) Biodiversity as a function of mutualism and competition intensities.

- [1] J. Sanz, C.-Y. Xia, S. Meloni and Y. Moreno, "Dynamics of interacting diseases", *Physical Review X* 4, 041005 (2014).
- [2] G. Ferraz de Arruda, E. Cozzo, T. P. Peixoto, F. A. Rodrigues, and Y. Moreno, "Disease Localization in Multilayer Networks", *Physical Review X* 7, 011014 (2017).
- [3] C. Gracia-Lázaro, L. Hernández, J. Borge-Holthoefer, and Y. Moreno, "The joint influence of competition and mutualism on the biodiversity of mutualistic ecosystems", preprint: <https://arxiv.org/abs/1703.06122> (2017).