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The Laplacian Renormalization Groups (LRG) unveils the structural organization of heterogeneous networks

Heterogeneous and complex networks represent the intertwined interactions between real-world elements or agents. Determining the multi-scale mesoscopic organization of clusters and intertwined structures is still a fundamental and open problem of complex network theory. By taking advantage of the recent Laplacian Renormalization Group [1-4] approach , we scrutinize information diffusion pathways throughout networks to shed further light on this issue. Based on inter-node communicability, our definition provides a clear-cut framework for resolving the multi-scale mesh of structures in complex networks, disentangling their intrinsic arboreal architecture. As it does not consider any topological null-model assumption, the LRG naturally permits the introduction of scale-dependent optimal partitions and determines the existence of a particular class of nodes, called “metastable” nodes, that switching regions to which they belong at different scales, are expected to play a central role in the communication between them and, therefore, in managing macroscopic effects of the whole network [5].

[1] P Villegas, T Gili, G Caldarelli, A Gabrielli, Laplacian renormalization group for heterogeneous networks, Nature Physics 19 (3), 445-450 (2023) [2] P Villegas, A Gabrielli, F Santucci, G Caldarelli, T Gili, Laplacian paths in complex networks: Information core emerges from entropic transitions, Physical Review Research 4, 033196 (2022) [3] A. Gabrielli, D. Garlaschelli, S. Patil, M. A. Serrano, Network Renormalization, https://arxiv.org/abs/2412.12988, to appear on Nature Review Physics (2025). [4] A. Poggialini, P. Villegas, M.A. Munoz, A. Gabrielli, Networks with Many Structural Scales: A Renormalization Group Perspective, Phys. Rev. Lett. 134, 057401 (2025) [5] P. Villegas, A. Gabrielli, A. Poggialini, T. Gili, Multi-scale Laplacian community detection in heterogeneous networks, Phys. Rev. Res. 7, 013065 (2025)

Role

Professor/PI

Primary author(s) : Prof. GABRIELLI, Andrea (Department of Civil, Computer Science and Aeronautical Technologies Engineering, University “Roma Tre”)

Presenter(s) : Prof. GABRIELLI, Andrea (Department of Civil, Computer Science and Aeronautical Technologies Engineering, University “Roma Tre”)