

A comparison of community-aware centrality measures in online social networks

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Identifying influential nodes is a fundamental task for amplifying or hindering any spreading phenomena. Community-aware centrality measures exploit the community structure to address this issue. More precisely, local measures based on intra-community links focus on the impact of a node in its community. In contrast, global ones rely on inter-community links to characterize a node's global influence. These measures differ in the way they handle the two link types. A community-aware centrality measure could emphasize the ability of nodes to link multiple communities, while another might target local hubs rather than bridges between communities. Previously, we looked at the correlation between classical and community-aware centrality measures and their relation to network topology [1]. Results show that the correlation between community-aware and classical centrality measures is very sensitive to the community structure strength. This work goes one step further. We compare the effectiveness of various community-aware centrality measures in an epidemic-spreading scenario. Considering the Susceptible-Infected-Recovered (SIR) spreading process, we perform extensive simulations on a set of ten online social networks and seven influential community-aware measures (Comm Centrality, Community-based Mediator, Community Hub-Bridge, K-shell with Community-, Community-based Centrality, Participation Coefficient, and Modularity Vitality). Results show that K-shell with Community and Community-based Centrality are the best performers in a single-spreader setting. Indeed, they have the lowest imprecision function (Figure 1 - Top). In other words, they predict more accurately the influential nodes compared to the nodes' ground truth spreading power. Additionally, Community-based Mediator performs better in networks with a weak community structure. Finally, results are generally insensitive to the variation of the SIR transmission rate (Figure 1 - Bottom). This study gives clear indications about the effectiveness of prominent community-aware centrality measures in a single-spreader scenario.

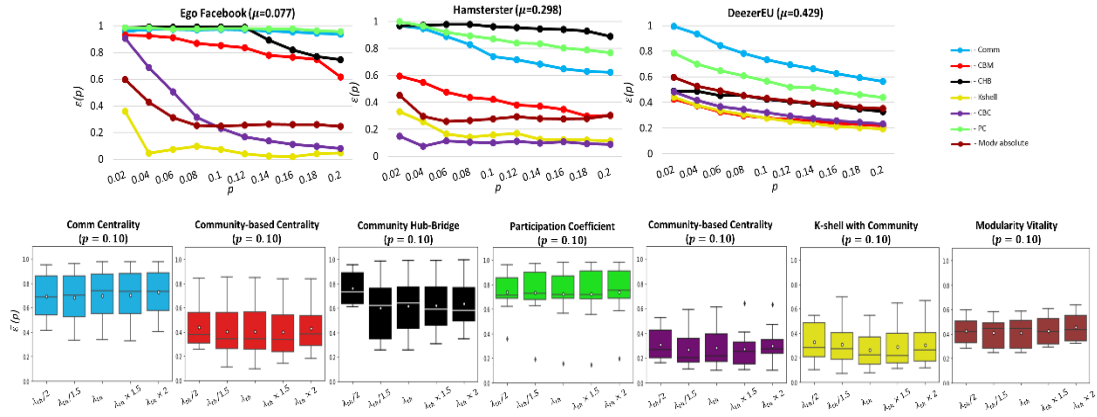


Figure 1: The top figures show the performance of the seven community-aware centrality measures based on the imprecision function $\varepsilon(p)$ which quantifies their predictive power in identifying influential nodes of top p nodes on 3 online social networks. The bottom figures show the average imprecision function $\bar{\varepsilon}(p)$ of each of the seven community-aware centrality measures as a function of different transmission rates set based on the epidemic threshold of the ten online social networks (λ_{th}).

References

[1] Rajeh, S., Savonnet, M., Leclercq, E. et al. Characterizing the interactions between classical and community-aware centrality measures in complex networks. Sci Rep 11, 10088 (2021).