

# Entropy-Driven Structural Influence in Social and Educational Networks: A Platform-Independent Framework for Hidden Influencers and Knowledge Mediators

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## Abstract

Identifying influential nodes in social networks is a central challenge in network science, with applications ranging from marketing and opinion diffusion to information resilience and epidemiology. Traditional approaches predominantly rely on centrality measures, such as degree, betweenness, or spectral methods, which focus on connectivity patterns but often fail to capture the deeper structural heterogeneity in network environments. In parallel, information-theoretic methods, including graph entropy and Shannon entropy formulations, have been applied to characterize network complexity and diffusion dynamics, but their integration into node influence quantification remains limited.

In this work, we introduce a platform-independent, entropy-driven definition of structural influence based on the k-hop neighborhood entropy of nodes, formalizing influencers as nodes whose local structural uncertainty is maximized relative to their surrounding topology. Building on our recent hybrid entropy metrics for k-hop environment analysis in complex networks [1, 2] and related Shannon-entropy approaches from social network analysis literature [3], we develop a theoretical framework that distinguishes structural influence from traditional centrality- and

diffusion-based notions of influence.

We analyze the proposed entropy-driven influence measure on generative network models, including Erdős–Rényi, small-world, and stochastic block models, and demonstrate that the measure highlights hidden influencers—nodes with moderate degree but high structural entropy—that remain undetected by classical metrics. We further position our framework relative to recent entropy-based influencer detection methods and structural entropy indices in social networks, including community-based structural entropy approaches [7] and entropy-augmented influence identification techniques [8].

Beyond social networks, we argue that the proposed notion of entropy-driven structural influence naturally extends to educational and learning networks, where nodes represent learners and edges capture interaction, collaboration, or knowledge exchange. In this context, entropy-maximizing nodes correspond to *knowledge mediators*: participants who connect structurally diverse learning communities and facilitate knowledge diffusion without necessarily exhibiting high activity or performance. This interpretation establishes a methodological link between entropy-based network analysis and learning analytics [4–6].

By providing a formal, information-theoretic, and platform-agnostic foundation for identifying influencers and knowledge mediators, this work opens new avenues for both theoretical and applied research in complex social and educational systems.

## References

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