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The Hubbard Model in Social Networks: Understanding Opinion Dynamics Through Many-Body Interactions

The Hubbard model, originally formulated to describe electron interactions in lattices, provides a powerful framework for understanding collective phenomena in complex systems. In this work, we adapt the Hubbard model to the study of social networks, drawing parallels between quantum many-body interactions and the dynamics of opinion formation, influence propagation, and polarization. The hopping term (t) represents the probability of individuals adopting or influencing opinions within their social connections, while the on-site interaction (U) models internal cognitive resistance to change. By incorporating external stimuli as driving forces, we explore phase transitions in social structures, such as consensus formation, polarization, and fragmentation. Furthermore, we investigate the impact of network topology—ranging from sparse, scale-free structures to fully connected networks—on the emergent collective behaviors. Using numerical simulations and analytical techniques, we analyze how variations in hopping strength and cognitive resistance influence stability and bifurcations in opinion dynamics. This adaptation offers insights into designing more effective interventions for mitigating polarization and enhancing information diffusion in social systems. The Hubbard model adaption provides a richer framework by including both local stability (U) and social dynamics (t), if we compare with other models that already have been investigating the behaviour of social systems.

Primary author: NIKAJ, Klotilda (University of Shkodra ”Luigj Gurakuqi”)

Presenter: NIKAJ, Klotilda (University of Shkodra ”Luigj Gurakuqi”)