NetSciX2026: International School and Conference on Network Science
February 17th-20th, 2026 - Auckland, New Zealand

Predicting higher-order spreading dynamics with unknown topology

Keywords: *Prediction, Spreading dynamics, Higher-order networks, Unknown topology, Machine Learning*

Extended Abstract

The study of dynamical processes in networked systems is fundamental in complexity science. Examples include the propagation diseases in complex networks and synchronization in coupled oscillator networks. The dynamical processes on networks are determined by two independent parts: the topological structure of the network and the fundamental physical rule that governs the system. One of the crucial challenges in the study of dynamical processes is the prediction of future dynamics on networks. Additionally, the majority of real-world network topologies is complicated, and a sufficiently accurate network reconstruction is a difficult task [1]. These factors further complicate the accurate prediction of complex system dynamics.

Moreover, the higher-order interactions among nodes, which have been found in a wide range of systems in recent years, such as the nets connecting multiple modules in circuits, further complicate accurate prediction of dynamics on hypergraphs. In this work [2][3], we propose a two-step method called the topology-agnostic higher-order dynamics prediction (TaHiP) algorithm. The observations of nodal states of the target hypergraph are used to train a surrogate matrix, which is then employed in the dynamical equation to predict future nodal states in the same hypergraph, given the initial nodal states. TaHiP outperforms three latest Transformer-based prediction models in different real-world hypergraphs. Furthermore, experiments in synthetic and real-world hypergraphs show that the prediction error of the TaHiP algorithm increases with mean hyperedge size of the hypergraph, and could be reduced if the hyperedge size distribution of the hypergraph is known.

References

[1] B. Prasse and P. Van Mieghem, “Predicting network dynamics without requiring the knowledge of the interaction graph,” Proceedings of the National Academy of Sciences, vol. 119, no. 44, p. e2205517119, 2022.

[2] Z. Zhou, C. Li, P. Van Mieghem, X. Li, “Predicting higher-order dynamics with unknown hypergraph topology”, IEEE Transactions on Circuits and Systems I: Regular Papers, 2025, DOI: 10.1109/TCSI.2024.3513406.

[3] Z. Zhou, C. Li, B. Qu, and X. Li, “Predicting higher-order dynamics without network topology by ridge regression,” in Proceedings of the IEEE International Symposium on Circuits and Systems, 2024.

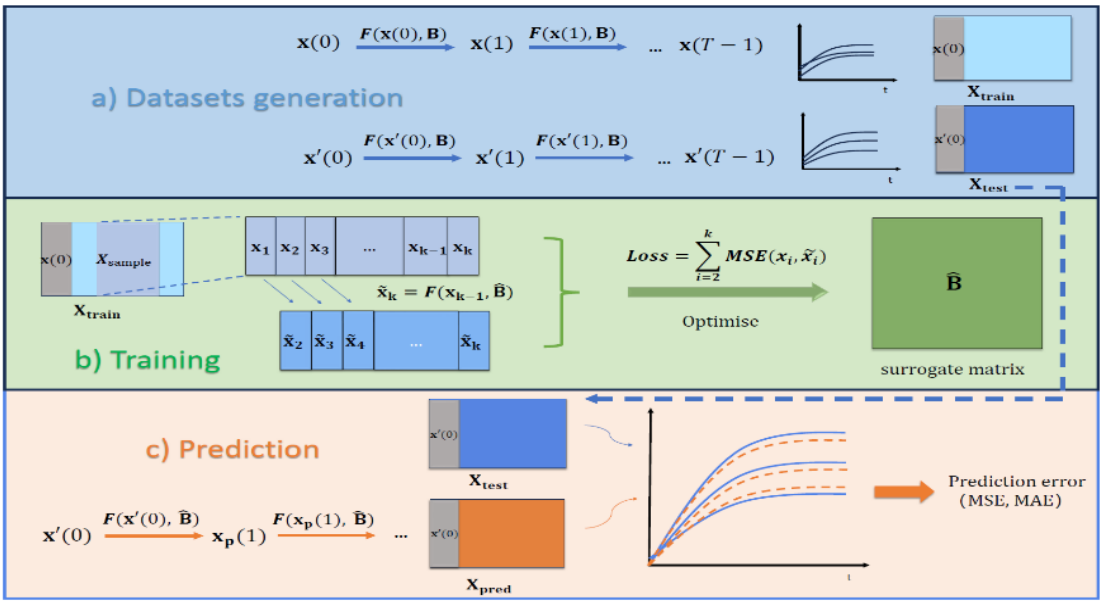

Figure 1. TaHiP architecture