

Biomass' flow modelling in ecological networks with higher order interactions

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The motivation of this talk is the broad research area of ecological network modelling. The research topics evolved from describing a food web as undirected tree, through the notions of (directed and undirected) multiplexes, networks of networks, and finally hypergraphs. Based on that structures one defines operators such as adjacency matrix or graph Laplacian to examine the dynamics of underlying ecosystem.

In this talk we elaborate on two questions.

1. What is the proper definition of digraph advection operator?

We show the construction that explains the relation between the first derivative operator and certain advection matrix. Furthermore, we examine the relation between their spectrum.

2. How to include the higher order interactions into the classical hypergraph model?

We modify the notion of diubergraph, defined first in [1], and interpret it in the context of food web modelling. Explaining imprecisely, diubergraph is the network structure that introduces relation between edges themselves, by introducing so called diuberedges. We examine basic properties of the new structure in comparison to dihypergraph.

As the conclusion we present the results on the coffee agroecosystem model showing the differences in dihypergraph and diubergraph approach.

The presentation is based two articles, [2] and [3]. The part of the research presented in this talk is a joint work with Mateusz Iskrzyński, Aleksanda Grzelik and Marjeta Kramar-Fijavž.

References

- [1] C. Joslyn, E.K. Nowak, *Ubergraphs: A definition of a recursive hypergraph structure.*, arXiv: abs/1704.05547 (2017).
- [2] A. Grzelik, M. Iskrzyński, G. Mutlu and A. Puchalska, *Ubergraphs as models of higher-order interactions in ecosystems*, in preparation
- [3] A. Puchalska et al., *Journey through the world of dynamical systems on networks*, preprint: https://mat-dyn-net.eu/uploads/documents/20240416/document_1760207217.pdf

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