

Modelling Interactions in Complex Systems: From Graphs to Simplicial Complexes

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Abstract

Complex systems consist of interacting units whose collective behaviour exhibits properties such as emergence, adaptability, and nonlinearity. In many systems, such as the human brain, social systems, and ecosystems, interactions are not only pairwise but can involve more than two units simultaneously, leading to higher-order interactions.

In this talk, we introduce some mathematical objects used to model such interactions. We begin with graphs used to model pairwise interactions and discuss some basic graph concepts such as adjacency relations, adjacency matrices, and degree distributions. We then extend some of these ideas to simplicial complexes, which model higher-order interactions present in the systems. We also explain how graphs can be viewed as one-dimensional simplicial complexes. This talk aims to provide the basic background needed to understand modern research on higher-order interactions in complex networks.