Beyond Mean-Field Theory: Interacting Processes on Sparse Graphs

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Large collections of randomly evolving particles that interact locally with respect to an underlying graph model a variety of phenomena ranging from magnetism, the spread of diseases, and neural and neuronal networks. Due to their high-dimensional nature, such interacting particle systems are typically intractable to analyze exactly. Classical work, falling under the rubric of mean-field limits, has mostly focused on the case when this interaction graph is complete or dense. However, most real-world networks are sparse and often random. We survey recent results that develop a rigorous mathematical framework for the asymptotic characterization of interacting processes on sparse graphs. The analysis requires a combination of tools from graph theory, combinatorics, partial differential equations, stochastic calculus and large deviations

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