Special Issue

Inferring Interactions from Spatial Patterns and Trajectories: An Overview from Quasiparticles to Biological Movement

Message from the Guest Editor

For many systems consisting of a group of interacting particles in motion, we often have experimental access only to measure (i) a part of the individual trajectories, and/or (ii) the spatial distribution of the group at particular times, but not the corresponding Hamiltonian/rules of interaction between individuals. Researchers then need to face the inverse problem of how to infer such rules from the partial observations available. There is a wide diversity of systems falling within this category, both physical (e.g., skyrmions, phonons, microbeads, or other quasiparticles or particles partially driven through thermal or external noise) and biological (e.g., in the analysis of single-cell trajectories or animal tracking). Due to the ubiquity of the problem, a large amount of learning/inference methods (based on Bayesian inference, information theory, machine learning, network theory, etc.) have been developed. The present issue is intended to provide both (i) an overview of the present state of the art, and (ii) some of the recent advances, in the field. Ideally, we want to illustrate the utility, range of application and advantages/disadvantages of the existing techniques.

Guest Editor

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The concept of entropy is traditionally a quantity in physics that has to do with temperature. However, it is now clear that entropy is deeply related to information theory and the process of inference. As such, entropic techniques have found broad application in the sciences.

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