Topology of Random Spaces

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Project description:

Understanding the structures which arise in random systems is important across many branches of mathematics and applications. Stochastic topology is one area which studies the topological properties of these structures. The structures may span the system (global) or may consist of small structures (local). Motivated by problems in topological data analysis, at the intersection of random systems and algebraic topology, stochastic topology is the area of study to understand the emergence of higher dimensional structures in random systems in geometric settings.

This has applications to many areas of science. A common approach is to model relationships by combinatorial structures, such as graphs, or for higher order interactions, simplicial complexes. Inferring these relationships is often difficult and error-prone, e.g. noisy. This uncertainty, as well as the lack of detailed models, e.g. unknown coefficients in mathematical relationships, makes topology a good approach to understanding its qualitative structure. Additionally, these structures are often the product of random processes, requiring a good understanding of what structures are the result of randomness and which models are the result of underlying structure.

The goal of this project is to understand the topological structures which appear in “null” models – models which only have randomness. This has been found to depend heavily on the geometry of the underlying space. This includes spaces such as Euclidean space (which arise in spatio-temporal data) and less familiar spaces such as “tree-like” spaces which arise in genetics. A key outcome of a better understanding of null models would be to develop tests which allow us to better understand which structures are significant in real-world datasets. As a foundational project, it is also applicable to the area of Data-centric engineering as it is a new approach to quantifying the fidelity of digital twins.

Further information:

How to apply

Entry requirements

Fees and funding