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New invariants for multi-parameter persistent homology

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Topological data analysis (TDA) is a field that lies at the intersection of data analysis, algebraic topology, computational geometry, computer science, and statistics. The main goal of TDA is to use ideas and results from geometry and topology to develop tools for studying qualitative features of data. One of the most successful methods in TDA is persistent homology (PH), a method that stems from algebraic topology, and has been used in a variety of applications from different fields, including robotics, material science, biology, and finance.

PH allows to study qualitative features of data across different values of a parameter, which one can think of as scales of resolution, and provides a summary of how long individual features persist across the different scales of resolution. In many applications, data depend not only on one, but several parameters, and to apply PH to such data one therefore needs to study the evolution of qualitative features across several parameters. While the theory of 1-parameter persistent homology is well understood, the theory of multi-parameter PH is hard, and it presents one of the biggest challenges of TDA.

In this talk I will briefly introduce persistent homology, give an overview of the complexity of the theory in the multi-parameter case, and then discuss how tools from commutative algebra give invariants able to capture homology classes with large persistence.

No prior knowledge on the subject is assumed.

This talk is based on joint work with Heather Harrington, Henry Schenck, and Ulrike Tillmann.