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Research field: Topology, differential geometry, applied mathematics

Key words: Microlocal sheaf theory, symplectic geometry, topological data analysis, persistent homology

Present research: I am interested in the application of microlocal sheaf theory to geometry. Developed by Kashiwara and Schapira in the 1980s, this theory enables us to analyze sheaves on manifolds microlocally (= locally in cotangent bundles) by considering their directional singularities. While it has been effectively used for linear partial differential equations and singularity theory, it also found various applications in symplectic geometry since the mid-2000s. Moreover, the relationship between microlocal sheaf theory and persistent homology has also been investigated since the 2010s.

In this context, I am studying symplectic geometry with techniques developed in the analysis of the relationship between microlocal sheaf theory and persistent homology. In particular, I have been interested in applying a sheaf-theoretic version of the interleaving distance, the distance between persistent homology, to quantitative problems in symplectic geometry. Recently, I have been trying to develop symplectic geometry for singular objects using a sheaf-theoretic approach.

In addition to the above research, I am also applying persistent homology and geometric methods to data analysis and machine learning. In particular, I am interested in topological control of learning by optimizing persistent-homology-based loss functions.

Notice for the students:

1. It is desirable that students become familiar with the basics of geometry (manifolds, vector bundles, differential forms, cohomology, etc.) before entering graduate school. I also suggest that they learn about other topics during undergraduate courses.
2. I hope you find a research topic that you find truly interesting. It does not need to match your advisor's research topics. Rather, I would like you to be familiar with your research field so that you can teach your advisor.
3. Try to study and research with a broad perspective and improve the skill to explain things to people with different specialties in an understandable way. These abilities should be beneficial for you in the future.