Mathematics > Algebraic Topology

Multidimensional Interleavings and Applications to Topological Inference

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This work concerns the theoretical foundations of persistence-based topological data analysis. We develop theory of topological inference in the multidimensional persistence setting, and directly at the (topological) level of filtrations rather than only at the (algebraic) level of persistent homology modules.

Our main mathematical objects of study are interleavings. These are tools for quantifying the similarity between two multidimensional filtrations or persistence modules. They were introduced for 1-D filtrations and persistence modules by Chazal, Cohen-Steiner, Glisse, Guibas, and Oudot. We introduce generalizations of the definitions of interleavings given by Chazal et al. and use these to define pseudometrics, called interleaving distances, on multidimensional filtrations and multidimensional persistence modules.

We present an in-depth study of interleavings and interleaving distances. We then use them to formulate and prove several multidimensional analogues of a topological inference theorem of Chazal, Guibas, Oudot, and Skraba. These results hold directly at the level of filtrations; they yield as corollaries corresponding results at the module level.

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