Topology of spatiotemporal trajectories

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Many processes in the life sciences are inherently multi-scale and dynamic. Spatial structures and patterns vary across levels of organisation, from molecular to multi-cellular to multi-organism. With more sophisticated mechanistic models and data available, quantitative tools are needed to study their evolution in space and time. Topological data analysis (TDA) provides a multi-scale summary of data. Recent work by Kim and Memoli introduced an interlevel Rips filtration for the case of dynamic metric spaces, requiring three parameter persistence. In-progress work by Lesnick, Bender and Gäfvert combines F4 and F5 Groebner bases algorithms to compute minimal presentations of multiparameter persistence. Here we build on this work and present an algorithm, GBlandscapes, which computes 3-parameter persistent homology landscapes. We highlight its utility with concrete case studies of spatio-temporal trajectories arising in biological systems.

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