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Extending Morse-Forman Theory Through Combinatorial Dynamics

The classical Morse theory studies the geometrical and topological properties of a manifold on which is defined a real-valued smooth function. Essentially, it states the critical points of the given function may be used to compute the homology of the manifold and to describe its global shape. In the late 1990s, Forman proposed a variant of the theory which follows the same ideas but applies to discrete topological spaces, such as cell complexes, rather than smooth manifolds. In the decade that followed, many applications in topological data analysis, notably in persistent homology, were derived from Morse-Forman theory.

In this presentation, we see how combinatorial dynamics, extensively developed in recent years, may be used to generalize Morse-Forman theory to spaces on which is defined a vector-valued function. This extension of the theory could eventually be of use in the topological analysis of multivariate data, mainly for optimizing the computation of multiparameter persistent homology.