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Persistent Homology: A roadmap in Topological Data Analysis

Persistent Homology provides a powerful framework for extracting robust topological features from data. In this course, we will introduce the foundational concepts underlying the theory, beginning with simplicial complexes constructed from point clouds, such as Čech and Vietoris–Rips complexes, and their associated filtrations. We will then review simplicial homology and show how it enables the passage from filtered simplicial complexes to persistent homology modules. Next, we will discuss how these modules decompose to yield persistence barcodes and in what sense these barcodes encode the underlying geometric and topological structure of the initial data. Time permitting, we will conclude with a proof of the stability of the full pipeline, from data to barcodes, establishing its 1-Lipschitz continuity.

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