Brain Image Analysis Seminars

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Introduction to Persistent Homology and Its Application to Brain Network Analysis

April 10, 2018 9:30am Medical Science Center 4765

Abstract: Persistent homology quantifies the persistent topological features of a topological space including a network at multiscales. These days, the persistent homology is widely used for modeling threshold-free brain networks. In this talk, I would like to introduce the persistent homology and its various representations such as Rips filtration, barcodes, and persistence diagrams. The barcodes and persistence diagrams visualize the evolutionary changes of topological features such as the Betti numbers over different network thresholds. By incorporating additional geometric information to the barcode, the single linkage dendrogram and single linkage matrix can be obtained. They show the overall changes of the connected structure of the network. I will also talk about network distances such as Gromov-Hausdorff, bottleneck and kernel distances based on the persistent homology. I will also show how the persistent homology can be applied to brain network analysis.

Detection of Abnormal Holes and Integration of Multimodal Networks via Persistent Homology

April 12, 2018 9:30am Medical Science Center 4765

Abstract: In this talk, I will introduce our recent works of brain network analysis based on persistent homology. I will present a new method to extract abnormal holes, which are another representation of network shape. While the modular structure of a brain network has been widely studied, the hole structure, which is the second most important topological feature in the persistent homology, is rarely used for brain network analysis. Our proposed method detect abnormal holes using the kernel density of a persistence diagrams, and localized the abnormal holes using the Hodge Laplacian. I will show that the abnormal holes characterize the network inefficiency during the progression of Alzheimer's disease. I will also give a new integrated multimodal network approach based on multidimensional persistent homology. Finding underlying relationships among multiple imaging modalities in a coherent fashion is one of the challenging problems in multimodal analysis. Our proposed method visualize and discriminate the topological change of integrated brain networks by changing not only the network threshold but also mixing ratio between two imaging modalities of PET and MRI.

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