Aggarwal _ 2019 ML-MSM Meeting - Abstract Submission Form

Title: Topological data analysis applied to pancreatic-islet architecture

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Abstract Text:

The arrangement of alpha-, delta-, and beta- cells in pancreatic islets influences communication and paracrine signaling within the islet. This functional significance suggests that the arrangement is not random. It has been observed in mouse islet architecture that the alpha-cells are normally located in the periphery of the islets but, in diabetic islets, many are found in the interior as well. This motivates us to determine topological features of islet architecture which may be altered in disease states such as different forms of diabetes.

In this work, we automated the process of extracting structural features from spatial data by using persistent homology (PH). An advantage of PH is that it analyzes the data across multiple scales and extracts the structural features of different dimensions as the observation scale changes. This multiscale perspective of the topological structure of the data is summarized as persistent diagrams. We have developed our own code to compute PH that allows incorporation of biological information, for example, defining properties of the different cell-cell interactions in the islet. Hence, the multiscale topological analysis of the data is driven by the underlying biology.

In addition to obtaining a multiscale perspective of the topological features, we were also able to compute the number of beta-cells surrounded by alpha-delta mantles using PH. Analysis of the data shows that the population average difference in the number of beta-cells surrounded by alpha-delta mantles between diabetic and non-diabetic islets is not significant. We are now analyzing the persistent diagrams using unsupervised learning to determine possibly significant differences in multiscale topological properties between control and diabetic groups.