MICHIGAN STATE UNIVERSITY
Department of Statistics and Probability

COLLOQUIUM

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Geometric Methods for Image-based Statistical Analysis of Brain Tumors

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Abstract

Biomedical studies are a common source of rich and complex imaging data. The statistical analysis of such datasets requires novel methodological developments due to two main challenges: (1) the functional nature of the data objects under study, and (2) the nonlinearity of their representation spaces. In this work, we consider the task of quantifying and analyzing two different types of tumor heterogeneity. The first type, which is represented by a probability density function, summarizes the tumor's texture information. We use the nonparametric Fisher-Rao Riemannian framework to develop intrinsic statistical methods on the space of probability density functions for summarization and inference. The second type, which is represented by a parameterized, planar closed curve, captures the tumor's shape information. A key component of analyzing tumor shapes is a suitable metric that enables efficient comparisons, provides tools for computing descriptive statistics and implementing principal component analysis on the tumor shape space, and allows for a rich class of continuous deformations of tumor shape. We demonstrate the utility of our framework on a dataset of Magnetic Resonance Images of patients diagnosed with Glioblastoma Multiforme, a malignant brain tumor with poor prognosis. This work was done in collaboration with my PhD student Abhijoy Saha, as well as colleagues Karthik Bharath (University of Nottingham), Veera Baladandayuthapani (University of Michigan) and Arvind Rao (University of Michigan).