University of California, Irvine
Statistics Seminar

Learning Temporal Evolution of Spatial Dependence from Dynamic Covariance Matrix to Time-dependent Spatial Kernel

Shiwei Lan
Arizona State University

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(Bldg. #314 on campus map)

We are living in an era of data explosion usually featured with `big data' or `big dimension'. However, there is another big challenge in data science that we cannot ignore { complex relationship. Spatiotemporal data are ubiquitous in our life and have been a trending topic in the scientific community, e.g. the dynamic brain connectivity study in neuroscience. There is usually complicated dependence among spatial locations and such relationship does not necessarily stay static over time. The temporal evolution of spatial dependence (TESD) is often of scientific interest in understanding the underlying mechanism behind natural phenomena such as cognition and disease progression. In this talk, I will introduce two novel statistical methods to learn TESD in various applications. The first is a semi-parametric method modeling TESD as dynamic covariance matrices [1]. A spherical product representation of covariance matrix is introduced to ensure its positive-definiteness along the process. An efficient MCMC algorithm based on the representation is implemented for Bayesian inference. The second is a fully nonparametric generalization of the first model based on spatiotemporal Gaussian process (STGP) [2]. It further enables scientists to extend the learned TESD to new territory where there are no data. While classic STGP with a covariance kernel separated in space and time fails in this task, I propose a novel generalization to introduce the time-dependence to the spatial kernel that can effectively and efficiently characterize TESD. The utility and advantage of the proposed methods will be demonstrated by a number of simulations, a study of dynamic brain connectivity and a longitudinal neuroimaging analysis of Alzheimer's patients.

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