THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

PhD Dissertation Presentation

Soham Bonnerjee
Department of Statistics
The University of Chicago

"Gaussian approximations for dependent data"

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Abstract

This thesis develops sharp Gaussian approximation theory for dependent data, with emphasis on non-stationary time series and modern machine learning algorithms. The first part establishes strong invariance principles and explicit Gaussian constructions for broad classes of stationary and non-stationary processes, together with applications to change-point detection and inference, simultaneous confidence bands, and wavelet-based inference. The second part extends this viewpoint to iterative learning systems, deriving refined Gaussian and asymptotic approximations for decentralized federated learning and Q-learning under non-classical dependence and non-stationarity. For federated learning, such strong approximation results naturally extend to a unified framework to tackle the Byzantine attack detection problem. Across these settings, the thesis combines optimal or near-optimal theoretical rates with extensive numerical experiments, showing how strong approximation methods can serve as a practical foundation for inference in modern applications.

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