STRUCTURAL CAUSAL MODELS FOR EXTREMES

Speaker: Shuyang (Ray) Bai
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Time&Venue:

SCMS Room 106, Dec. 10 (Wednesday), 10:00-11:00

Abstract:

Structural causal models, recursive systems of stochastic equations organized by directed acyclic graphs, play a central role in causal analysis. Extending these models to the realm of extreme values has recently become an active area of research. In this talk, I will introduce a new formulation tailored specifically to extremes, which we call *extremal structural causal models* (*eSCMs*). Unlike conventional structural causal models, whose randomness is governed by a probability distribution, eSCMs use exponent measures, infinite-mass laws that arise naturally in multivariate extreme value theory.

A key feature of the framework is the introduction of activation variables, which abstract the single-big-jump principle, together with an additional randomization that enriches the class of extremal laws. This formulation is sufficiently general to encompass all directed graphical models satisfying the recently developed notion of extremal conditional independence.

We further uncover a natural asymmetry inherent to eSCMs under mild assumptions, enabling the identifiability of causal directions, a long-standing difficulty in causal inference. Building on this, we propose a causal discovery method that exploits this asymmetry, and demonstrate its effectiveness through both simulation studies and real benchmark datasets.

This is joint work with Fei Fang and Tiandong Wang.

Biography:

Dr. Shuyang Bai is an Associate Professor in the Department of Statistics at the University of Georgia. He received his PhD in Mathematics from Boston University in 2016. His research interests include probability, long-range dependence, heavy-tailed phenomena, limit theorems, time series, and extreme value analysis. His publications appear in journals such as *The Annals of Statistics*, *The Annals of Probability*, *Bernoulli*, and *Annals of Applied Statistics*. He also serves on the Editorial Board of the *Journal of Statistical Planning and Inference*.