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DEPARTMENT OF STATISTICS

PhD Dissertation Presentation

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“Bayesian Nonparametric Learning and Uncertainty Quantification in
the Age of Artificial Intelligence”

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Abstract

This thesis develops methodology grounded in recent advances in artificial intelligence for fundamental problems in Bayesian nonparametric learning. Primarily, we apply reinforcement learning and online decision-making tools in tandem with recursive partitioning to intelligently propose future simulations in likelihood-free inference, from which the posterior can be more efficiently approximated. In a second line of work, we propose a novel Bayesian nonparametric generative model which yields a posterior distribution over a conditional generative map by modeling all conditional quantiles simultaneously. Finally, we propose a framework for incorporating large-scale predictive systems (including generative AI) into prior elicitation for downstream usage in generalized Bayesian inference over risk minimizers. In a complementary direction, we additionally develop a distribution-free method for adaptive uncertainty quantification of AI predictions using a novel robust recursive partitioning. Together, this work demonstrates that ideas from the fields of artificial intelligence, machine learning, and reinforcement learning can enrich Bayesian methodology across posterior computation, generative modeling, and prior elicitation. This relationship is symbiotic, as uncertainty quantification tools also allow us to more reliably incorporate AI predictions for high-stakes output.