STATISTICS
COLORADO STATE UNIVERSITY

Fall 2025 Departmental Seminar

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Model-Free Approaches to Constructing Prediction Regions Under Target Shift

Abstract

In many real-world applications, obtaining labeled data is a significant challenge due to high costs and technical limitations. This scarcity of labeled outcomes presents a major obstacle for traditional statistical inference. To address this, we introduce a model-free approach for constructing prediction regions for new target outcomes. Our method leverages a labeled source distribution, which is different from the target but related through a distributional shift, to overcome the lack of target labels. When target data are fully unlabeled, our predictions rely entirely on the rich source data; when some labels are available, we seamlessly integrate them to boost efficiency. A key innovation in this new approach lies in how we handle the complexities of different data distributions. We tackle non-exchangeability and non-identifiability by estimating the likelihood ratio through a novel technique: matching the covariate distributions of the source and target domains using a B-spline basis. This powerful approach allows us to accommodate complex error structures, including asymmetry and multimodality. To this end, we construct the highest predictive density sets using a new weight-adjusted conditional density estimator. This estimator models the source conditional density and then transforms it through a weighting scheme to accurately approximate the target conditional density. We will discuss the theoretical guarantees of our method and demonstrate its strong performance. We validate our approach through comprehensive simulation studies and a compelling real-world application using the MIMIC-III clinical database. This is a joint work with Menghan Yi and Yanlin Tang.