THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

Master’s Thesis Presentation

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“k-Nearest Neighbors Probabilistic Conformal Prediction”

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Abstract

We studied probabilistic conformal prediction based on conditional random samples. Traditional methods would produce continuous sets. Probabilistic conformal prediction (PCP) constructs discontinuous prediction sets that are more informative. However, PCP may include isolated low-density regions, which can make the resulting prediction set noisy or overly large. High-density PCP (HD-PCP) addresses this issue by retaining only samples from high-density regions, but it requires density estimation in addition to sampling. This extra requirement can be challenging when the conditional distribution is complex or difficult to estimate accurately. To overcome this limitation, we propose a new conformal score inspired by the k-nearest-neighbor idea. Instead of explicitly estimating the conditional density, our method uses the local concentration of conditional random samples to mimic the effect of retaining high-density regions. We compare the proposed kNN-PCP method with PCP and HD-PCP on synthetic data. Our experiments show that \(k\)NN-PCP has marginal coverage guarantees while reducing isolated low-density artifacts, leading to more stable and often smaller prediction sets.

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