THE UNIVERSITY OF CHICAGO

Computational and Applied Mathematics & Statistics Student Seminar

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Improving the calibration of probabilistic weather forecasts with conformal prediction

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ABSTRACT

Probabilistic weather forecasting is undergoing rapid transformation with new, highly accurate artificial intelligence (AI)-based models. Still, a central challenge is calibration: Forecasts should correctly represent the underlying statistical distribution of future states. In traditional numerical weather prediction, computing power limits how many ensemble members characterize empirical forecast distributions. Fast inference for AI-based models enables larger ensembles and, ideally, better uncertainty quantification. These state-of-the-art models produce forecasts that are often considered well-calibrated, especially when trained with probabilistic considerations in mind. However, we show that the statistical coverage of such models can struggle, especially on climatologically extreme events. We turn to conformal prediction, a class of algorithms that mathematically guarantees coverage. We apply adaptive conformal inference to the forecasts of three leading global weather models, GenCast, NeuralGCM, and AIFS-ENS, correcting their coverage deficiencies at no expense to other probabilistic metrics. This promising alternative post-processing method can be applied to the output of any forecasting model.