THE UNIVERSITY OF CHICAGO | **DEPARTMENT OF STATISTICS**

PhD Dissertation Proposal Presentation

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"Estimation, prediction, and uncertainty quantification using sparse data in weather applications"

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Abstract

Incompleteness of data, both in the spatial and temporal dimensions, has been a pervasive issue in weather forecasting applications and has led to the development of numerous methods to circumvent this issue. This dissertation explores handling sparse observations for three different tasks of operational interest in weather forecasting applications.

Part 1 explores estimating a high dimensional representation of key weather variables across time using sparse data and a surrogate-based forecasting model. In particular, we assess the data-driven weather forecast model FourCastNet in its ability to be integrated into the data assimilation method 3DVar with this sparse data. We evaluate the analysis products of this assimilation in various tasks of operational interest, such as extreme weather event prediction.

Part 2 explores our ability to provide robust uncertainty quantification in data assimilation tasks. We combine ideas in conformal prediction and data assimilation to outline a procedure to obtain distribution-free uncertainty inference in data assimilation tasks, particularly in settings where there is partial, noisy observational data that may not be missing at random. Our particular focus is on the Ensemble Kalman Filter (EnKF) algorithm paired with split conformal prediction in weather settings.

Lastly, part 3 outlines an optimization procedure for determining near-optimal weather sensor placement in order to maximize the predictive performance of neighborhood air conditioning consumption in the city of Chicago. This optimization is subject to many constraints, including a finite budget for sensor placement.

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