

Data-driven optimization of sensor placement and forecasting

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Abstract: The increasingly high-dimensional data generated by complex systems poses a tremendous challenge for downstream optimization, inference, and control. Dimensionality reduction is a powerful tool for analyzing data from systems strictly governed by physical laws, and can uncover heavily compressed representations of the underlying dynamics. This compression step facilitates many downstream optimization tasks, such as optimal sensor placement. In general, determining the optimum scales combinatorially in the number of candidate placement locations. We demonstrate a highly efficient, greedy algorithm for sensor placement that utilizes PCA as a dimension reduction step to optimize sensor locations. The resulting sensor measurements are then used to reconstruct high-dimensional fluid flows, images and structural features in aircraft manufacturing.

If time permits, we discuss a recent direction in data-driven forecasting using partial observations of multiscale systems. This kernel analog forecasting method expresses the prediction in a basis of specially constructed diffusion features, leveraging Koopman operator theory, reproducing kernel Hilbert spaces and dimensionality reduction. The resulting prediction is provably consistent with the dynamical system evolution even for long lead times, and provides a framework for quantifying the uncertainty associated with partial observations.

Bio: Krithika Manohar is an incoming Assistant Professor in Mechanical Engineering at the University of Washington, starting January 2021. Dr. Manohar specializes in data-driven learning, prediction and control of large-scale dynamical systems. She investigates optimizing measurements and sensor placements for these objectives, with applications ranging across fluid dynamics, biology, climate, and manufacturing. A UW alumna, Manohar received her Ph.D. in applied mathematics in 2018. She is currently an NSF postdoctoral fellow and von Kármán Instructor in Computing & Mathematical Sciences at the California Institute of Technology.

