THE UNIVERSITY OF CHICAGO

Computational and Applied Mathematics & Statistics Student Seminar

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Auto-differentiable data assimilation: Co-learning of states, dynamics, and filtering algorithms

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Rosenwald 011
1115 E 58th St

ABSTRACT

Data assimilation algorithms estimate the state of a dynamical system from partial observations, where the successful performance of these algorithms hinges on costly parameter tuning and on employing an accurate model for the dynamics. This paper introduces a framework for jointly learning the state, dynamics, and parameters of filtering algorithms in data assimilation through a process we refer to as auto-differentiable filtering. The framework leverages a theoretically motivated loss function that enables learning from partial, noisy observations via gradient-based optimization using auto-differentiation. We further demonstrate how several well-known data assimilation methods can be learned or tuned within this framework. To underscore the versatility of auto-differentiable filtering, we perform experiments on dynamical systems spanning multiple scientific domains, such as the Clohessy-Wiltshire equations from aerospace engineering, the Lorenz ’96 system from atmospheric science, and the generalized Lotka-Volterra equations from systems biology. Finally, we provide guidelines for practitioners to customize our framework according to their observation model, accuracy requirements, and computational budget.