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Abstract Title: A Topological Approach For Data Assimilation (TADA)

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Introduction: Topological Data Analysis (TDA) is a collection of tools for studying structure and shape of spaces. It has been widely used to quantify topological invariants of spaces such as connectivity, loops, and voids in spaces by encoding that information in a mathematical construction called the persistence diagram. These diagrams provide a two dimensional summary of when those invariants appear and disappear as a scale parameter is varied.

Objectives: Despite the many successful applications of TDA to dynamical systems in many domains, a differential framework for persistence has only been recently discovered. The introduction of this framework has opened the door to many possibilities that include optimization and Data Assimilation (DA).

Methods: In this talk I will show how persistence differentiation can be leveraged to incorporate measurements of dynamical systems with model outputs to improve prediction accuracy within DA pipeline. I will show how this Topological Approach for Data Assimilation (TADA) can lead to enhanced forecasting of dynamical systems.

Results: In addition to applying TADA to prototypical dynamical systems such as Lorenz, I also show an application to high-fidelity simulation of Hall Effect Thrusters (HETs).

Significance: The operation of HETs involves complex processes such as ionization of gases, strong magnetic fields, and complicated solar panel power supply interactions. Therefore, their operation is extremely difficult to model thus necessitating Data Assimilation (DA) approaches for estimating and predicting their operational states. Because HET's operating environment is often noisy with non-Gaussian sources, this significantly limits applicable DA tools. I will show how TADA, which does not have the Gaussian noise assumption, produces accurate forecasts for HETs' states.

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