Programme des Leçons Jacques-Louis Lions 2023

données par Andrew Stuart

du 12 au 15 décembre 2023

La huitième édition des Leçons Jacques-Louis Lions aura lieu du 12 au 15 décembre 2023.

Données par Andrew Stuart (Institut de technologie de Californie (Caltech)), les Leçons Jacques-Louis Lions 2023 consisteront en :

– un **mini-cours** intitulé

Ensemble Kalman filter: Algorithms, analysis and applications

3 séances, les mardi 12, mercredi 13 et jeudi 14 décembre 2023 de 11h à 12h30,
Salle du séminaire du Laboratoire Jacques-Louis Lions,
barre 15-16, 3ème étage, salle 09 (15-16-3-09),
Sorbonne Université, Campus Jussieu, 4 place Jussieu, Paris 5ème,

– et un **colloquium** intitulé

Operator learning: Acceleration and discovery of computational models

le vendredi 15 décembre 2023 de 14h à 15h,
Amphithéâtre 25,
entrée face à la tour 25, niveau dalle Jussieu,
Sorbonne Université, Campus Jussieu, 4 place Jussieu, Paris 5ème.

Tous les exposés seront donnés en présence et retransmis en temps réel par Zoom.

Le lien Zoom pour suivre à distance la Leçon du jour sera diffusé chaque matin par email à la liste de diffusion du Séminaire du Laboratoire Jacques-Louis Lions.

Ce lien sera également mis en ligne chaque matin sur les pages web
https://www.ljll.math.upmc.fr/lecons-jacques-louis-lions-2023-andrew-stuart
https://www.ljll.math.upmc.fr/seminaire-du-laboratoire
https://www.ljll.math.upmc.fr/seminaire-du-laboratoire/seminaires-de-l-annee-2023

Attention : ce lien Zoom sera différent chaque jour.

Résumé du mini-cours

Ensemble Kalman filter: Algorithms, analysis and applications

In 1960 Rudolph Kalman [1] published what is arguably the first paper to develop a systematic, principled approach to the use of data to improve the predictive capability of dynamical systems. As our ability to gather data grows at an enormous rate, the importance of this work continues to grow too. Kalman's paper is confined to linear dynamical systems subject to Gaussian noise; the work of Geir Evensen [2] in 1994 opened up far wider applicability of Kalman's ideas by introducing the ensemble Kalman filter.

The ensemble Kalman filter applies to the setting in which nonlinear and noisy observations are used to make improved predictions of the state of a Markov chain. The algorithm results in an interacting particle system combining elements of the Markov chain and the observation process. In these lectures I will introduce a unifying mean-field perspective on the algorithm, derived in the limit of an infinite number of interacting particles. I will then describe how the methodology can be used to study inverse problems, opening up diverse applications beyond prediction in dynamical systems. Finally I will describe analysis of the accuracy of the methodology, both in terms of accuracy and uncertainty quantification; despite its widespread adoption in applications, a complete mathematical theory is lacking and there are many opportunities for analysis in this area.

Lecture 1: The algorithm

Lecture 2: Inverse problems and applications

Lecture 3: Analysis of accuracy and uncertainty quantification

[1] R. Kalman, *A new approach to linear filtering and prediction problems.* Journal of Basic Engineering, 82:3545, 1960.

[2] G. Evensen, *Sequential data assimilation with a nonlinear quasi-geostrophic model using Monte Carlo methods to forecast error statistics.* Journal of Geophysical Research: Oceans, 99(C5):1014310162, 1994.

Résumé du colloquium

Operator learning: Acceleration and discovery of computational models

Neural networks have shown great success at learning function approximators between spaces X and Y, in the setting where X is a finite dimensional Euclidean space and where Y is either a finite dimensional Euclidean space (regression) or a set of finite cardinality (classification); the neural networks learn the approximator from N data pairs (x_n, y_n). In many problems arising in physics it is desirable to learn maps between spaces of functions X and Y; this may be either for the purposes of scientific discovery, or to provide cheap surrogate models which accelerate computations. New ideas are needed to successfully address this learning problem in a scalable, efficient manner.

In this talk I will overview the methods that have been introduced in this area and describe theoretical results underpinning the emerging methodologies. Illustrations will

be given from a variety of PDE-based problems including learning the solution operator for dissipative PDEs, learning the homogenization operator in various settings, and learning the smoothing operator in data assimilation.

Adresse de la page web des Leçons Jacques-Louis Lions 2023 (Andrew Stuart)

https://www.ljll.math.upmc.fr/lecons-jacques-louis-lions-2023-andrew-stuart