Multidisciplinary Simulation, Estimation, and Assimilation Systems

Seminar Series

Qiqi Wang

Assistant Professor of Aeronautics and Astronautics

MIT

Taming the Butterfly Effect -- Long Time Sensitivity Analysis of Unsteady and Chaotic Systems

Abstract: Many dynamical systems of scientific and engineering importance are unsteady and chaotic. These systems can be found in unsteady fluid flows around airplanes and inside gas turbine engines, aero-elastic oscillations, our climate system and molecular dynamics. This talk focus on computational sensitivity analysis of chaotic dynamical systems, whose applications include optimization, control, uncertainty quantification, and data based inference.

In long time simulations of chaotic dynamical systems, we show that existing methods for sensitivity analysis produces results that are orders of magnitude larger than what is useful for typical applications. This failure is caused by the ill-conditioned initial value problem of chaos. This talk presents a method to overcome this failure by replacing the initial value problem with a well-conditioned problem, the "least squares shadowing problem". The resulting algorithm solves either the linearized or the adjoint least squares shadowing problem, then computes the derivative of a long time averaged quantity that is consistent with the derivative of the infinitely long time average. Sensitivity analysis with this algorithm has been demonstrated in chaotic dynamical systems, including some turbulent flow problems.

Friday, Nov. 8, 2013

11:00AM; Rm. 5-314

Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139

Host: Pierre F.J. Lermusiaux
http://mseas.mit.edu