

Joint seminar series on
Big Data Sciences and Analytics by
AMA, CEE, COMP & LSGI

***Computing Multiscale Stochastic
Partial Differential Equations
using Data-Driven Stochastic Basis
by Professor Thomas Yizhao Hou***



Abstract

One of the major challenges in uncertainty quantification is to solve stochastic partial differential equations with both multiscale features in the physical space and high dimensional random input variables. To solve these problems, we not only need to use a very fine mesh to resolve the small scales of the solution in the physical space, but also need to approximate the solution in the stochastic space with high input dimension. To overcome this difficulty, we have developed two effective numerical methods that combine multiscale model reduction with our data-driven stochastic method. The first method is called multiscale data-driven stochastic method and the second method multiscale multilevel Monte Carlo method. We will demonstrate that both methods offer considerable saving over traditional methods. In a related effort, we have developed localized representation of stochastic fields with high stochastic dimension. These stochastic fields typically have small correlation length. Such problems are known to be extremely challenging. Even if we use the Karhunen-Loeve expansion to extract a data-driven basis, the number of unknowns is still prohibitively expensive. Inspired by the recently developments in information theory, we introduce the low rank plus sparsity criteria in constructing spatially localized basis. We give numerical examples to show the advantage of the new approach, and present the reduction of computational cost by careful analysis of numerical complexities.

Biography

Professor Thomas Yizhao Hou is the Charles Lee Powell professor of applied and computational mathematics at Caltech and a world renowned applied mathematician. He obtained his Ph.D. in Mathematics from UCLA in 1987 and joined Courant Institute as a junior faculty member from 1989 to 1993. He moved to Caltech in 1993, served as the department chair of Applied and Computational Mathematics from 2000 to 2006. Prof. Hou has received a number of honors and awards, including Fellow of American Academy of Art and Sciences (2011) and an inaugural Fellow of Society of Industrial and Applied Mathematics (2009) and American Mathematical Society (2012). He was also an invited speaker of International Congress of Mathematicians (1998) and an invited plenary speaker of International Congress of Industrial and Applied Mathematics (2003), the founding Editor-in-Chief of the SIAM Journal on Multiscale Modeling and Simulation from 2002 to 2007, and the Chairman of the Board of Governors of the Institute of Mathematics and its Applications from 2012 to 2013.

Date : 8 December 2014 (Monday)

Time : 3:00 – 4:00pm

Venue : Room P116, Mathematics Laboratory, PolyU

ALL ARE WELCOME !

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