Washington University in St. Louis

SCHOOL OF ENGINEERING & APPLIED SCIENCE

Preston M. Green Department of Electrical & Systems Engineering

Seminar Announcement

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Thursday, January 24, 2019
Green Hall, Room 0120

10:00 A.M.

Large Scale Inverse Problems and Uncertainty Quantification Governed by Partial Differential Equations: Computational Tools and Imaging Applications

Abstract:
Efficient techniques for the solution of inverse problems governed by partial differential equations (PDEs) are an essential component of modern numerical simulations and represent an area of highly active and rapidly-evolving research. Inverse problems are often ill-posed, i.e. the data—even when large scale—do not provide sufficient information to fully determine the model parameters. In such cases, uncertainty is a fundamental feature of the inverse problem: we wish to both infer the parameters, as well as quantify the uncertainty associated with this inference. This would open the door to powerful capabilities for model-based decision-making under uncertainty. Bayesian inference provides a powerful framework for the solution of inverse problems under uncertainty. However, its application to engineering-relevant problems—such as medical imaging, geophysics, numerical weather prediction, and seismology—poses substantial challenges to state-of-the-art algorithms. First, the parameter to be inferred is often a spatially correlated field and it leads—after discretization—to a high dimensional parameter space. Second, the forward model is often highly complex and computationally expensive to solve. This talk will examine the use of efficient numerical methods for the Bayesian solution to large-scale PDE constrained inverse problems, uncertainty quantification, optimal design of experiments, and optimization under-uncertainty, with specific emphasis on techniques that allow mitigating the curse of dimensionality. An application to quantitative optoacoustic tomography, part of an ongoing collaboration with Dr. Mark Anastasio as part of the School of Engineering & Applied Science's transdisciplinary Imaging Initiative, will be presented.

Professor Villa earned his Bachelor's and Master in Mathematical Engineering from Politecnico di Milano, Italy, and his PhD in Mathematics from Emory University (Atlanta, GA) with Prof. Veneziani. He completed his postdoctoral training at the Center for Applied Scientific Computing of Lawrence Livermore National Laboratory. In August 2018, Professor Villa joined the Electrical & Systems Engineering Department of Washington University in St. Louis from the Institute for Computational Engineering and Sciences of The University of Texas at Austin, where was a Research Associate in the Center for Computational Geosciences and Optimization led by Professor Ghattas.

Host: Joseph O'Sullivan