Final Program

SIAM Conference on Uncertainty Quantification

April 16-19, 2018
Hyatt Regency–Orange County
Garden Grove, California, USA

This conference is sponsored by the SIAM Activity Group on Uncertainty Quantification (SIAG/UQ). This conference is being held in cooperation with the American Statistical Association (ASA) and GAMM Activity Group on Uncertainty Quantification (GAMM AG UQ).

Sponsored by the SIAM Activity Group on Uncertainty Quantification

The SIAM Activity Group on Uncertainty Quantification (SIAG/UQ) fosters activity and collaboration on all aspects of the effects of uncertainty and error on mathematical descriptions of real phenomena. It seeks to promote the development of theory and methods to describe quantitatively the origin, propagation, and interplay of different sources of error and uncertainty in analysis and predictions of the behavior of complex systems, including biological, chemical, engineering, financial, geophysical, physical and social/political systems. The SIAG/UQ serves to support interactions among mathematicians, statisticians, engineers, and scientists working in the interface of computation, analysis, statistics, and probability.

The activity group sponsors the biennial SIAM Conference on Uncertainty Quantification and maintains a member directory and an electronic mailing list.

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Table of Contents

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Massachusetts Institute of Technology, USA

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(ASA Representative)

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University of Missouri, USA

Description

Uncertainty quantification (UQ) is essential for producing informative computational predictions in a wide range of sciences and engineering. The field relies on a broad range of mathematical and statistical foundations, with associated algorithmic and computational developments. This conference will bring together mathematicians, statisticians, scientists, and engineers with an interest in the development and implementation of uncertainty quantification methods. Major conference themes will include the mathematical and statistical foundations of UQ, applications of UQ in the physical sciences and biosciences, and connections between UQ and machine learning. The goal of the meeting is to provide a forum to share ideas and enhance communication among this diverse group of technical experts, thereby contributing to future advances in the field.

SIAM Registration Desk

The SIAM registration desk is located in Grand Ballroom E, on the 1st Floor. It is open during the following hours:

Sunday, April 15
5:00 PM - 8:00 PM

Monday, April 16
7:00 AM - 5:00 PM

Tuesday, April 17
7:45 AM - 5:00 PM

Wednesday, April 18
7:45 AM - 5:00 PM

Thursday, April 19
7:45 AM - 3:00 PM

Hotel Address

Hyatt Regency Orange County
11999 Harbor Blvd.
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Toll Free Reservations (USA and Canada): 1-888-421-1442
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Hotel Telephone Number

To reach an attendee or leave a message, call +1-714-750-1234. If the attendee is a hotel guest, the hotel operator can connect you with the attendee's room.

Hotel Check-in and Check-out Times

Check-in time is 4:00 PM.
Check-out time is 12:00 PM.

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The Hyatt Regency Orange County recommends Destination Sitters (888-748-5439) and Around the Clock Sitters (949-551-5111) for attendees interested in child care services. Attendees are responsible for making their own child care arrangements.

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US Naval Research Labs

List current February 2018.

Funding Agency

SIAM and the Conference Organizing Committee wish to extend their thanks

and appreciation to the U.S. National Science Foundation for its support of this conference.

Internet Access

Attendees booked within the SIAM room block will receive complimentary wireless Internet access in their guest rooms and the public areas of the hotel. All conference attendees will have complimentary wireless Internet access in the meeting space.

SIAM will also provide a limited number of email stations.
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Leading the applied mathematics community . . .

SIAM members save up to $140 on full registration for the 2018 SIAM Conference on Uncertainty Quantification (UQ18)! Join your peers in supporting the premier professional society for applied mathematicians and computational scientists. SIAM members receive subscriptions to *SIAM Review, SIAM News* and *SIAM Unwrapped*, and enjoy substantial discounts on SIAM books, journal subscriptions, and conference registrations.

If you are not a SIAM member and paid the Non-Member or Non-Member Mini Speaker/Organizer rate to attend the conference, you can apply the difference between what you paid and what a member would have paid ($140 for a Non-Member and $70 for a Non-Member Mini Speaker/Organizer) towards a SIAM membership. Contact SIAM Customer Service for details or join at the conference registration desk.

If you are a SIAM member, it only costs $15 to join the SIAM Activity Group on Uncertainty Quantification (SIAG/UQ). As a SIAG/UQ member, you are eligible for an additional $15 discount on this conference, so if you paid the SIAM member rate to attend the conference, you might be eligible for a free SIAG/UQ membership. Check at the registration desk.

Free Student Memberships are available to students who attend an institution that is an Academic Member of SIAM, are members of Student Chapters of SIAM, or are nominated by a Regular Member of SIAM.

Join onsite at the registration desk, go to *www.siam.org/joinsiam* to join online or download an application form, or contact SIAM Customer Service:
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Standard Audio/Visual Set-Up in Meeting Rooms

SIAM does not provide computers for any speaker. When giving an electronic presentation, speakers must provide their own computers. SIAM is not responsible for the safety and security of speakers' computers.

A data (LCD) projector and screen will be provided in all technical session meeting rooms. The data projectors support both VGA and HDMI connections. Presenters requiring an alternate connection must provide their own adaptor.

Registration Fee Includes

- Admission to all technical sessions
- Business Meeting (open to SIAG/UQ members)
- Coffee breaks daily
- Room set-ups and audio/visual equipment
- Welcome Reception and Poster Session

Job Postings

Please check with the SIAM registration desk regarding the availability of job postings or visit *http://jobs.siam.org*.

Important Notice to Poster Presenters

The poster session is scheduled for 8:00 PM – 10:00 PM on Monday, April 16. Poster presenters are expected to set up their poster material on the provided 4' x 8' poster boards in the Royal Ballroom between the hours of 2:00 PM and 8:00 PM. All materials must be posted by 8:00 PM on Monday, April 16, the official start time of the session. Posters will remain on display through the end of the poster session. **Posters must be removed by 9:00 AM on Tuesday, April 17.**

SIAM Books and Journals

Display copies of books and complimentary copies of journals are available on site. SIAM books are available at a discounted price during the conference. The books booth will be staffed from 9:00 AM through 5:00 PM. If a SIAM books representative is temporarily away from the booth, completed order forms and payment (credit cards are preferred) may be taken to the SIAM registration desk. The books table will close at 3:00 PM on Thursday, April 19.

Table Top Displays

SIAM

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Name Badges

A space for emergency contact information is provided on the back of your name badge. Help us help you in the event of an emergency!

Comments?

Comments about SIAM meetings are encouraged! Please send to: Cynthia Phillips, SIAM Vice President for Programs (*vpp@siam.org*).

Get-togethers

Welcome Reception
and Poster Session
Monday, April 16
8:00 PM - 10:00 PM

Business Meeting
(open to SIAG/UQ members)
Tuesday, April 17
6:45 PM - 7:45 PM
Complimentary beer and wine will be served.

Statement on Inclusiveness

As a professional society, SIAM is committed to providing an inclusive climate that encourages the open expression and exchange of ideas, that is free from all forms of discrimination, harassment, and retaliation, and that is welcoming and comfortable to all members and to those who participate in its activities. In pursuit of that commitment, SIAM is dedicated to the philosophy of equality of opportunity and treatment for all participants regardless of gender, gender identity or expression, sexual orientation, race, color, national or ethnic origin, religion or religious belief, age, marital status, disabilities, veteran status, field of expertise, or any other reason not related to scientific merit. This philosophy extends from SIAM conferences, to its publications, and to its governing structures and bodies. We expect all members of SIAM and participants in SIAM activities to work towards this commitment.

Please Note

SIAM is not responsible for the safety and security of attendees' computers. Do not leave your personal electronic devices unattended. Please remember to turn off your cell phones and other devices during sessions.

Recording of Presentations

Audio and video recording of presentations at SIAM meetings is prohibited without the written permission of the presenter and SIAM.

Social Media

SIAM is promoting the use of social media, such as Facebook and Twitter, in order to enhance scientific discussion at its meetings and enable attendees to connect with each other prior to, during and after conferences. If you are tweeting about a conference, please use the designated hashtag to enable other attendees to keep up with the Twitter conversation and to allow better archiving of our conference discussions. The hashtag for this meeting is #SIAMUQ18.

SIAM's Twitter handle is @TheSIAMNews.

Changes to the Printed Program

The printed program and abstracts were current at the time of printing, however, please review the online program schedule *(http://meetings.siam.org/program.cfm?CONFCODE=uq18)* or use the mobile app for the most up-to-date information.

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Minitutorials

All Minitutorials will take place in Grand Ballroom G - 1st Floor.

Monday, April 16

9:30 AM - 11:30 AM

MT1 Statistical Parameter Estimation and Inference for Dynamical Models

Organizer: **Jennifer Hoeting,** *Colorado State University, USA*

2:00 PM - 4:00 PM

MT2 Approximate Bayesian Computation

Organizer: **David Nott**, *National University of Singapore, Singapore*

Tuesday, April 17

8:10 AM - 10:10 AM

MT3 Numerical Analysis of Computational UQ for PDEs

Organizer: **Christoph Schwab**, *ETH Zürich, Switzerland*

2:00 PM - 4:00 PM

MT4 Foundations of Compressed Sensing for Learning Sparsity of High-dimensional Problems

Organizer: **Clayton G. Webster**, *University of Tennessee and Oak Ridge National Laboratory, USA*

Minitutorials

All Minitutorials will take place in Grand Ballroom G - 1st Floor.

Wednesday, April 18

8:10 AM - 10:10 AM

MT5 Stochastic Multiscale Space-time Modelling and Practical Bayesian Inference

Organizers: **Daniel Simpson,** *University of Toronto, Canada*

Finn Lindgren, *University of Edinburgh, United Kingdom*

2:00 PM - 4:00 PM

MT6 Low-rank Tensor Methods

Organizer: **Ming Yuan**, *Columbia University, USA*

Thursday, April 19

8:10 AM - 10:10 AM

MT7 Particle and Ensemble Kalman Filters for Nonlinear Filtering Problems

Organizers: **Claudia Schillings**, *Universitaet Mannheim, Germany*

Jana de Wiljes, *Universität Potsdam, Germany*

2:30 PM - 4:30 PM

MT8 Optimization and Control Under Uncertainty

Organizer: **Drew P. Kouri,** *Sandia National Laboratories, USA*

Invited Plenary Speakers

All Invited Plenary Presentations will take place in Grand Ballroom ABCD - 1st Floor.

Monday, April 16

8:15 AM - 9:00 AM

IP1 Scalable Algorithms for PDE-Constrained Optimization Under Uncertainty
Omar Ghattas, *University of Texas at Austin, USA*

1:00 PM - 1:45 PM

IP2 On Gradient-Based Optimization: Accelerated, Stochastic and Nonconvex
Michael I. Jordan, *University of California, Berkeley, USA*

Tuesday, April 17

10:45 AM - 11:30 AM

IP3 A Contemporary View of High-dimensional Quasi Monte Carlo
Ian H. Sloan, *University of New South Wales, Australia*

1:00 PM - 1:45 PM

IP4 Model Uncertainty and Uncertainty Quantification
Merlise Clyde, *Duke University, USA*

Invited Plenary Speakers

All Invited Plenary Presentations will take place in Grand Ballroom ABCD - 1st Floor.

Wednesday, April 18

10:45 AM - 11:30 AM

IP5 Three Principles of Data Science: Predictability, Stability, and Computability
Bin Yu, *University of California, Berkeley, USA*

1:00 PM - 1:45 PM

IP6 Multi-level and Multi-index Monte Carlo Methods in Practice
Fabio Nobile, *École Polytechnique Fédérale de Lausanne, Switzerland*

Thursday, April 19

11:15 AM - 12:00 PM

IP7 Data Assimilation and Uncertainty Quantification — A Lagrangian Interacting Particle Perspective
Sebastian Reich, *Universität Potsdam, Germany and University of Reading, United Kingdom*

1:30 PM - 2:15 PM

IP8 Good and Bad Uncertainty: Consequences in UQ and Design
Johannes O. Royset, *Naval Postgraduate School, USA*

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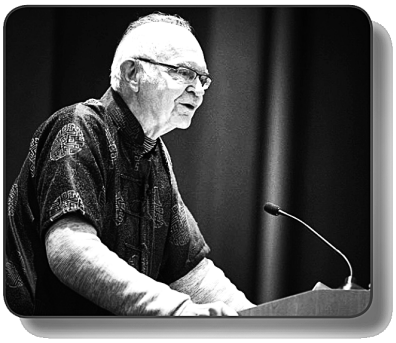

- **algebraic geometry**
- **atmospheric and oceanographic science**
- **computational science**
- **data mining**
- **geophysical science**
- **optimization**
- **uncertainty quantification and more...**

The collection, *Featured Lectures from our Archives*, includes audio and slides from more than 30 conferences since 2008, including talks by invited and prize speakers, select minisymposia, and minitutorials. Presentations from SIAM meetings are being added throughout the year.

In addition you can view short video clips of speaker interviews from sessions at Annual Meetings starting in 2010.

Plans for adding more content are on the horizon. Keep an eye out!

The audio, slide, and video presentations are part of SIAM's outreach activities to increase the public's awareness of mathematics and computational science in the real world, and to bring attention to exciting and valuable work being done in the field. Funding from SIAM, the National Science Foundation, and the Department of Energy was used to partially support this project.

New presentations are posted every few months as the program expands with sessions from additional SIAM meetings. Users can search for presentations by category, speaker name, and/or key words.

www.siam.org/meetings/presents.php

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Prize Lecture

The Prize Lecture will take place in Grand Ballroom ABCD - 1st Floor.

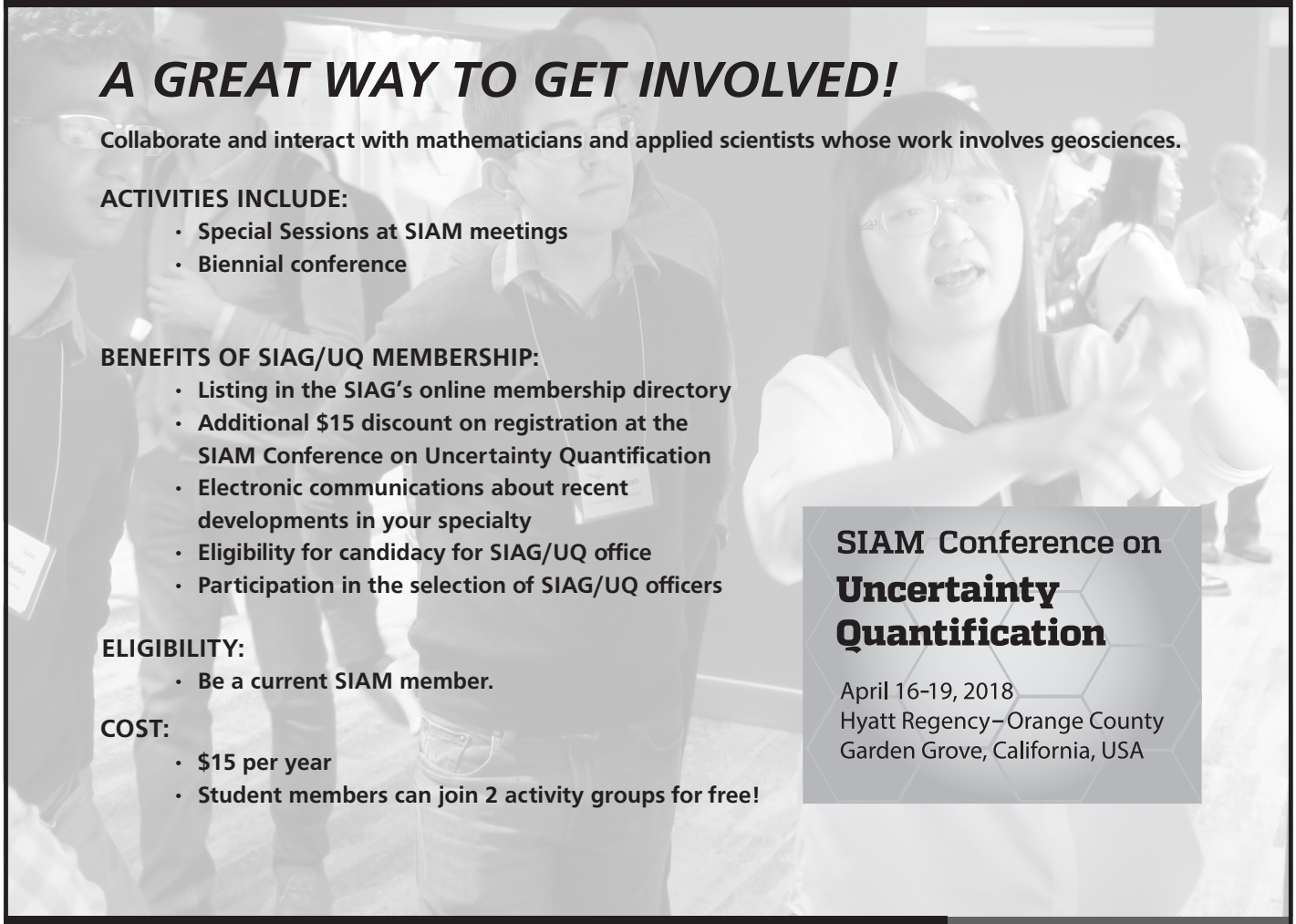
Thursday, April 19

10:45 AM - 11:15 AM

SP1 SIAG/Uncertainty Quantification Early Career Prize Lecture -
Multilevel Markov Chain Monte Carlo Methods for Uncertainty Quantification
Aretha L. Teckentrup, *University of Edinburgh, United Kingdom*

SIAM Activity Group on Uncertainty Quantification (SIAG/UQ)

www.siam.org/activity/uq



A GREAT WAY TO GET INVOLVED!

Collaborate and interact with mathematicians and applied scientists whose work involves geosciences.

ACTIVITIES INCLUDE:

- **Special Sessions at SIAM meetings**
- **Biennial conference**

BENEFITS OF SIAG/UQ MEMBERSHIP:

- **Listing in the SIAG's online membership directory**
- **Additional $15 discount on registration at the SIAM Conference on Uncertainty Quantification**
- **Electronic communications about recent developments in your specialty**
- **Eligibility for candidacy for SIAG/UQ office**
- **Participation in the selection of SIAG/UQ officers**

ELIGIBILITY:

- **Be a current SIAM member.**

COST:

- **$15 per year**
- **Student members can join 2 activity groups for free!**

SIAM Conference on Uncertainty Quantification

April 16-19, 2018
Hyatt Regency–Orange County
Garden Grove, California, USA

2017-18 SIAG/UQ OFFICERS

Chair:	Roger Ghanem, University of Southern California
Vice Chair:	Elaine Spiller, Marquette University
Program Director:	Youssef Marzouk, Massachusetts Institute of Technology
Secretary:	Noemi Petra, University of California, Merced

TO JOIN:

SIAG/UQ: ***my.siam.org/forms/join_siag.htm***
SIAM: ***www.siam.org/joinsiam***

Program Schedule

SIAM Conference on Uncertainty Quantification

April 16-19, 2018
Hyatt Regency–Orange County
Garden Grove, California, USA

Notes

Sunday, April 15

Registration

5:00 PM-8:00 PM

Room:Grand Ballroom E - 1st Floor

Monday, April 16

Registration

7:00 AM-5:00 PM

Room:Grand Ballroom E - 1st Floor

Opening Remarks

8:00 AM-8:15 AM

Room:Grand Ballroom ABCD - 1st Floor

Monday, April 16

IP1

Scalable Algorithms for PDE-constrained Optimization Under Uncertainty

8:15 AM-9:00 AM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Youssef M. Marzouk, Massachusetts Institute of Technology, USA

We consider optimization problems governed by PDEs with infinite dimensional random parameter fields. Such problems arise in numerous applications: optimal design/control of systems with stochastic forcing or uncertain material properties or geometry; inverse problems with stochastic forward problems; or Bayesian optimal experimental design problems with the goal of minimizing the uncertainty or maximizing the information gain in the inferred parameters. Monte Carlo evaluation of the objective as per the popular Sample Average Approximation (SAA) algorithm results in an optimization problem that is constrained by N PDE systems, where N is the number of samples. This results in an optimization problem that is prohibitive to solve, especially when the PDEs are "complex' (large-scale, nonlinear, coupled) and discretization of the infinite-dimensional parameter field results in a high-dimensional parameter space. We discuss high-order derivative-based approximations of the parameter-to-objective maps that, in combination with randomized algorithms, exploit the structure of these maps (smoothness, low effective dimensionality). Their use as a basis for variance reduction is demonstrated to significantly accelerate Monte Carlo sampling and permit solution of problems with $O(10^6)$ uncertain parameters. This work is joint with Peng Chen and Umberto Villa (ICES, UT Austin).

Omar Ghattas
University of Texas at Austin, USA

Coffee Break

9:00 AM-9:30 AM

Room:Grand Ballroom Foyer - 1st Floor

Monday, April 16

MT1

Statistical Parameter Estimation and Inference for Dynamical Models

9:30 AM-11:30 AM

Room:Grand Ballroom G - 1st Floor

In this minitutorial I will survey a variety of statistical methods that enable statistical inference for parameters of dynamical models such as ordinary differential equation, continuous-time Markov chain, and stochastic differential equation models. In the study of biological or ecological dynamical processes, many theoretical models have been developed but it is not common practice to estimate model parameters using statistical functions of observed data. A challenge is to develop methods to address the issue of the computationally intensive or intractable likelihoods required for these problems. Another challenge is that observed data can be messy and incomplete, such as the case when some state variables are unobserved and observed states are sparse over time.

I will survey a variety of statistical methods for parameter estimation and model selection to address these challenges including methods fundamental to frequentist and Bayesian statistics. I will discuss approaches for maximum likelihood estimation using Monte Carlo integration and importance sampling, as well as an approach for model selection using approximate Bayesian computation (ABC). In each case, I will introduce the statistical methodology and then discuss how the methods are used to enable statistical inference and parameter estimation for dynamical models.

Organizer and Speaker:

Jennifer Hoeting
Colorado State University, USA

Monday, April 16

MS1

Uncertainty Quantification and Data Assimilation in Earth System Modeling and Prediction - Part I of II

9:30 AM-11:30 AM

Room:Grand Ballroom ABCD - 1st Floor

For Part 2 see MS14

Uncertainty quantification (UQ) of earth system forecasts presents fundamental challenges in mathematics and statistics that is intertwined with limitations in observations, scientific understanding of the processes that determine this uncertainty and how best to combine this with our current generation models with data assimilation (DA). The goal of the minisymposium is to provide a forum for this diverse group to discuss and share ideas for advancing the science of UQ and DA in climate modeling or any of its components (e.g. atmosphere, ocean, ice sheets, or sea ice). We also welcome contributions that address uncertainties from initial conditions or the response to a change in boundary conditions and different flavors of DA techniques. Some questions of potential interest include: 1.) How can uncertainty in observations and model states be appropriately quantified and represented? 2.) How to use UQ efficiently to improve DA with model error representation? 3.) How to use DA techniques to better estimate model uncertainty? Possible topics of interest include UQ and DA in a hierarchical set of climate models, representing uncertainties that arise from the coupling of one or more climate system model components, risk assessment strategies, use of new approaches such as information theoretic metrics for uncertainty quantification, assimilation and calibration for UQ of initial and forcing fields.

continued in next column

Organizer: Aneesh Subramanian
University of Oxford, United Kingdom

Organizer: Ibrahim Hoteit
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Ian Grooms
University of Colorado Boulder, USA

Organizer: Mohamed Iskandarani
University of Miami, USA

9:30-9:55 Episodic, Non-linear and Non-Gaussian: Uncertainty Quantification for Cloud, Precipitation, Fire and Ice

Craig Bishop, Naval Research Laboratory, USA; Derek J. Posselt, Jet Propulsion Laboratory, California Institute of Technology

10:00-10:25 Balanced Data Assimilation for Highly-Oscillatory Mechanical Systems

Maria Reinhardt, Universität Potsdam, Germany; Gottfried Hastermann and Rupert Klein, Freie Universität Berlin, Germany; Sebastian Reich, Universität Potsdam, Germany and University of Reading, United Kingdom

10:30-10:55 Reducing Precision in Ensemble Data Assimilation to Improve Forecast Skill

Samuel Hatfield, University of Oxford, United Kingdom; Peter D. Dueben, European Weather Centre, United Kingdom; Matthew Chantry and Tim Palmer, University of Oxford, United Kingdom

11:00-11:25 Singular Likelihoods to Prevent Particle Filter Collapse

Gregor Robinson, University of Colorado Boulder, USA

Monday, April 16

MS2

Recent Advances on Optimal Experimental Design (OED) for Large-scale Systems - Part I of II

9:30 AM-11:30 AM

Room:Grand Ballroom F - 1st Floor

For Part 2 see MS15

Many systems, such as flexible structures, fluid flow, geophysics, and climate, exhibit behavior that varies spatially in several dimensions, as well as in time. The issue in many applications is to deduce the state and/or parameter of these systems based on a mathematical model, as well as measurements made by sensors at a limited number of locations. A well-known example is weather prediction, which combines complex mathematical models with data obtained from measurements. Other examples are estimation of structural vibrations and the determination of the extent of oil deposits, contaminants and buried explosives. Similar issues occur in medical imaging. It is well known that the accuracy of the estimate is limited by the accuracy of the model and of the sensors. Optimal Experimental Design (OED) for large-scale systems is inherently interdisciplinary and requires the synergy of partial differential equation theory, numerical analysis and large-scale simulations, and inverse problems, as well as both frequentist and Bayesian inference and uncertainty quantification. This minisymposium aims to present recent advances in innovative, fast and scalable OED algorithms for various applications including, but not limited to, fluid flow, geophysics, climate, subsurface flows, etc.

Organizer: Tan Bui-Thanh
University of Texas at Austin, USA

Organizer: Ralph Smith
North Carolina State University, USA

9:30-9:55 Mutual Information-based Experimental Design for Problems in Nuclear Engineering

Ralph C. Smith, North Carolina State University, USA; Brian Williams, Los Alamos National Laboratory, USA; Isaac Michaud, John Mattingly, and Jason Hite, North Carolina State University, USA

10:00-10:25 Solving Integer Programming Problems in Design of Experiments

Jing Yu, University of Chicago, USA; Mihai Anitescu, Argonne National Laboratory, USA

10:30-10:55 Mutual Information Estimation in High Dimensions

Gabriel Terejanu and Xiao Lin, University of South Carolina, USA

11:00-11:25 Optimal Experimental Design for Prediction Using a Consistent Bayesian Approach

Tim Wildey, Sandia National Laboratories, USA; Troy Butler, University of Colorado, Denver, USA; John D. Jakeman, Sandia National Laboratories, USA

continued in next column

Monday, April 16

MS3

Randomized Methods in Inverse Problems and Uncertainty Quantification - Part I of II

9:30 AM-11:30 AM

Room:Garden 1 - 1st Floor

For Part 2 see MS16

In many applications, large volumes of data present a fundamental computational challenge for data analysis and the solution of inverse problems. These challenges are magnified when one seeks to quantify uncertainty in the solutions of such inverse problems and in subsequent predictions. Randomized methods offer a powerful approach to overcoming these challenges: they can mitigate storage, communication, and processing costs; and they are broadly used in settings where classical methods from numerical linear algebra and optimization would fail. This minisymposium will bring together researchers from diverse fields to discuss advances in randomized methods and their analysis, with a particular focus on the use of such methods in inverse problems, estimation, and inference. We will discuss new developments in stochastic approximation, algorithmic leveraging, data summaries and coresets, optimal experimental design, and other related topics.

Organizer: Matthias Chung
Virginia Tech, USA

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

Organizer: Jayanth Mohan
Massachusetts Institute of Technology, USA

continued on next page

Monday, April 16

MS3

Randomized Methods in Inverse Problems and Uncertainty Quantification - Part I of II

9:30 AM-11:30 AM

continued

9:30-9:55 Randomized Newton and Quasi-Newton Methods for Large Linear Least Squares Problems

Matthias Chung and Julianne Chung, Virginia Tech, USA; David A. Kozak, Colorado School of Mines, USA; Joseph T. Slagel, Virginia Tech, USA; Luis Tenorio, Colorado School of Mines, USA

10:00-10:25 Maximize the Expected Information Gain in Bayesian Experimental Design Problems: A Fast Optimization Algorithm Based on Laplace Approximation and Randomized Eigensolvers

Umberto Villa and Omar Ghattas, University of Texas at Austin, USA

10:30-10:55 A Probabilistic Subspace Bound, with Application to Active Subspaces

Ilse Ipsen, Ralph Smith, and John Holodnak, North Carolina State University, USA

11:00-11:25 Recovery from Random Observations of Non-linear Low-rank Structures

Malik Magdon-Ismail, Rensselaer Polytechnic Institute, USA; Alex Gittens, University of California, Berkeley, USA

Monday, April 16

MS4

Probabilistic Numerical Methods for Quantification of Discretisation Error - Part I of III

9:30 AM-11:30 AM

Room:Garden 2 - 1st Floor

For Part 2 see MS17

In many important inverse problems - e.g. numerical weather prediction, seismography, and medical tomography - data are related to parameters of interest through the solution of an ordinary or partial differential equation (DE). To proceed with computation, the DE must be discretised. However, such discretisation introduces bias into parameter estimates and can in turn cause conclusions to be over-confident. Probabilistic numerical methods for DEs aim to provide uncertainty quantification in the solution space of the DE to properly account for the fact that the governing equations have been altered through discretisation. In contrast to the worst-case error bounds of classical numerical analysis, the stochasticity in such DE solvers serves as the carrier of uncertainty about discretisation error and its impact. This statistical notion of discretisation uncertainty can then be more easily propagated to later inferences, e.g. in a Bayesian inverse problem. Several such probabilistic numerical methods have been developed in recent years, but the connections and distinctions between these methods are not yet fully understood. In particular, an important challenge is to ensure that such uncertainty estimates are well-calibrated. This minisymposium will examine recent advances in both the development and implementation of probabilistic numerical methods in general. The talks cover aspects from foundations and theory through to computation and application.

Organizer: Tim Sullivan
Freie Universität Berlin, Germany

Organizer: Chris Oates
Newcastle University, United Kingdom

Organizer: Philipp Hennig
Max Planck Institute for Intelligent Systems, Germany

Organizer: Mark Girolami
Imperial College London, United Kingdom

9:30-9:55 Bayesian Probabilistic Numerical Methods

Tim Sullivan, Freie Universität Berlin, Germany; Jon Cockayne, University of Warwick, United Kingdom; Chris Oates, Newcastle University, United Kingdom; Mark Girolami, Imperial College London, United Kingdom

10:00-10:25 Approximate Integral Methods for Fast Model Diagnostics

Dave A. Campbell, Simon Fraser University, Canada

10:30-10:55 Bayesian Probabilistic Numerical Methods for Industrial Process Monitoring

Jon Cockayne, University of Warwick, United Kingdom

11:00-11:25 Convergence Rates of Gaussian ODE Filters

Hans Kersting, Max Planck Institute for Intelligent Systems, Germany; Tim Sullivan, Freie Universität Berlin, Germany; Philipp Hennig, Max Planck Institute for Intelligent Systems, Germany

continued in next column

Monday, April 16

MS5

Model Reduction and Fast Sampling Methods for Bayesian Inference - Part I of II

9:30 AM-11:00 AM

Room:Garden 3 - 1st Floor

For Part 2 see MS18

It is increasingly important to equip a numerical model or simulation with estimates of uncertainty. For these estimates to be meaningful, they must be carefully derived, e.g., by Bayes' rule and conditional probability, which allows one to estimate model uncertainties from noisy data. Numerical methods to perform such Bayesian inference often rely on Monte Carlo sampling. The cost of these methods can be high, because they require repeated simulation/evaluation of a numerical model, where each evaluation may be computationally expensive. This session focuses on techniques that aim to mitigate this computational burden, including replacing high-fidelity models with surrogate models, reducing the dimensionality of the parameter space, devising efficient sampling methods, and employing goal-oriented approaches.

Organizer: Fei Lu
Johns Hopkins University, USA

Organizer: Matthias Morzfeld
University of Arizona, USA

9:30-9:55 Speeding Up Sequential Tempered MCMC for Fast Bayesian Inference and Uncertainty Quantification
Thomas A. Catanach, Sandia National Laboratories, USA

10:00-10:25 Implicit Sampling for Stochastic Differential Equations
Jonathan Goodman, Courant Institute of Mathematical Sciences, New York University, USA; Andrew Leach, *Kevin K. Lin,* and Matthias Morzfeld, University of Arizona, USA

10:30-10:55 Local Ensemble Kalman Filter with a Small Sample Size
Xin T. Tong, National University of Singapore, Singapore

Monday, April 16

MS6

Quantification and Prediction of Extreme Events in Complex Systems - Part I of II

9:30 AM-11:30 AM

Room:Garden 4 - 1st Floor

For Part 2 see MS19

For many natural and engineering systems, extreme events, corresponding to large excursions, have significant consequences and are important to understand. Important examples can be found in mechanical systems, in nonlinear waves, fluid mechanics, and geophysics. These extreme events are formed due to the synergistic action of the inherent system stochasticity and dynamical instabilities, which are randomly and intermittently triggered. There are two important challenges related to extreme events: i) the problem of short term prediction given information for the current system state, and ii) the quantification of the tail properties for quantities of interest. The aim of this MS is to present recently developed methods tackling these two general problems. Approaches based on data, equations, or combination of both will be discussed and assessed on various applications.

Organizer: Themistoklis Sapsis
Massachusetts Institute of Technology, USA

9:30-9:55 New Statistically Accurate Algorithms for Fokker-Planck Equations in Large Dimensions and Predicting Extreme Events
Andrew Majda, Courant Institute of Mathematical Sciences, New York University, USA

10:00-10:25 A Variational Approach to Probing Extreme Events in Turbulent Dynamical Systems
Mohammad Farazmand and Themistoklis Sapsis, Massachusetts Institute of Technology, USA

10:30-10:55 Predictability of Extreme-causing Weather Patterns in the Midlatitude Turbulence
Pedram Hassanzadeh, Rice University, USA

11:00-11:25 Closed-loop Reduced-order Control of Extreme Events in High-dimensional Systems
Saviz Mowlavi and Themistoklis Sapsis, Massachusetts Institute of Technology, USA

Monday, April 16

MS7

Sparse Approximations Algorithms for High-dimensional Problems in Uncertainty Quantification - Part I of III

9:30 AM-11:30 AM

Room:Pacific - 2nd Floor

For Part 2 see MS20

Many problems in uncertainty quantification rely on robust and efficient approximations of parametric variability. A large number of parameters raises the challenge of high-dimensional approximation. One of the more successful approaches to address this challenge seeks sparse or compressible representations of parametric variation. Such an approach is flexible enough to exploit structure such as smoothness, sparsity, low-rank manifolds, or low intrinsic dimensionality. This minisymposium highlights recent advances in theory and algorithms for sparse approximation as applied to problems in uncertainty quantification, and brings together researchers from across the applied and computational mathematics community to discuss and collaborate on novel theoretical and computational advances in sparse approximation strategies, and to discuss future directions for research.

Organizer: Akil Narayan
University of Utah, USA

Organizer: Ben Adcock
Simon Fraser University, Canada

9:30-9:55 Title Not Available
Clayton G. Webster, University of Tennessee and Oak Ridge National Laboratory, USA

10:00-10:25 Induced Distribution Sampling for Sparse Approximations
Mani Razi, University of Utah, USA; Ben Adcock, Simon Fraser University, Canada; Simone Brugiapaglia, Politecnico di Milano, Italy; Akil Narayan, University of Utah, USA

continued on next page

Monday, April 16

MS7

Sparse Approximations Algorithms for High-dimensional Problems in Uncertainty Quantification - Part I of III

9:30 AM-11:30 AM

continued

10:30-10:55 Sparsity in Low-rank Tensor Decompositions

Alex Gorodetsky and John D. Jakeman, Sandia National Laboratories, USA

11:00-11:25 Alternating Direction Method for Enhancing Sparsity of the Representation of Uncertainty

Xiu Yang, Pacific Northwest National Laboratory, USA

Monday, April 16

MS8

Machine Learning Approaches to Multi-fidelity Modeling, Optimization, and Uncertainty Quantification - Part I of II

9:30 AM-11:30 AM

Room:Harbor - 2nd Floor

For Part 2 see MS21

The concept of multi-fidelity modeling has been a key enabler of scalability across many diverse applications including optimization under uncertainty, assimilation of heterogenous and noisy data, and efficient estimation of model parameters. With a goal of identifying and exploiting any cross-correlation between variable fidelity data, recent approaches aim to design scalable and robust information fusion algorithms by seamlessly blending state-of-the-art machine learning with classical mathematical concepts such as the general embedding theorems of Nash, Takens, and Whitney. This minisymposium invites contributions that showcase the potential of machine learning techniques in multi-fidelity modeling, and highlight their effectiveness in predictive modeling, uncertainty quantification, and the analysis and optimization of complex systems.

Organizer: Paris Perdikaris
Massachusetts Institute of Technology, USA

Organizer: Maziar Raissi
Brown University, USA

Organizer: George Em Karniadakis
Brown University, USA

9:30-9:55 Multi-fidelity Modeling for Optimizing Battery Design

Wenxiao Pan, University of Wisconsin, Madison, USA; Xiu Yang, Jie Bao, and Michelle Wang, Pacific Northwest National Laboratory, USA

continued in next column

10:00-10:25 Using the Problem Symmetries to Improve Surrogates Models

María Giselle Fernández-Godino, Raphael Haftka, and S. Balachandar, University of Florida, USA

10:30-10:55 Linking Gaussian Process Regression with Data-driven Manifold Embeddings for Robust Nonlinear Information Fusion

Lee Seungjoon, Johns Hopkins University, USA; George Em Karniadakis, Brown University, USA; Ioannis Kevrekidis, Princeton University, USA

11:00-11:25 Deep Neural Networks for Multifidelity Uncertainty Quantification

Rohit Tripathi and Ilias Bilionis, Purdue University, USA

Monday, April 16

MS9

Characterizing Nonlinear Dynamical Systems from Noisy Data - Part I of II

9:30 AM-11:30 AM

Room:Salon I - 2nd Floor

For Part 2 see MS22

The data-driven characterization of dynamical systems is a central goal in many diverse fields, ranging from fluid mechanics and climate modeling to neuroscience and epidemiology. Our ability to model dynamics from data has benefited dramatically from recent developments in machine learning and optimization. However, these techniques generally require large volumes of relatively clean measurement data. Effective characterization of highly noisy and stochastic systems remains an important focus of research attention. In this minisymposium, we will investigate various aspects of data-driven discovery, with an emphasis on noisy, uncertain, or corrupt measurements. Theoretical results will be highlighted with compelling domain examples.

Organizer: Steven Brunton

University of Washington, USA

Organizer: Nathan Kutz

University of Washington, USA

9:30-9:55 Identifying Nonlinear Dynamics and Intrinsic Coordinates under Uncertainty

Steven Brunton, University of Washington, USA

10:00-10:25 Sparse Identification of Nonlinear Dynamics for Model Predictive Control in the Low-data Limit

Eurika Kaiser, University of Washington, USA

10:30-10:55 Nonparametric Estimation for Stochastic Dynamical Systems

Harish S. Bhat, University of California, Merced, USA

11:00-11:25 Robust and Scalable Methods for the Dynamic Mode Decomposition

Travis Askham, University of Washington, USA

Monday, April 16

MS10

Computational Methods for Uncertainties in Complex Fluid Flows - Part I of II

9:30 AM-11:30 AM

Room:Salon II - 2nd Floor

For Part 2 see MS23

This minisymposium will address uncertainty quantification (UQ) for complex fluid flow problems, with an emphasis on applications in energy systems. Examples are wind energy, multiphase flow transport in pipelines or tankers, and geophysical fluid dynamics. A common denominator in all these applications is the very high computational costs associated with forward model runs, and the presence of multiscale phenomena. The main challenges in UQ of such systems are: (i) to determine and parameterize the most important uncertainties, (ii) to calibrate the mathematical-physical models (such as turbulence closure terms) based on measurement data or high-fidelity models, and (iii) to determine how uncertainties propagate through the models and influence the quantity of interest, such as the cost of energy. In this minisymposium we bring together researchers with a variety of backgrounds and applications to discuss and learn about dealing with this type of problems: calibration and propagation of uncertainties and closure models in high-dimensional random parameter spaces, combined with high computational cost associated with model runs.

Organizer: Benjamin Sanderse

Centrum voor Wiskunde en Informatica (CWI), Netherlands

Organizer: Daan Crommelin

Centrum voor Wiskunde en Informatica (CWI), Netherlands

continued in next column

Organizer: Olivier P. Le Maître

LIMSI-CNRS, France

Organizer: Pietro M. Congedo

Inria Bordeaux Sud-Ouest, France

9:30-9:55 UQ with Dependent Variables in Wind Farm Applications

Anne Eggels and Daan Crommelin, Centrum voor Wiskunde en Informatica (CWI), Netherlands

10:00-10:25 Uncertainty Quantification in Large-scale Multiphysics Applications using Exascale Approaches

Gianluca Iaccarino and Lluis Jofre, Stanford University, USA; Gianluca Geraci, Sandia National Laboratories, USA; Alireza Doostan, University of Colorado Boulder, USA

10:30-10:55 Closure Models for Quantifying Uncertainty in Multiphase Flow Transport Problems

Benjamin Sanderse, Sirshendu Misra, and Yous van Halder, Centrum voor Wiskunde en Informatica (CWI), Netherlands

11:00-11:25 An Efficient Reliability Analysis Tool for the Computation of Low Tail Probabilities and Extreme Quantiles in Multiple Failure Regions: Application to Organic Rankine Cycles

Nassim Razaaly and Pietro M. Congedo, Inria Bordeaux Sud-Ouest, France

Monday, April 16

MS11

UQ and Stochastic Optimization for Complex Energy Systems - Part I of II

9:30 AM-11:30 AM

Room:Salon VIII - 2nd Floor

For Part 2 see MS24

Design, analysis, and operation of energy systems often require solving high-dimensional stochastic optimization problems and require uncertainty characterizations of myriad factors such as multi-scale electricity markets, physical models, fatigue, and demands. This minisymposium brings together experts in uncertainty quantification, stochastic optimization, and mathematical modeling to explore novel approaches applied to emerging energy applications such as electricity transmission and natural gas networks, solar power systems, fossil-fueled systems with carbon capture, and nuclear energy systems.

Organizer: Alexander W. Dowling
University of Notre Dame, USA

Organizer: Victor M. Zavala
University of Wisconsin, Madison, USA

Organizer: Emil M. Constantinescu
Argonne National Laboratory, USA

9:30-9:55 Optimal Energy Storage Scheduling in Electricity Markets with Multiscale Uncertainty
Alexander W. Dowling, University of Notre Dame, USA

10:00-10:25 Real-time Data Assimilation in Natural Gas Networks
Victor M. Zavala, University of Wisconsin, Madison, USA

10:30-10:55 Estimating Uncertainities using Neural Network Surrogates and Dropout
Ryan McClarren, University of Notre Dame, USA

11:00-11:25 Uncertainty Quantification for Carbon Capture Systems
Peter W. Marcy, Troy Holland, K. Sham Bhat, Christine Anderson-Cook, and James Gattiker, Los Alamos National Laboratory, USA

Monday, April 16

MS12

Stochastic Modeling and Simulation for UQ in Computational Mechanics - Part I of II

9:30 AM-11:30 AM

Room:Salon V - 2nd Floor

For Part 2 see MS25

This minisymposium focuses on methodological, mathematical, and algorithmic aspects of stochastic modeling and simulation of uncertainties in Computational Mechanics. This issue is relevant to multi-scale and multi-physics analysis, where randomness can arise when scale separation is not reached or when knowledge about subscale features or coupled physics phenomena remains imperfect because of data paucity, for example. More generally, representing random data in a way that is both physically realistic and mathematical consistent is key for high-fidelity simulations relying on UQ. Historically, the modeling task has been mostly achieved through mathematical statistics methods and Karhunen-Loève and polynomial chaos expansions of random vectors and fields. These techniques have enabled the construction of efficient stochastic solvers and are now widely used in academia and industry. Additional contributions have also been devoted to the construction of admissible algebraic or spectral representations, as well as to the development of Bayesian approaches. The aim of this MS is to present recent advances in stochastic modeling in both linear and nonlinear computational mechanics. More specifically, this session will be focused on the construction and updating of stochastic models, on the construction of associated robust sampling techniques, and on the propagation of uncertainties at or across relevant scales and physical components.

continued in next column

Organizer: Johann Guilleminot
Duke University, USA

Organizer: Maarten Arnst
Université de Liège, Belgium

9:30-9:55 Mathematical Modeling and Sampling of Stochastic Nonlinear Constitutive Laws on Smooth Manifolds
Brian Staber and *Johann Guilleminot,* Duke University, USA

10:00-10:25 Stochastic Modeling of Multiscale Materials
Loujaine Mehrez and Roger Ghanem, University of Southern California, USA

10:30-10:55 Bayesian Uncertainty Quantification in the Prediction of Thermodynamical, Mechanical and Electronic Properties of Alloys using the Cluster Expansion Method
Sina Malakpour Estalaki and Nicholas Zabaras, University of Notre Dame, USA

11:00-11:25 Identifying Sample Properties of Random Fields that Yield Response Maxima
Wayne Isaac T. Uy and Mircea Grigoriu, Cornell University, USA

Monday, April 16

MS13

Exploring the Links Between Parameter Sensitivity, Identifiability, and Uncertainty Quantification - Part I of II

9:30 AM-11:30 AM

Room:Salon VI - 2nd Floor

For Part 2 see MS26

Parameter space reduction and parameter estimation are essential for many questions in mathematical modeling and uncertainty quantification. As such, different disciplines have developed methods in parallel for approaching the questions in their field. Many of these approaches, including identifiability, sloppiness, and active subspaces, use related ideas to address questions of parameter dimension reduction, parameter estimation, and robustness of inferences and quantities of interest. This minisymposium will provide an overview of different techniques and bring together researchers from different fields to provide algebraic, geometric, and statistical perspectives on their use in uncertainty quantification.

Organizer: Andrew F. Brouwer
University of Michigan, USA

Organizer: Marisa Eisenberg
University of Michigan, USA

9:30-9:55 The Underlying Connections Between Identifiability, Sloppiness, and Active Subspaces
Marisa Eisenberg and Andrew F. Brouwer, University of Michigan, USA

10:00-10:25 Active Subspaces in Parameterized Dynamical Systems
Izabel P. Aguiar and Paul Constantine, University of Colorado Boulder, USA

10:30-10:55 Identifiability of Linear Compartmental Models: The Singular Locus
Nicolette Meshkat, Santa Clara University, USA; Elizabeth Gross, San Jose State University, USA; Anne Shiu, Texas A&M University, USA

11:00-11:25 Gauss--Christoffel Quadrature for Inverse Regression
Andrew Glaws and Paul Constantine, University of Colorado Boulder, USA

Monday, April 16

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

IP2

On Gradient-Based Optimization: Accelerated, Stochastic and Nonconvex

1:00 PM-1:45 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Jennifer Hoeting, Colorado State University, USA

Many new theoretical challenges have arisen in the area of gradient-based optimization for large-scale statistical data analysis, driven by the needs of applications and the opportunities provided by new hardware and software platforms. I discuss several recent results in this area, focusing on: (1) a new framework for understanding Nesterov acceleration, obtained by taking a continuous-time, Lagrangian/Hamiltonian/symplectic perspective, (2) a discussion of how to escape saddle points efficiently in nonconvex optimization, and (3) the acceleration of Langevin diffusion.

Michael I. Jordan
University of California, Berkeley, USA

Intermission

1:45 PM-2:00 PM

Monday, April 16

MT2

Approximate Bayesian Computation

2:00 PM-4:00 PM

Room:Grand Ballroom G - 1st Floor

Bayesian inference is an attractive framework for combining information and uncertainty quantification. However, for some statistical models of interest it may be difficult to compute the likelihood, and this complicates the application of usual Bayesian computational methods. If it is possible to simulate data from the model, Bayesian inference can sometimes be performed without evaluating the likelihood using so-called likelihood-free inference methods. This tutorial is an introduction to these methods focusing mostly on approximate Bayesian computation (ABC) approaches. After considering first the earliest ABC algorithms, more advanced topics will be discussed such as Markov chain Monte Carlo and Sequential Monte Carlo ABC, regression post-processing adjustments, variational methods and expectation propagation, model choice and high-dimensional ABC. Although it is not possible to give a comprehensive discussion of current research on likelihood-free inference methods, the focus will be on discussing some methods which may be of particular interest to the uncertainty quantification community.

Organizer and Speaker:

David Nott
National University of Singapore, Singapore

Monday, April 16

MS14

Uncertainty Quantification and Data Assimilation in Earth System Modeling and Prediction - Part II of II

2:00 PM-4:00 PM

Room:Grand Ballroom ABCD - 1st Floor

For Part 1 see MS1

Uncertainty quantification (UQ) of earth system forecasts presents fundamental challenges in mathematics and statistics that is intertwined with limitations in observations, scientific understanding of the processes that determine this uncertainty and how best to combine this with our current generation models with data assimilation (DA). The goal of the minisymposium is to provide a forum for this diverse group to discuss and share ideas for advancing the science of UQ and DA in climate modeling or any of its components (e.g. atmosphere, ocean, ice sheets, or sea ice). We also welcome contributions that address uncertainties from initial conditions or the response to a change in boundary conditions and different flavors of DA techniques. Some questions of potential interest include: 1.) How can uncertainty in observations and model states be appropriately quantified and represented? 2.) How to use UQ efficiently to improve DA with model error representation? 3.) How to use DA techniques to better estimate model uncertainty? Possible topics of interest include UQ and DA in a hierarchical set of climate models, representing uncertainties that arise from the coupling of one or more climate system model components, risk assessment strategies, use of new approaches such as information theoretic metrics for uncertainty quantification, assimilation and calibration for UQ of initial and forcing fields.

continued in next column

Organizer: Ian Grooms
University of Colorado Boulder, USA

Organizer: Aneesh Subramanian
University of Oxford, United Kingdom

Organizer: Ibrahim Hoteit
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Mohamed Iskandarani
University of Miami, USA

2:00-2:25 State Estimation for a Filtered Representation of a Chaotic Field

Daniel Hodyss, Naval Research Laboratory, USA; Peter O. Schwartz, Lawrence Berkeley National Laboratory, USA

2:30-2:55 On the Interaction of Observation and Prior Error Correlations

Alison M. Fowler, Sarah Dance, and Joanne Waller, University of Reading, United Kingdom

3:00-3:25 Feature Data Assimilation: A Tool for Model Tuning

John Maclean, University of North Carolina, Chapel Hill, USA

3:30-3:55 Addressing Uncertainty in Cloud Microphysics Using Radar Observations and Bayesian Methods

Marcus van Lier-Walqui, NASA Goddard Institute for Space Studies, USA

Monday, April 16

MS15

Recent Advances on Optimal Experimental Design (OED) for Large-scale Systems - Part II of II

2:00 PM-4:00 PM

Room:Grand Ballroom F - 1st Floor

For Part 1 see MS2

Many systems, such as flexible structures, fluid flow, geophysics, and climate, exhibit behavior that varies spatially in several dimensions, as well as in time. The issue in many applications is to deduce the state and/or parameter of these systems based on a mathematical model, as well as measurements made by sensors at a limited number of locations. A well-known example is weather prediction, which combines complex mathematical models with data obtained from measurements. Other examples are estimation of structural vibrations and the determination of the extent of oil deposits, contaminants and buried explosives. Similar issues occur in medical imaging. It is well known that the accuracy of the estimate is limited by the accuracy of the model and of the sensors.

Organizer: Tan Bui-Thanh
University of Texas at Austin, USA

Organizer: Ralph C. Smith
North Carolina State University, USA

2:00-2:25 Efficient Randomized Methods for D-Optimal Sensor Placement for Infinite-dimensional Bayesian Linear Inverse Problems Governed by PDEs

Alen Alexanderian, Elizabeth Herman, and Arvind Saibaba, North Carolina State University, USA

continued on next page

2:30-2:55 Optimal Positioning of Mobile Radiation Sensors Using Mutual Information

Kathleen Schmidt, Lawrence Livermore National Laboratory, USA; Ralph C. Smith, North Carolina State University, USA; Deepak Rajan and Ryan Goldhahn, Lawrence Livermore National Laboratory, USA; Jason Hite and John Mattingly, North Carolina State University, USA

3:00-3:25 Fast Methods for Bayesian Optimal Experimental Design

Sriramkrishnan Muralikrishnan, Brad Marvin, and Tan Bui-Thanh, University of Texas at Austin, USA

3:30-3:55 Sparse Sensor Placement in Bayesian Inverse Problems

Daniel Walter, Technische Universität München, Germany

Monday, April 16

MS16

Randomized Methods in Inverse Problems and Uncertainty Quantification - Part II of II

2:00 PM-4:00 PM

Room:Garden 1 - 1st Floor

For Part 1 see MS3

In many applications, large volumes of data present a fundamental computational challenge for data analysis and the solution of inverse problems. These challenges are magnified when one seeks to quantify uncertainty in the solutions of such inverse problems and in subsequent predictions. Randomized methods offer a powerful approach to overcoming these challenges: they can mitigate storage, communication, and processing costs; and they are broadly used in settings where classical methods from numerical linear algebra and optimization would fail. This minisymposium will bring together researchers from diverse fields to discuss advances in randomized methods and their analysis, with a particular focus on the use of such methods in inverse problems, estimation, and inference. We will discuss new developments in stochastic approximation, algorithmic leveraging, data summaries and coresets, optimal experimental design, and other related topics.

Organizer: Matthias Chung
Virginia Tech, USA

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

Organizer: Jayanth Mohan
Massachusetts Institute of Technology, USA

2:00-2:25 Subsampled Second Order Machine Learning and Scalable Quantification of Uncertainties

Michael Mahoney and Fred Roosta, University of California, Berkeley, USA

continued in next column

2:30-2:55 Low-Rank Independence Samplers for Bayesian Inverse Problems

Arvind Saibaba and Alen Alexanderian, North Carolina State University, USA; Johnathan M. Bardsley, University of Montana, USA; Andrew Brown, Clemson University, USA; Sarah Vallelian, Statistical and Applied Mathematical Sciences Institute, USA

3:00-3:25 Convergence Properties of a Randomized Quasi-Newton Method for Least Squares Solutions to Linear Systems

David A. Kozak, Colorado School of Mines, USA; Julianne Chung, Matthias Chung, and Joseph T. Slagel, Virginia Tech, USA; Luis Tenorio, Colorado School of Mines, USA

3:30-3:55 A Unifying Framework for Randomization Methods for Inverse Problems

Ellen B. Le, Brad Marvin, and Tan Bui-Thanh, University of Texas at Austin, USA

Monday, April 16

MS17

Probabilistic Numerical Methods for Quantification of Discretisation Error - Part II of III

2:00 PM-4:00 PM

Room:Garden 2 - 1st Floor

For Part 1 see MS4
For Part 3 see MS32

In many important inverse problems - e.g. numerical weather prediction, seismography, and medical tomography - data are related to parameters of interest through the solution of an ordinary or partial differential equation (DE). To proceed with computation, the DE must be discretised. However, such discretisation introduces bias into parameter estimates and can in turn cause conclusions to be over-confident. Probabilistic numerical methods for DEs aim to provide uncertainty quantification in the solution space of the DE to properly account for the fact that the governing equations have been altered through discretisation. In contrast to the worst-case error bounds of classical numerical analysis, the stochasticity in such DE solvers serves as the carrier of uncertainty about discretisation error and its impact. This statistical notion of discretisation uncertainty can then be more easily propagated to later inferences, e.g. in a Bayesian inverse problem. Several such probabilistic numerical methods have been developed in recent years, but the connections and distinctions between these methods are not yet fully understood. In particular, an important challenge is to ensure that such uncertainty estimates are well-calibrated. This minisymposium will examine recent advances in both the development and implementation of probabilistic numerical methods in general. The talks cover aspects from foundations and theory through to computation and application.

continued in next column

Organizer: Tim Sullivan
Freie Universität Berlin, Germany

Organizer: Chris Oates
Newcastle University, United Kingdom

Organizer: Philipp Hennig
Max Planck Institute for Intelligent Systems, Germany

Organizer: Mark Girolami
Imperial College London, United Kingdom

2:00-2:25 Why Uncertainty Matters in Deterministic Computations: A Decision Theoretic Perspective

Motonobu Kanagawa, Max Planck Institute for Intelligent Systems, Germany

2:30-2:55 Boundary Value Problems: A Case Study for Nested Probabilistic Numerical Methods

Michael Schober, Bosch Center for Artificial Intelligence, Germany

3:00-3:25 Probabilistic Implicit Methods for Initial Value Problems

Onur Teymur, Imperial College London, United Kingdom

3:30-3:55 Compression, Inversion and Approximate Principal Component Analysis of Dense Kernel Matrices at Near-linear Computational Complexity

Florian Schaefer, California Institute of Technology, USA; Tim Sullivan, Freie Universität Berlin, Germany; Houman Owhadi, California Institute of Technology, USA

Monday, April 16

MS18

Model Reduction and Fast Sampling Methods for Bayesian Inference - Part II of II

2:00 PM-4:00 PM

Room:Garden 3 - 1st Floor

For Part 1 see MS5

It is increasingly important to equip a numerical model or simulation with estimates of uncertainty. For these estimates to be meaningful, they must be carefully derived, e.g., by Bayes' rule and conditional probability, which allows one to estimate model uncertainties from noisy data. Numerical methods to perform such Bayesian inference often rely on Monte Carlo sampling. The cost of these methods can be high, because they require repeated simulation/evaluation of a numerical model, where each evaluation may be computationally expensive. This session focuses on techniques that aim to mitigate this computational burden, including replacing high-fidelity models with surrogate models, reducing the dimensionality of the parameter space, devising efficient sampling methods, and employing goal-oriented approaches.

Organizer: Fei Lu
Johns Hopkins University, USA

Organizer: Matthias Morzfeld
University of Arizona, USA

2:00-2:25 MCMC for High Energy X-Ray Radiography

Jesse Adams, University of Arizona, USA

2:30-2:55 Iterative Construction of Gaussian Process Surrogate Models for Bayesian Inference in Combustion

Leen Alawieh and Marcus Day, Lawrence Berkeley National Laboratory, USA; Jonathan Goodman, Courant Institute of Mathematical Sciences, New York University, USA; John B. Bell, Lawrence Berkeley National Laboratory, USA

continued on next page

3:00-3:25 Rigorous Integration of Reduced-order Models in Bayesian Inference via Statistical Error Models

Kevin T. Carlberg, Sandia National Laboratories, USA; Wayne Isaac T. Uy, Cornell University, USA; Fei Lu, Johns Hopkins University, USA; Matthias Morzfeld, University of Arizona, USA

3:30-3:55 Data Assimilation with Stochastic Reduced Models

Fei Lu, Johns Hopkins University, USA; Alexandre Chorin, University of California, Berkeley, USA; Xuemin Tu, University of Kansas, USA

Monday, April 16

MS19

Quantification and Prediction of Extreme Events in Complex Systems - Part II of II

2:00 PM-3:30 PM

Room:Garden 4 - 1st Floor

For Part 1 see MS6

For many natural and engineering systems, extreme events, corresponding to large excursions, have significant consequences and are important to understand. Important examples can be found in mechanical systems, in nonlinear waves, fluid mechanics, and geophysics. These extreme events are formed due to the synergistic action of the inherent system stochasticity and dynamical instabilities, which are randomly and intermittently triggered. There are two important challenges related to extreme events: i) the problem of short term prediction given information for the current system state, and ii) the quantification of the tail properties for quantities of interest. The aim of this MS is to present recently developed methods tackling these two general problems. Approaches based on data, equations, or combination of both will be discussed and assessed on various applications.

Organizer: Themistoklis Sapsis

Massachusetts Institute of Technology, USA

2:00-2:25 A Sequential Sampling Strategy for Extreme Event Statistics in Nonlinear Dynamical Systems

Mustafa Mohamad and Themistoklis Sapsis, Massachusetts Institute of Technology, USA

2:30-2:55 Predicting Statistical Response and Extreme Events in Uncertainty Quantification Through Reduced-order Models

Di Qi, New York University, USA

3:00-3:25 Complementing Imperfect Models with Data for the Prediction of Extreme Events in Complex Systems

Zhong Wan and Themistoklis Sapsis, Massachusetts Institute of Technology, USA

Monday, April 16

MS20

Sparse Approximations Algorithms for High-dimensional Problems in Uncertainty Quantification - Part II of III

2:00 PM-4:00 PM

Room:Pacific - 2nd Floor

For Part 1 see MS7
For Part 3 see MS42

Many problems in uncertainty quantification rely on robust and efficient approximations of parametric variability. A large number of parameters raises the challenge of high-dimensional approximation. One of the more successful approaches to address this challenge seeks sparse or compressible representations of parametric variation. Such an approach is flexible enough to exploit structure such as smoothness, sparsity, low-rank manifolds, or low intrinsic dimensionality. This minisymposium highlights recent advances in theory and algorithms for sparse approximation as applied to problems in uncertainty quantification, and brings together researchers from across the applied and computational mathematics community to discuss and collaborate on novel theoretical and computational advances in sparse approximation strategies, and to discuss future directions for research.

Organizer: Akil Narayan

University of Utah, USA

Organizer: Ben Adcock

Simon Fraser University, Canada

continued on next page

Monday, April 16

MS20

Sparse Approximations Algorithms for High-dimensional Problems in Uncertainty Quantification - Part II of III

2:00 PM-4:00 PM

continued

2:00-2:25 Title Not Available
Dongbin Xiu, Ohio State University, USA

2:30-2:55 Sparse Approximation for Data-driven Polynomial Chaos Expansion and their Applications in UQ
Ling Guo and Yongle Liu, Shanghai Normal University, China; Akil Narayan, University of Utah, USA; Tao Zhou, Chinese Academy of Sciences, China

3:00-3:25 L1 Minimization Method for Link Flow Correction
Penghang Yin, University of California, Los Angeles, USA; Zhe Sun, Wenlong Jin, and Jack Xin, University of California, Irvine, USA

3:30-3:55 Design of Optimal Experiments for Compressive Sampling of Polynomial Chaos Expansions
Paul Diaz, Jerrad Hampton, and Alireza Doostan, University of Colorado Boulder, USA

Monday, April 16

MS21

Machine Learning Approaches to Multi-fidelity Modeling, Optimization, and Uncertainty Quantification - Part II of II

2:00 PM-4:00 PM

Room:Harbor - 2nd Floor

For Part 1 see MS8

The concept of multi-fidelity modeling has been a key enabler of scalability across many diverse applications including optimization under uncertainty, assimilation of heterogenous and noisy data, and efficient estimation of model parameters. With a goal of identifying and exploiting any cross-correlation between variable fidelity data, recent approaches aim to design scalable and robust information fusion algorithms by seamlessly blending state-of-the-art machine learning with classical mathematical concepts such as the general embedding theorems of Nash, Takens, and Whitney. This minisymposium invites contributions that showcase the potential of machine learning techniques in multi-fidelity modeling, and highlight their effectiveness in predictive modeling, uncertainty quantification, and the analysis and optimization of complex systems.

Organizer: Paris Perdikaris
Massachusetts Institute of Technology, USA

Organizer: Maziar Raissi
Brown University, USA

Organizer: George Em Karniadakis
Brown University, USA

2:00-2:25 Physics-based Machine Learning via Adaptive Reduced Models and Multi-fidelity Modeling
Laura Mainini, Massachusetts Institute of Technology, USA; Renee Swischuk, Texas A&M University, USA; *Karen Wilcox*, Massachusetts Institute of Technology, USA

2:30-2:55 Warpings, Embeddings, and Latent Variables: The Quest of Learning from Multi-fidelity Data
Paris Perdikaris, Massachusetts Institute of Technology, USA

3:00-3:25 Hidden Physics Models: Machine Learning of Partial Differential Equations
Maziar Raissi and George Em Karniadakis, Brown University, USA

3:30-3:55 Uncertainty Quantification in High-dimensional Dynamical Systems Using a Data-driven Low-rank Approximation
Hessam Babaee, University of Pittsburgh, USA

continued in next column

Monday, April 16

MS22

Characterizing Nonlinear Dynamical Systems from Noisy Data - Part II of II

2:00 PM-4:00 PM

Room:Salon I - 2nd Floor

For Part 1 see MS9

The data-driven characterization of dynamical systems is a central goal in many diverse fields, ranging from fluid mechanics and climate modeling to neuroscience and epidemiology. Our ability to model dynamics from data has benefited dramatically from recent developments in machine learning and optimization. However, these techniques generally require large volumes of relatively clean measurement data. Effective characterization of highly noisy and stochastic systems remains an important focus of research attention. In this minisymposium, we will investigate various aspects of data-driven discovery, with an emphasis on noisy, uncertain, or corrupt measurements. Theoretical results will be highlighted with compelling domain examples.

Organizer: Steven Brunton

University of Washington, USA

Organizer: Nathan Kutz

University of Washington, USA

2:00-2:25 Title Not Available

Pierre F. Lermusiaux, Massachusetts Institute of Technology, USA

2:30-2:55 Title Not Available

Zhizhen Zhao, University of Illinois, USA

3:00-3:25 An Information-theoretic Approach to Selecting Data-driven, Dynamical Systems via Sparse Regression

Joshua L. Proctor, Institute for Disease Modeling, USA

3:30-3:55 Control of Weakly Observed Nonlinear Dynamical Systems using Reinforcement Learning

Lionel Mathelin, CNRS, France; Alex Gorodetsky, Sandia National Laboratories, USA; Laurent Cordier, CNRS, France

Monday, April 16

MS23

Computational Methods for Uncertainties in Complex Fluid Flows - Part II of II

2:00 PM-4:00 PM

Room:Salon II - 2nd Floor

For Part 1 see MS10

This minisymposium will address uncertainty quantification (UQ) for complex fluid flow problems, with an emphasis on applications in energy systems. Examples are wind energy, multiphase flow transport in pipelines or tankers, and geophysical fluid dynamics. A common denominator in all these applications is the very high computational costs associated with forward model runs, and the presence of multiscale phenomena. The main challenges in UQ of such systems are: (i) to determine and parameterize the most important uncertainties, (ii) to calibrate the mathematical-physical models (such as turbulence closure terms) based on measurement data or high-fidelity models, and (iii) to determine how uncertainties propagate through the models and influence the quantity of interest, such as the cost of energy. In this minisymposium we bring together researchers with a variety of backgrounds and applications to discuss and learn about dealing with this type of problems: calibration and propagation of uncertainties and closure models in high-dimensional random parameter spaces, combined with high computational cost associated with model runs.

Organizer: Benjamin Sanderse

Centrum voor Wiskunde en Informatica (CWI), Netherlands

Organizer: Daan Crommelin

Centrum voor Wiskunde en Informatica (CWI), Netherlands

Organizer: Olivier P. Le Maître

LIMSI-CNRS, France

Organizer: Pietro M. Congedo

Inria Bordeaux Sud-Ouest, France

continued in next column

2:00-2:25 Bayesian Inference for Estimating Discrepancy Functions in Rans Turbulence Model Closures

Wouter N. Edeling and Gianluca Iaccarino, Stanford University, USA

2:30-2:55 Inference of Model Parameters in a Debris Flow Model Using Experimental Data

Maria I. Navarro Jimenez, King Abdullah University of Science & Technology (KAUST), Saudi Arabia; Olivier Le Maitre, LIMSI-CNRS, France; Ibrahim Hoteit, King Abdullah University of Science & Technology (KAUST), Saudi Arabia; David George, USGS Cascades Volcano Observatory, USA; Kyle T. Mandli, Columbia University, USA; Omar Knio, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

3:00-3:25 Uncertainty Quantification Strategies in Systems of Solvers

Francois J. Sanson, Inria Bordeaux Sud-Ouest, France; Olivier Le Maitre, LIMSI-CNRS, France; Pietro M. Congedo, Inria Bordeaux Sud-Ouest, France

3:30-3:55 Comparison of Different Approximation Techniques for Uncertain Time Series Arising in Ocean Simulations

Pierre Sochala, BRGM, France; Mohamed Iskandarani, University of Miami, USA

Monday, April 16

MS24

UQ and Stochastic Optimization for Complex Energy Systems - Part II of II

2:00 PM-4:00 PM

Room:Salon VIII - 2nd Floor

For Part 1 see MS11

Design, analysis, and operation of energy systems often require solving high-dimensional stochastic optimization problems and require uncertainty characterizations of myriad factors such as multi-scale electricity markets, physical models, fatigue, and demands. This minisymposium brings together experts in uncertainty quantification, stochastic optimization, and mathematical modeling to explore novel approaches applied to emerging energy applications such as electricity transmission and natural gas networks, solar power systems, fossil-fueled systems with carbon capture, and nuclear energy systems.

Organizer: Alexander W. Dowling

University of Notre Dame, USA

Organizer: Victor M. Zavala

University of Wisconsin, Madison, USA

Organizer: Emil M. Constantinescu

Argonne National Laboratory, USA

2:00-2:25 Assimilating Data in Stochastic Dynamics

Emil M. Constantinescu, Argonne National Laboratory, USA; Noemi Petra, University of California, Merced, USA; Cosmin G. Petra, Lawrence Livermore National Laboratory, USA; Julie Bessac, Argonne National Laboratory, USA

continued in next column

2:30-2:55 PDF Estimation for Power Grid Systems via Sparse Regression

Xiu Yang, David A. Barajas-Solano, *Alexandre M. Tartakovsky*, and William Rosenthal, Pacific Northwest National Laboratory, USA

3:00-3:25 Risk-averse Optimal Power Flow via Surrogate Models

David A. Barajas-Solano, Xiu Yang, and Alexandre M. Tartakovsky, Pacific Northwest National Laboratory, USA

3:30-3:55 Optimization and Design of Complex Engineering Systems using High-performance Computing

Cosmin G. Petra, Lawrence Livermore National Laboratory, USA

Monday, April 16

MS25

Stochastic Modeling and Simulation for UQ in Computational Mechanics - Part II of II

2:00 PM-4:00 PM

Room:Salon V - 2nd Floor

For Part 1 see MS12

This minisymposium focuses on methodological, mathematical, and algorithmic aspects of stochastic modeling and simulation of uncertainties in Computational Mechanics. This issue is relevant to multi-scale and multi-physics analysis, where randomness can arise when scale separation is not reached or when knowledge about subscale features or coupled physics phenomena remains imperfect because of data paucity, for example. More generally, representing random data in a way that is both physically realistic and mathematical consistent is key for high-fidelity simulations relying on UQ. Historically, the modeling task has been mostly achieved through mathematical statistics methods and Karhunen-Loève and polynomial chaos expansions of random vectors and fields. These techniques have enabled the construction of efficient stochastic solvers and are now widely used in academia and industry. Additional contributions have also been devoted to the construction of admissible algebraic or spectral representations, as well as to the development of Bayesian approaches. The aim of this MS is to present recent advances in stochastic modeling in both linear and nonlinear computational mechanics. More specifically, this session will be focused on the construction and updating of stochastic models, on the construction of associated robust sampling techniques, and on the propagation of uncertainties at or across relevant scales and physical components.

continued on next page

Organizer: Johann Guilleminot
Duke University, USA

Organizer: Maarten Arnst
Université de Liège, Belgium

2:00-2:25 Stochastic Modeling of Uncertainties in Fast Essential Antarctic Ice Sheet Model

Kevin Bulthuis, Université de Liège, Belgium; Lionel Favier and Frank Pattyn, Université Libre de Bruxelles, Belgium; Maarten Arnst, Université de Liège, Belgium

2:30-2:55 Surrogate-based Bayesian Inversion for the Model Calibration of Fire Insulation Panels

Paul-Remo Wagner, Reto Fahrni, Michael Klippel, and Bruno Sudret, ETH Zürich, Switzerland

3:00-3:25 Coarse Approximation of Highly Oscillatory Random Elliptic Problems

Frederic Legoll, Ecole Nationale des Ponts et Chaussées, France

3:30-3:55 On the Robustness of Variational Multiscale Error Estimators for the Forward Propagation of Uncertainty

Oriol Colomés, Guglielmo Scovazzi, and Johann Guilleminot, Duke University, USA

Monday, April 16

MS26

Exploring the Links Between Parameter Sensitivity, Identifiability, and Uncertainty Quantification - Part II of II

2:00 PM-4:00 PM

Room:Salon VI - 2nd Floor

For Part 1 see MS13

Parameter space reduction and parameter estimation are essential for many questions in mathematical modeling and uncertainty quantification. As such, different disciplines have developed methods in parallel for approaching the questions in their field. Many of these approaches, including identifiability, sloppiness, and active subspaces, use related ideas to address questions of parameter dimension reduction, parameter estimation, and robustness of inferences and quantities of interest. This minisymposium will provide an overview of different techniques and bring together researchers from different fields to provide algebraic, geometric, and statistical perspectives on their use in uncertainty quantification.

Organizer: Andrew F. Brouwer
University of Michigan, USA

Organizer: Marisa Eisenberg
University of Michigan, USA

2:00-2:25 Inherent Limitations to Parameter Estimation in Cancer Incidence Data

Andrew F. Brouwer, Rafael Meza, and Marisa Eisenberg, University of Michigan, USA

2:30-2:55 Parameter Identifiability and Effective Theories in Physics, Biology, and Beyond

Mark K. Transtrum, Brigham Young University, USA

3:00-3:25 Structural Identifiability Analysis of Matrix Models for Structured Populations

Ariel Cintron-Arias, East Tennessee State University, USA

3:30-3:55 Robustness of Solutions of the Inverse Problem for Linear Dynamical Systems with Uncertain Data

Shelby Stanhope, Temple University, USA; David Swigon and Jonathan E. Rubin, University of Pittsburgh, USA

Monday, April 16

Coffee Break

4:00 PM-4:30 PM

Room:Grand Ballroom Foyer - 1st Floor

MS27

Stochastic Computing and Data Assimilation - Part I of II

4:30 PM-6:30 PM

Room:Grand Ballroom ABCD

For Part 2 see MS30

Stochastic computing is an important topic in uncertainty quantification. With the rapid development of high performance computing (HPC) facilities and the swift growing exascale computing power, it is essential to develop more accurate and efficient stochastic computing methods and discover possible applications of developed methods. In this minisymposium, we explore various methodologies on stochastic computing and focus on its applications in data assimilation, including nonlinear filtering problems, machine learning, uncertainty quantification of complex systems, and other engineering and scientific areas.

Organizer: Feng Bao
University of Tennessee, Chattanooga, USA

Organizer: Yanzhao Cao
Auburn University, USA

4:30-4:55 Adaptive Meshfree Backward SDE Filter

Feng Bao, University of Tennessee, Chattanooga, USA; Vasileios Maroulas, University of Tennessee, Knoxville, USA

5:00-5:25 Multilevel Picard Approximations for High-dimensional Nonlinear Parabolic Partial Differential Equations and High-dimensional Nonlinear Backward Stochastic Differential Equations

Martin Hutzenthaler, Universität Duisburg-Essen, Germany

continued on next page

Monday, April 16

MS27

Stochastic Computing and Data Assimilation - Part I of II

4:30 PM-6:30 PM

continued

5:30-5:55 Bayesian Inference via Filtering Equations for Financial Ultra-high Frequency Data

Yong Zeng, University of Missouri, Kansas City, USA; Grace Xing Hu, University of Hong Kong, Hong Kong; David Kuipers, University of Missouri, Kansas City, USA; Junqi Yin, Oak Ridge National Laboratory, USA

6:00-6:25 Deep Optimal Stopping: Solving High-dimensional Optimal Stopping Problems with Deep Learning

Sebastian Becker, University of Frankfurt, Germany; Patrick Cheridito, Arnulf Jentzen, and *Timo Welti*, ETH Zürich, Switzerland

Monday, April 16

MS28

Advances in Global Sensitivity Analysis

4:30 PM-6:30 PM

Room:Grand Ballroom G - 1st Floor

The classical framework of global sensitivity analysis considers a collection of statistically independent inputs which map to a real-valued quantity of interest (QoI). The sensitivity of the QoI to the inputs may be determined by various classical methods, Sobol' indices and Morris screening being two examples. However, these classical methods can be inadequate or difficult to interpret for several types of problems encountered in practice. This minisymposium will highlight new developments addressing these challenges. Two areas of particular interest are problems with dependent inputs and problems whose quantity of interest is a quantile or exceedance probability.

Organizer: Joseph L. Hart
North Carolina State University, USA

Organizer: Pierre Gremaud
North Carolina State University, USA

Organizer: Alen Alexanderian
North Carolina State University, USA

4:30-4:55 Sobol' Indices for Sensitivity Analysis with Dependent Inputs

Joseph L. Hart and Pierre Gremaud, North Carolina State University, USA

5:00-5:25 Shapley Effects for Sensitivity Analysis with Dependent Inputs

Clémentine Prieur, Université Grenoble Alpes, France

5:30-5:55 Global Sensitivity Analysis of Models with Dependent and Independent Inputs

Sergei S. Kucherenko, Imperial College London, United Kingdom; Oleksiy Klymenko, University of Surrey, United Kingdom; Nilay Shah, Imperial College London, United Kingdom

6:00-6:25 Goal-oriented Sensitivity Analysis Using Perturbed-law Based Indices

Thibault Delage, Bertrand Iooss, *Anne-Laure Popelin*, and Roman Sueur, EDF, France

Monday, April 16

MS29

Recent Advances in Computational Methods for High Dimensional Bayesian Inversion - Part I of III

4:30 PM-6:30 PM

Room:Garden 3 - 1st Floor

For Part 2 see MS33

In many practical Bayesian inverse problems, the parameters of interest are of very high dimensions. On the other hand, the relation between the parameters and the data is often described by computationally intensive mathematical models. Thus, developing efficient and accurate algorithms for such high dimensional problems poses a big challenge computationally. The purpose of that this minisymposium is bring researchers from different fields to discuss the recent advances in computational methods for such problems

Organizer: Jinglai Li
Shanghai Jiao Tong University, China

Organizer: Guang Lin
Purdue University, USA

Organizer: Qifeng Liao
ShanghaiTech University, China

4:30-4:55 An Iterative Local Updating Ensemble Smoother for High-dimensional Inverse Modeling with Multimodal Distributions

Guang Lin, Purdue University, USA; Jiangjiang Zhang, Zhejiang University, China; Weixuan Li, ExxonMobil, USA; Lingzao Zeng, Zhejiang University, China; Laosheng Wu, University of California, Riverside, USA

5:00-5:25 Using Surrogate Models to Accelerate Bayesian Inverse UQ

James Rynn, Simon Cotter, and Catherine Powell, University of Manchester, United Kingdom; Louise Wright, National Physical Laboratory, United Kingdom

5:30-5:55 High-dimensional Stochastic Inversion via Adjoint Models and Machine Learning

Xiao Chen, Lawrence Livermore National Laboratory, USA

6:00-6:25 Learning Physical Laws from Noisy Data

Sheng Zhang, Guang Lin, and Jiahao Zhang, Purdue University, USA

Monday, April 16

CP1

Gaussian Processes and Surrogate Modeling I

4:30 PM-6:10 PM

Room:Grand Ballroom F - 1st Floor

Chair: Edmund M. Ryan, Lancaster University, United Kingdom

4:30-4:45 Uncertainty Quantification for Numerical Models with Two or More Solutions

Louise Kimpton, University of Exeter, United Kingdom

4:50-5:05 Nonstationary Gaussian Process Emulation of Computer Models via Cluster-based Covariance Mixtures

Victoria Volodina and Daniel Williamson, University of Exeter, United Kingdom

5:10-5:25 Gibbs Reference Posterior for Robust Gaussian Process Emulation

Joseph Muré, Université Paris-Diderot, France; Josselin Garnier, Ecole Polytechnique, France; Loic Le Gratiet and Anne Dutfoy, EDF, France

5:30-5:45 Uncertainty Quantification of Atmospheric Chemical Transport Models using Gaussian Process Emulators

Edmund M. Ryan and Oliver Wild, Lancaster University, United Kingdom; Apostolos Voulgarakis, Imperial College London, United Kingdom; Fiona O'Connor, Met Office, United Kingdom; Paul Young, Lancaster University, United Kingdom; David Stevenson, University of Edinburgh, United Kingdom

5:50-6:05 Probabilistic Graphical Model Based Approach for Nonlinear Stochastic Dynamic Analysis

Souvik Chakraborty and Nicholas Zabaras, University of Notre Dame, USA

Monday, April 16

CP2

Reduced-order Modeling and Dynamical Systems I

4:30 PM-6:30 PM

Room:Garden 1 - 1st Floor

Chair: Erik Johnson, University of Southern California, USA

4:30-4:45 Quantifying Uncertainty in Reduced Models for Discrete Fracture Networks

Jaime A. Lopez-Merizalde and James Hyman, Tulane University, USA; Humberto C. Godinez, Los Alamos National Laboratory, USA

4:50-5:05 Stochastic Analysis and Robust Optimization of a Reduced Order Model for Flow Control

Noemi Friedman and Elmar Zander, Technische Universität Braunschweig, Germany

5:10-5:25 Reduced Order Model for Random Vibroacoustic Problems

Mathilde Chevreuil, Université de Nantes, France; Erwan Grelier and Anthony Nouy, Ecole Centrale de Nantes, France

5:30-5:45 Probabilistic Model Validation of Large-scale Systems using Reduced Order Models

Erik Johnson, Subhayan De, and Agnimitra Dasgupta, University of Southern California, USA; Steven Wojtkiewicz, Clarkson University, USA

5:50-6:05 Reduced Order Modeling for Nonlinear Structural Analysis using Gaussian Process Regression

Mengwu Guo and Jan S. Hesthaven, École Polytechnique Fédérale de Lausanne, Switzerland

6:10-6:25 Progressively Refining Reduced Order Models for Estimating Failure Probabilities of Dynamical Systems

Agnimitra Dasgupta, University of Southern California, USA; Debraj Ghosh, Indian Institute of Science, Bangalore, India

Monday, April 16

CP3

Numerical Methods for Stochastic PDEs

4:30 PM-6:30 PM

Room:Garden 2 - 1st Floor

Chair: Dominique Poirel, Royal Military College, Canada

4:30-4:45 Random Partial Differential Equations on Moving Hypersurfaces

Ana Djurdjevac, Freie Universität Berlin, Germany; Charlie Elliott, University of Warwick, United Kingdom; Ralf Kornhuber, Freie Universität Berlin, Germany; Thomas Ranner, University of Leeds, United Kingdom

4:50-5:05 Optimal Iterative Solvers for Linear Systems with Random PDE Origins: 'Balanced Black-box Stopping Tests'

Pranjal Pranjal and David Silvester, University of Manchester, United Kingdom

5:10-5:25 Domain Decomposition Solvers for Spectral Sfem Versus Non-intrusive Sparse Grid Based Solvers for Large Stochastic Dimensions

Abhijit Sarkar and Ajit Desai, Carleton University, Canada; Mohammad Khalil, Sandia National Laboratories, USA; Chris Pettit, United States Naval Academy, USA; *Dominique Poirel*, Royal Military College, Canada

5:30-5:45 UQ for Nearly Incompressible Linear Elasticity

Arbaz Khan, Catherine Powell, and David Silvester, University of Manchester, United Kingdom

5:50-6:05 Uncertainty Quantification of {PDE}s on Random Domains using Hierarchical Matrices

Juergen Doelz, Technische Universität Darmstadt, Germany; Helmut Harbrecht, Universität Basel, Switzerland

6:10-6:25 Advection-Diffusion PDEs with Random Discontinuous Coefficients

Andreas Stein and Andrea Barth, Universität Stuttgart, Germany

Monday, April 16

CP4

UQ in Engineering and Materials Applications

4:30 PM-6:30 PM

Room:Garden 4 - 1st Floor

Chair: Manav Vohra, Vanderbilt University, USA

4:30-4:45 Challenge of Detonation Modeling in Extreme Condition and its Uncertainty Quantification Methods

Ruili Wang and Song Jiang, Institute of Applied Physics and Computational Mathematics, China; Liang Xiao, Shandong University of Science and Technology, China; Hu lxingzhi, China Aerodynamics Research and Development Center, China

4:50-5:05 Parameter Calibration and Model Validation of JWL Equation of State Based on Multi-output

Hua Chen, Guozhao Liu, Haibing Zhou, and Shudao Zhang, Institute of Applied Physics and Computational Mathematics, China; Zhanfeng Sun, Chinese Academy of Engineering Physics (CAEP), China

5:10-5:25 Characterizing Errors and Uncertainties in Non-equilibrium Molecular Dynamics Simulations of Phonon Transport

Manav Vohra and Sankaran Mahadevan, Vanderbilt University, USA

5:30-5:45 Bayesian Inference for Estimating Model Discrepancy of an Electric Drive Model

David John, Universität Heidelberg, Germany; Michael Schick, Robert Bosch GmbH, Germany; Vincent Heuveline, Universität Heidelberg, Germany

5:50-6:05 Stochastic Reconstruction of Porous Media from Voxel Data

Prem Ratan Mohan Ram, Elmar Zander, Noemi Friedman, and Ulrich Roemer, Technische Universität Braunschweig, Germany

6:10-6:25 Parameter Identification for a Viscoplastic Model with Damage and Effect of Conditions on Results using Bayesian Approaches

Ehsan Adeli, Bojana Rosic, and Hermann G. Matthies, Technische Universität Braunschweig, Germany

Monday, April 16

CP5

Polynomial Chaos and Polynomial Approximation

4:30 PM-6:10 PM

Room:Pacific - 2nd Floor

Chair: Subhayan De, University of Southern California, USA

4:30-4:45 Uncertainty Quantification of Locally Nonlinear Dynamical Systems using Polynomial Chaos Expansion

Subhayan De and Erik Johnson, University of Southern California, USA; Steven Wojtkiewicz, Clarkson University, USA

4:50-5:05 Uncertainty Quantification for an Optical Grating Coupler using Adaptive Stochastic Collocation

Niklas Georg, Technische Universität Darmstadt, Germany; Ulrich Roemer, Technische Universität Braunschweig, Germany; Sebastian Schoeps, Technische Universität Darmstadt, Germany; Rolf Schuhmann, Technische Universität Berlin, Germany

5:10-5:25 Estimation of Plume Dispersion in Hetrogeneous Formations by Transformed Adaptive Stochastic Collocation Method

Qinzhuo Liao, King Fahd University of Petroleum and Minerals, Saudi Arabia; Dongxiao Zhang, Peking University, China

5:30-5:45 Adaptive Pseudo-spectral Projection for Time-dependent Problems

Michael Schick, Robert Bosch GmbH, Germany

5:50-6:05 Adaptive Sparse Interpolation Methods for Electromagnetic Field Computation with Random Input Data

Dimitrios Loukrezis, Technische Universität Darmstadt, Germany; Ulrich Roemer, Technische Universität Braunschweig, Germany; Herbert De Gersem, Technische Universität Darmstadt, Germany

Monday, April 16

CP6

Sensitivity Analysis I

4:30 PM-5:50 PM

Room:Harbor - 2nd Floor

Chair: Zach Grey, University of Colorado Boulder, USA

4:30-4:45 Bayesian Estimation of Probabilistic Sensitivity Measures for Computer Experiments

Xuefei Lu, Emanuele Borgonovo, and Isadora Antoniano-Villalobos, Bocconi University, Italy

4:50-5:05 Efficient Evaluation of Reliability-oriented Sensitivity Indices

Guillaume Perrin and Gilles Defaux, CEA, France

5:10-5:25 The Space of Shapes and Sensitivity Analysis: An Application of Differential Geometry

Zach Grey, University of Colorado Boulder, USA

5:30-5:45 Advanced Sensitivity Analysis for Offshore Wind Cost Modelling

Esteve Borras Mora, EDF Energy R&D UK Centre, IDCORE, United Kingdom; James Spelling, EDF Energy R&D UK Centre, United Kingdom; Harry van der Weijde, University of Edinburgh, United Kingdom

Monday, April 16

CP7

UQ in Biology and Medicine

4:30 PM-6:10 PM

Room:Salon I - 2nd Floor

Chair: Shemra Rizzo, University of California, Riverside, USA

4:30-4:45 Fluid-structure Interaction with Uncertainty in Medical Engineering

Jonas Kratzke and Vincent Heuveline, Universität Heidelberg, Germany

4:50-5:05 Uncertainty Quantification for the Reliable Simulation of a Blood Pump Device

Chen Song, Heidelberg Institute for Theoretical Studies, Germany; Vincent Heuveline, Universität Heidelberg, Germany

5:10-5:25 Using Computer Models and UQ to Diagnose Diastolic Heart Failure

Peter Challenor and Lauric Ferrat, University of Exeter, United Kingdom; Steven Niederer, King's College London, United Kingdom

5:30-5:45 Data-extraction Uncertainty in Meta-analysis of Published Medical Data

Shemra Rizzo, University of California, Riverside, USA

5:50-6:05 Bayesian Uncertainty Quantification for Epidemic Spread on Networks

Karen Larson, Zhizhong Chen, and Clark Bowman, Brown University, USA; Panagiotis Hadjidoukas, ETH Zürich, Switzerland; Costas Papadimitriou, University of Thessaly, Greece; Petros Koumoutsakos, ETH Zürich, Switzerland; Anastasios Matzavinos, Brown University, USA

Monday, April 16

CP8

UQ in Fluid Dynamics and Turbulence Applications I

4:30 PM-6:10 PM

Room:Salon II - 2nd Floor

Chair: Jorge Sousa, Stanford University, USA

4:30-4:45 Eigenspace-based Uncertainty Characterization in Large-Eddy Simulation of Turbulent Flow

Lluis Jofre, Stanford University, USA; Stefan P. Domino, Sandia National Laboratories, USA; Gianluca Iaccarino, Stanford University, USA

4:50-5:05 Estimation of Uncertainty of Turbulence Model Predictions in SU2

Jayant Mukhopadhaya, Stanford University, USA; Aashwin A. Mishra, Stanford University/NASA Ames, USA; Gianluca Iaccarino and Juan J. Alonso, Stanford University, USA

5:10-5:25 Validation of a Framework for Data Assimilation and Uncertainty Quantification for Urban Flow Predictions

Jorge Sousa and Catherine Gorle, Stanford University, USA

5:30-5:45 Predictive Simulations for Calculating Wind Loads on Buildings

Giacomo Lamberti, Columbia University, USA; Catherine Gorle, Stanford University, USA

5:50-6:05 High Performance Computing for Uncertainty Quantification: Challenges and Perspectives for Flow Problems

Vincent Heuveline and Saskia Haupt, Universität Heidelberg, Germany

Monday, April 16

CP9

Optimization under Uncertainty

4:30 PM-5:50 PM

Room:Salon VIII - 2nd Floor

Chair: Geoffrey M. Oxberry, Lawrence Livermore National Laboratory, USA

4:30-4:45 Global Optimization of Expensive Functions using Adaptive Radial Basis Functions Based Surrogate Model via Uncertainty Quantification

Ray-Bing Chen, National Cheng Kung University, Taiwan; Yuan Wang, Wells Fargo, USA; C. F. Jeff Wu, Georgia Institute of Technology, USA

4:50-5:05 Solving Stochastic Optimal Power Flow Problem via Polynomial Chaos Expansions

Tillmann Muehlpfordt, Timm Faulwasser, and Veit Hagenmeyer, Karlsruhe Institute of Technology, Germany

5:10-5:25 Topology Optimization using Conditional Value at Risk

Geoffrey M. Oxberry, Lawrence Livermore National Laboratory, USA

5:30-5:45 Uncertainty Quantification for Stochastic Approximation Limits using Chaos Expansion

Uladzislau Stazhynski, Ecole Polytechnique, France; Stephane C. Crepey, Evry University, France; Gersende Fort, Universite de Toulouse, France; Emmanuel Gobet, École Polytechnique, France

Monday, April 16

CP10

Inverse Problems and Data Assimilation I

4:30 PM-6:30 PM

Room:Salon V - 2nd Floor

Chair: David Swigon, University of Pittsburgh, USA

4:30-4:45 Beyond Black-boxes in Model-based Bayesian Inverse Problems
Phaedon S. Koutsourelakis and *Maximilian Koschade*, Technische Universität München, Germany

4:50-5:05 A Bayesian Approach for Quantifying the Uncertainty of Physical Models Integrated into Computer Codes
Guillaume Damblin and Pierre Gaillard, CEA, France

5:10-5:25 Bayesian Inversion for High Dimensional Systems using Data Assimilation
Sangeetika Ruchi and Svetlana Dubinkina, Centrum voor Wiskunde en Informatica (CWI), Netherlands; Marco Iglesias, University of Nottingham, United Kingdom

5:30-5:45 Inverse Problem for Random-parameter Dynamical Systems
David Swigon, University of Pittsburgh, USA; Shelby Stanhope, Temple University, USA; Jon Rubin, University of Pittsburgh, USA

5:50-6:05 4D-Var Data Assimilation using Exponential Integrators
Ulrich Roemer, Technische Universität Braunschweig, Germany; Mahesh Narayanamurthi and Adrian Sandu, Virginia Tech, USA

6:10-6:25 When Models and Data Disagree: Sparse Resolutions to Inconsistent Datasets in B2BDC
Arun Hegde, Wenyu Li, James Oreluk, Andrew Packard, and Michael Frenklach, University of California, Berkeley, USA

Monday, April 16

CP11

Bayesian Methods and Applications

4:30 PM-6:30 PM

Room:Salon VI - 2nd Floor

Chair: Alexandros A. Taflanidis, University of Notre Dame, USA

4:30-4:45 Climate Model Discrepancy: Thinking Outside of the UQ Toolbox
Daniel Williamson, University of Exeter, United Kingdom

4:50-5:05 Self-Exciting Point Processes and Uncertainty Quantification in Recording and Forecasting Long Duration Episodic Phenomena Like Volcanic Events
Andrea Bevilacqua, Abani Patra, and Marcus Bursik, State University of New York, Buffalo, USA; Augusto Neri, Istituto Nazionale di Geofisica e Vulcanologia, Italy; E. Bruce Pitman, State University of New York at Buffalo, USA

5:10-5:25 Bayesian Model Averaging Kriging
Alexandros A. Taflanidis and Jize Zhang, University of Notre Dame, USA

5:30-5:45 Bayesian Updating for Uncertain Condition State using Monitoring and Sequential Inspections
Christelle Geara and Rafic Faddoul, Saint Joseph University, Lebanon; Alaa Chateauneuf, Université Clermont Auvergne, France; Wassim Raphael, Saint Joseph University, Lebanon

5:50-6:05 A Bayesian Coarse-graining Approach to the Solution of Stochastic Partial Differential Equations
Constantin Grigo and Phaedon S. Koutsourelakis, Technische Universität München, Germany

6:10-6:25 Bayesian Inference on Uncertain Kinetic Parameters for the Pyrolysis of Composite Ablators
Joffrey Coheur, Université de Liège, Belgium; Thierry Magin, von Karman Institute for Fluid Dynamics, Belgium; Philippe Chatelain, Université Catholique de Louvain, Belgium; Maarten Arnst, Université de Liège, Belgium

Monday, April 16

CP12

Statistical Methods I

4:30 PM-6:30 PM

Room:Salon IV - 2nd Floor

Chair: Roger Ghanem, University of Southern California, USA

4:30-4:45 Experiment Design in Non-linear Regression with Additional Random Parameters
Daniela Jaruskova, Czech Technical University, Prague, Czech Republic

4:50-5:05 Approximate Optimal Designs for Multivariate Polynomial Regression
Fabrice Gamboa, Institut de Mathématiques de Toulouse, France; Yohann De Castro, Université d'Orsay, France; Didier Henrion, Roxana Hess, and Jean-Bernard Lasserre, LAAS-CNRS, Toulouse, France

5:10-5:25 Probabilistic Models and Sampling on Manifolds
Roger Ghanem, University of Southern California, USA; Christian Soize, Universite de Paris-Est, France

5:30-5:45 Nonparametric Functional Calibration of Computer Models
Andrew Brown and Sez Atamturktur, Clemson University, USA

5:50-6:05 Quantifying Uncertainties with Distribution Element Trees
Daniel W. Meyer, Institute of Fluid Dynamics, Switzerland

6:10-6:25 The Interacting Particle System Method Adapted to Piecewise Deterministic Processes
Thomas A. Galtier, EDF, France

Dinner Break

6:30 PM-8:00 PM

Attendees on their own

JUQ Editorial Board Meeting

6:30 PM-8:00 PM

Room:Salon VII - 2nd Floor

Monday, April 16

PP1

Welcome Reception and Poster Session

8:00 PM-10:00 PM

Room:Royal Ballroom - 1st Floor (South Tower)

Modeling Nonstationary Response Surfaces with Bayesian Warped Gaussian Processes

Steven Atkinson and Nicholas Zabaras, University of Notre Dame, USA

Bayesian Optimization with Variables Selection

Malek Ben Salem, Ecole des Mines de St Etienne, France; Francois Bachoc and Fabrice Gamboa, Institut de Mathématiques de Toulouse, France; Lionel Tomaso, ANSYS, Inc., USA; Olivier Roustant, Ecole des Mines de St Etienne, France

Bayesian Inference and Statistical Modeling with TransportMaps

Daniele Bigoni, Alessio Spantini, Rebecca Morrison, Ricardo Baptista, and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

Simulation-based Machine Learning: An Application to Structural Health Monitoring

Caterina Bigoni, and Jan S. Hesthaven, École Polytechnique Fédérale de Lausanne, Switzerland

Efficient Uncertainty Propagation of Physics-based Nondestructive Measurement Simulations using Sparse Sampling and Stochastic Expansions

Xiasong Du, Leifur Leifsson, Jiming Song, William Meeker, and Ronald Roberts, Iowa State University, USA

Sparse Pseudo-spectral Projections in Linear Gyrokinetics

Ionut-Gabriel Farcas, Technische Universität München, Germany; Tobias Goerler, Max Planck Institute for Plasma Physics, Germany; Tobias Neckel and Hans-Joachim Bungartz, Technische Universität München, Germany

Comparing Two Dimension Reduction Techniques

Jordan R. Hall, University of Colorado, Denver, USA

continued in next column

Künzel Model and Non-Intrusive Inverse Problem

Jan Havelka, Jan Sykora, and Anna Kucerova, Czech Technical University, Prague, Czech Republic

Optimal Kernel-based Dynamic Mode Decomposition

Patrick Heas and Cedric Herzet, Inria Rennes Bretagne Atlantique, France

Heterogeneous Material Model Calibration using Stochastic Inversion

Eliska Janouchova and Anna Kucerova, Czech Technical University, Prague, Czech Republic

Bootstrap Stochastic Approximation Monte Carlo Algorithms

Georgios Karagiannis, University of Durham, United Kingdom

Slow Scale Split Step Tau Leap Method for Stiff Stochastic Chemical Systems

Abdul Khaliq, Middle Tennessee State University, USA; Viktor Reshniak, Oak Ridge National Laboratory, USA; David A. Voss, Western Illinois University, USA

Robust Experiment Design for Nonlinear Model Calibration using Polynomial Chaos

Anna Kucerova, Jan Sykora, Daniela Jaruskova, and Eliska Janouchova, Czech Technical University, Prague, Czech Republic

Locally Stationary Spatio-Temporal Interpolation of Argo Profiling Float Data

Mikael Kuusela, SAMSI and University of North Carolina at Chapel Hill, USA; Michael Stein, University of Chicago, USA

Solving Stochastic Inverse Problems with Consistent Bayesian Inference

Brad Marvin, University of Texas at Austin, USA

Multilevel Adaptive^2 Sparse Grid Stochastic Collocation

Friedrich Menhorn, Ionut-Gabriel Farcas, Tobias Neckel, and Hans-Joachim Bungartz, Technische Universität München, Germany

Efficient Iterative Methods for Discrete Stokes Equations with Random Viscosity

Christopher Mueller, Sebastian Ullmann, and Jens Lang, Technische Universität Darmstadt, Germany

continued in next column

Optimal Experimental Design of Time Series Data in a Consistent Bayesian Framework

Michael Pilosov, University of Colorado, Denver, USA

Quantifying Spatio-temporal Boundary Condition Uncertainty for the Deglaciation

James M. Salter and Daniel Williamson, University of Exeter, United Kingdom; Lauren Gregoire, University of Leeds, United Kingdom

Multiscale Interfaces for Large-scale Optimization

Daniel T. Seidl, Bart G. Van Bloemen Waanders, and Tim Wildey, Sandia National Laboratories, USA

A Study of Elliptic PDEs with Jump Diffusion Coefficients

Andreas Stein and Andrea Barth, Universität Stuttgart, Germany

Image-based Covariance Functions for Characterisation of Material Heterogeneity

Jan Sykora, Anna Kucerova, and Jan Zeman, Czech Technical University, Prague, Czech Republic

Numerical Algorithms for Solving the Weighted Poisson Equation with Application to Particle Flow Algorithms

Amirhossein Taghvaei, University of Illinois at Urbana-Champaign, USA

Stochastic Galerkin Reduced Basis Methods for Parametrized Elliptic PDEs

Sebastian Ullmann and Lang Jens, Technische Universität Darmstadt, Germany

A Comparative Study of the Intrusive and Non-intrusive Polynomial Chaos Methods for Uncertainty Quantification of the Rossler Chaotic Dynamical System

Heng Wang, Qingyun Duan, Wei Gong, Zhenhua Di, Chiyuan Miao, and Aizhong Ye, Beijing Normal University, China

Adaptive Gaussian Process Approximation for Bayesian Inference with Expensive Likelihood Functions

Hongqiao Wang and Jinglai Li, Shanghai Jiao Tong University, China

A Model-independent Iterative Ensemble Smoother for High-dimensional Inversion and Uncertainty Estimation

Jeremy White, GNS Science, New Zealand

continued on next page

Monday, April 16

PP1

Welcome Reception and Poster Session

8:00 PM-10:00 PM

continued

Physics-informed Machine Learning for Data-driven Turbulence Modeling
Jinlong Wu and Carlos Michelén, Virginia Tech, USA; Jian-Xun Wang, University of California, Berkeley, USA; Heng Xiao, Virginia Tech, USA

Calibration – Optimal Designs for Computer Experiments
Wenzhe Xu, University of Exeter, United Kingdom

Monday, April 16

PP101

Minisymposterium: Parameter Space Dimension Reduction

8:00 PM-10:00 PM

Room:Royal Ballroom - 1st Floor (South Tower)

Organizer: Paul Constantine, University of Colorado, Boulder, USA

Visualizing Dynamic Global Sensitivities in Time-dependent Systems
Izabel P. Aguiar and Paul Constantine, University of Colorado Boulder, USA

Parameter Space Dimension Reduction
Paul Constantine, University of Colorado Boulder, USA

A Lanczos-Stieltjes Method for One-dimensional Ridge Function Integration and Approximation
Andrew Glaws and Paul Constantine, University of Colorado Boulder, USA

Characterizing a Subspace of Shapes using Differential Geometry
Zach Grey and Paul Constantine, University of Colorado Boulder, USA

Exploiting Ridge Structure in Chance Constrained Design under Uncertainty
Jeffrey M. Hokanson and Paul Constantine, University of Colorado Boulder, USA

Tuesday, April 17

Registration

7:45 AM-5:00 PM

Room:Grand Ballroom E - 1st Floor

MT3

Numerical Analysis of Computational UQ for PDEs

8:10 AM-10:10 AM

Room:Grand Ballroom G - 1st Floor

A 2hr. survey of recent developments in the mathematical and numerical analysis of UQ algorithms for PDEs. MT focus is on high-order, non-intrusive methods. Contents: Part I: Forward UQ. I.1 Small amplitude UQ for elliptic and parabolic problems. Linear Problems: Sparse Tensor (DP) Galerkin discretization, Fast kth moment computation, Hierarchic Bases, Combination Technique. Example: parabolic evolution problems. Nonlinearities: linearization, sparse tensor first-order, k-th moment approximations Example: domain uncertainty quantification via shape sensitivity computation. Non-Hilbertian setting: FoSM approach. Open Problems. I.2 Large amplitude UQ. Sparsity in gpc expansions. MC, QMC, stochastic Galerkin and collocation, CS, LSQ. Multilevel Discretizations. Holomorphy and sparsity, convergence rates. Part II: Inverse UQ. II.1 Bayesian Inverse UQ for PDEs: formulation, prior modelling, perturbation. II.2 Posterior sparsity and approximation. Conclusion. Wrapup and outlook on upcoming developments.

Organizer and Speaker:

Christoph Schwab
ETH Zürich, Switzerland

Tuesday, April 17

MS30

Stochastic Computing and Data Assimilation - Part II of II

8:10 AM-10:10 AM

Room:Grand Ballroom ABCD - 1st Floor

For Part 1 see MS27

Stochastic computing is an important topic in uncertainty quantification. With the rapid development of high performance computing (HPC) facilities and the swift growing exascale computing power, it is essential to develop more accurate and efficient stochastic computing methods and discover possible applications of developed methods. In this minisymposium, we explore various methodologies on stochastic computing and focus on its applications in data assimilation, including nonlinear filtering problems, machine learning, uncertainty quantification of complex systems, and other engineering and scientific areas.

Organizer: Feng Bao

University of Tennessee, Chattanooga, USA

Organizer: Yanzhao Cao

Auburn University, USA

8:10-8:35 Efficient Numerical Methods for Stochastic Schrodinger Equations

Jialin Hong, Chinese Academy of Sciences, China

8:40-9:05 Bridging High Performance Computing for Experimental Neutron Sciences

Rich Archibald, Oak Ridge National Laboratory, USA

9:10-9:35 Accounting for Model Error from Unresolved Scales in Ensemble Kalman Filters by Stochastic Parameterization

Xuemin Tu, University of Kansas, USA; Fei Lu, Johns Hopkins University, USA; Alexandre Chorin, University of California, Berkeley, USA

9:40-10:05 A Probabilistic Analysis and Rare Event Study of a Dynamical Queue for Modeling Human Operators

Benjamin J. Zhang, Massachusetts Institute of Technology, USA; Tuhin Sahai, United Technologies Research Center, USA; Youssef M. Marzouk, Massachusetts Institute of Technology, USA

Tuesday, April 17

MS31

Optimal Experimental Design with Applications - Part I of II

8:10 AM-10:10 AM

Room:Grand Ballroom F - 1st Floor

For Part 2 see MS37

Optimal design of experiments deals with the problems of data acquisition in sciences and engineering. The designed experiments should generate the most informative data to achieve the research purpose. The design process is challenging from the perspective of numerical stability, computational efficiency, and data management. The minisymposium will cover a broad spectrum of the methodologies and applications in the optimal design of experiments, for example, designs based on high-fidelity and large-scale PDE models, approaches which are pure data-driven, plans conditioned on the dynamic of sequential data, advanced optimization methods for the exploration of the design space, etc. We invite talks with the focus on methodologies and applications.

Organizer: Quan Long

United Technologies Research Center, USA

8:10-8:35 Optimal Experimental Design for Metallic Fatigue Data

Marco Scavino, Universidad de la República, Uruguay

8:40-9:05 Accelerated MCMC using Bayesian Optimization

Asif Chowdhury and Gabriel Terejanu, University of South Carolina, USA

9:10-9:35 Leader Selection in Stochastically Forced Consensus Network

Fu Lin, United Technologies Research Center, USA

9:40-10:05 A Scalable Design of Experiments Framework for Optimal Sensor Placement

Jing Yu and *Mihai Anitescu*, University of Chicago, USA; Victor M. Zavala, University of Wisconsin, Madison, USA

Tuesday, April 17

MS32

Probabilistic Numerical Methods for Quantification of Discretisation Error - Part III of III

8:10 AM-10:10 AM

Room:Garden 2 - 1st Floor

For Part 2 see MS17

In many important inverse problems - e.g. numerical weather prediction, seismography, and medical tomography - data are related to parameters of interest through the solution of an ordinary or partial differential equation (DE). To proceed with computation, the DE must be discretised. However, such discretisation introduces bias into parameter estimates and can in turn cause conclusions to be over-confident. Probabilistic numerical methods for DEs aim to provide uncertainty quantification in the solution space of the DE to properly account for the fact that the governing equations have been altered through discretisation. In contrast to the worst-case error bounds of classical numerical analysis, the stochasticity in such DE solvers serves as the carrier of uncertainty about discretisation error and its impact. This statistical notion of discretisation uncertainty can then be more easily propagated to later inferences, e.g. in a Bayesian inverse problem. Several such probabilistic numerical methods have been developed in recent years, but the connections and distinctions between these methods are not yet fully understood. In particular, an important challenge is to ensure that such uncertainty estimates are well-calibrated. This minisymposium will examine recent advances in both the development and implementation of probabilistic numerical methods in general. The talks cover aspects from foundations and theory through to computation and application.

continued on next page

Tuesday, April 17

MS32

Probabilistic Numerical Methods for Quantification of Discretisation Error - Part III of III

8:10 AM-10:10 AM

continued

Organizer: Tim Sullivan
Freie Universität Berlin, Germany

Organizer: Chris Oates
Newcastle University, United Kingdom

Organizer: Philipp Hennig
Max Planck Institute for Intelligent Systems, Germany

Organizer: Mark Girolami
Imperial College London, United Kingdom

8:10-8:35 Adaptive Bayesian Cubature using Quasi-Monte Carlo Sequences
Fred J. Hickernell, Illinois Institute of Technology, USA

8:40-9:05 Bayesian Quadrature for Multiple Related Integrals
Francois-Xavier Briol, University of Warwick, United Kingdom

9:10-9:35 Adaptive Bayesian Quadrature for Approximate Inference
Alexandra Gessner, Max Planck Institute for Intelligent Systems, Germany

9:40-10:05 Fully Symmetric Sets for Efficient Large-Scale Probabilistic Integration
Toni Karvonen and Simo Särkkä, Aalto University, Finland

Tuesday, April 17

MS33

Recent Advances in Computational Methods for High Dimensional Bayesian Inversion - Part II of III

8:10 AM-10:10 AM

Room:Garden 3 - 1st Floor

For Part 1 see MS29
For Part 3 see MS40

In many practical Bayesian inverse problems, the parameters of interest are of very high dimensions. On the other hand, the relation between the parameters and the data is often described by computationally intensive mathematical models. Thus, developing efficient and accurate algorithms for such high dimensional problems poses a big challenge computationally. The purpose of that this minisymposium is bring researchers from different fields to discuss the recent advances in computational methods for such problems

Organizer: Jinglai Li
Shanghai Jiao Tong University, China

Organizer: Guang Lin
Purdue University, USA

Organizer: Qifeng Liao
ShanghaiTech University, China

8:10-8:35 Scalable Inference with Transport Maps
Daniele Bigoni, Alessio Spantini, and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

8:40-9:05 A Discrete Sequential Optimal Transport method for Bayesian Inverse Problems
Aaron Myers and Tan Bui-Thanh, University of Texas at Austin, USA; Alexandre H. Thiery, National University of Singapore, Singapore; Kainan Wang, Halliburton, USA

9:10-9:35 A Spatially-correlated Bayesian Gaussian Process Latent Variable Model for Dimensionality Reduction
Steven Atkinson and Nicholas Zabaras, University of Notre Dame, USA

9:40-10:05 An Approximate Empirical Bayesian Method for Large-scale Linear-gaussian Inverse Problems
Jinglai Li, Shanghai Jiao Tong University, China

Tuesday, April 17

MS34

Multilevel and Multifidelity Bayesian Methods for Inverse Problems and Beyond - Part I of III

8:10 AM-10:10 AM

Room:Harbor - 2nd Floor

For Part 2 see MS43

Exploring the posterior distribution in Bayesian inverse problems can quickly exceed available computationally resources if each forward-model solve is computationally demanding. In many situations, however, there is not only the expensive high-fidelity forward model available. Rather, there are several models that describe the same phenomenon as the high-fidelity model but with varying costs and fidelities. For example, there are often coarse-grid approximations, projection-based reduced models, data-fit models, and simplified-physics models. This minisymposium presents multilevel and multifidelity methods that leverage these low-cost low-fidelity models to speedup the exploration of the posterior distribution.

Organizer: Tiangang Cui
Monash University, Australia

Organizer: Benjamin Peherstorfer
University of Wisconsin, Madison, USA

8:10-8:35 Provably Convergent Multi-fidelity Bayesian Inference using Adaptive Delayed Acceptance
Tiangang Cui, Monash University, Australia

8:40-9:05 Multifidelity Transport Maps for Bayesian Inference
Matthew Parno, US Army Cold Regions Research and Engineering Lab (CRREL), USA

9:10-9:35 Incorporating Epistemic Uncertainty from Lower-fidelity Models in Bayesian Inverse Problems
Joseph Nagel, Maximilian Koschade, and Phaedon S. Koutsourelakis, Technische Universität München, Germany

9:40-10:05 A Bayesian Interpretation of Kernel-based Methods for Multifidelity Approximation
Akil Narayan, University of Utah, USA

Tuesday, April 17

MS126

Uncertainty Quantification in Biomathematical Modeling

8:10 AM-10:10 AM

Room:Salon I - 2nd Floor

The goal of this session is to provide some perspectives on uncertainty quantification in biomathematics, with particular emphasis on disease modeling. The talks in this session will deal with parameter identification for infectious disease modeling and for dynamical models of cancer treatment and progression. The speakers will emphasize connections with data-driven modeling.

Organizer: Eric J. Kostelich
Arizona State University, USA

8:10-8:35 Data Assimilation and Parameter Identification in a Dynamical Model of Cancer Treatment
Eric J. Kostelich, Javier Baez, and Yang Kuang, Arizona State University, USA

8:40-9:05 Implications of Uncertainty in Parameter Estimation for a Biomthematical Based Response Metric for Glioblastoma
Andrea Hawkins-Daarud and Susan Massey, Mayo Clinic, USA

9:10-9:35 Sub-exponential Growth for Modeling Plague: A Case Study of the 1904 Bombay Plague
Tin Phan, Arizona State University, USA

9:40-10:05 Fitting Dynamic Models to Epidemic Outbreaks with Quantified Uncertainty: Parameter Uncertainty, Identifiability, and Forecasts
Gerardo Chowell, Georgia State University, USA

Tuesday, April 17

CP13

Reduced-order Modeling and Dynamical Systems II

8:10 AM-9:50 AM

Room:Garden 1 - 1st Floor

Chair: Izabel P. Aguiar, University of Colorado Boulder, USA

8:10-8:25 A Weighted Reduced Basis Method for Parabolic PDEs with Random Data
Christopher Spannring, Sebastian Ullmann, and Jens Lang, Technische Universität Darmstadt, Germany

8:30-8:45 Statistical Learning in Tree-based Tensor Format
Erwan Grelier and Anthony Nouy, Ecole Centrale de Nantes, France; Mathilde Chevreuil, Université de Nantes, France

8:50-9:05 Low-rank Dynamic Mode Decomposition: Optimal Solution in Polynomial-time
Patrick Heas and Cedric Herzet, Inria Rennes Bretagne Atlantique, France

9:10-9:25 Active-subspace Analysis of Up-crossing Probability for Shallow-water Model
Kenan Šehic and Mirza Karamehmedovic, Technical University of Denmark, Denmark

9:30-9:45 Contrast Enhancement in Electrical Impedance Tomography using the Approximation Error Approach
Ville P. Kolehmainen, University of Eastern Finland, Finland; Antti Nissinen, Rocsole Ltd, Finland; Jari Kaipio, University of Auckland, New Zealand; Marko Vauhkonen, University of Eastern Finland, Finland

Tuesday, April 17

CP14

Gaussian Processes and Surrogate Modeling II

8:10 AM-9:50 AM

Room:Garden 4 - 1st Floor

Chair: To Be Determined

8:10-8:25 Finite-dimensional Gaussian Approximation with Linear Inequality Constraints
Andres F. Lopez-Lopera, Ecole des Mines de St Etienne, France; Francois Bachoc, Institut de Mathématiques de Toulouse, France; Nicolas Durrande and Olivier Roustant, Ecole des Mines de St Etienne, France

8:30-8:45 Emulating Dynamic Non-linear Simulators using Gaussian Processes
Hossein Mohammadi, *Peter Challenor*, and Marc Goodfellow, University of Exeter, United Kingdom

8:50-9:05 Surrogate Modeling of Two Nested Codes with Functional Outputs
Sophie Marque-Pucheu, Universite Paris 7-Denis Diderot, France; Guillaume Perrin, CEA, France; Josselin Garnier, Ecole Polytechnique, France

9:10-9:25 Universal Prediction Distribution
Malek Ben Salem and Olivier Roustant, Ecole des Mines de St Etienne, France; Fabrice Gamboa, Institut de Mathématiques de Toulouse, France; Lionel Tomaso, ANSYS, Inc., USA

9:30-9:45 Experimental Design for Non-parametric Correction of Misspecified Dynamical Models
Gal Shulkind, Massachusetts Institute of Technology, USA

Tuesday, April 17

CP15

Numerical Analysis and Methods for UQ

8:10 AM-9:50 AM

Room:Pacific - 2nd Floor

Chair: Kookjin Lee, University of Maryland, College Park, USA

8:10-8:25 Multi-Index Quasi-Monte Carlo and H-Matrices
Michael Feischl, University of New South Wales, Sydney, Australia

8:30-8:45 Utilizing Multisymmetry Properties in Uncertainty Quantification
Gudmund Pammer, Vienna University of Technology, Austria; Stefan Rigger, Technische Universität Wien, Austria and Arizona State University, USA; Clemens Heitzinger, Vienna University of Technology, Austria

8:50-9:05 A Provably Stable Coupling of Numerical Integration and Stochastic Galerkin Projection
Jan Nordström, Markus K. Wahlsten, and Oskar Alund, Linköping University, Sweden

9:10-9:25 An Adaptive (Quasi-) Monte Carlo Method for Forward Uncertainty Quantification in Differential Equations with Random Coefficients
Kan Zhang and Fred J. Hickernell, Illinois Institute of Technology, USA

9:30-9:45 Stochastic Least-Squares Petrov-Galerkin Method for Parameterized Linear Systems
Kookjin Lee, University of Maryland, College Park, USA; Kevin T. Carlberg, Sandia National Laboratories, USA; Howard C. Elman, University of Maryland, College Park, USA

Tuesday, April 17

CP16

UQ in Fluid Dynamics and Turbulence Applications II

8:10 AM-10:10 AM

Room:Salon II - 2nd Floor

Chair: Michael E. Mueller, Princeton University, USA

8:10-8:25 Uncertainty Analysis and Bayesian Calibration of Vortex-induced Vibration Phenomenological Model
Gabriel Guerra and Bruno Soares, Universidade Federal de Rio de Janeiro, Brazil; Rodolfo Freitas, Federal University of Rio de Janerio, Brazil; Fernando A. Rochinha, COPPE/ Universidade Federal do Rio e Janeiro, Brazil

8:30-8:45 Uncertainty Quantification of Rans Turbulence Models Using Bayesian Deep Learning with Stein Variational Gradient Descent
Nicholas Geneva and Nicholas Zabaras, University of Notre Dame, USA

8:50-9:05 Uncertainty Quantification of Rans Initialization in Modeling Shock-driven Turbulent Mixing
Yan-Jin Wang, Institute of Applied Physics and Computational Mathematics, China

9:10-9:25 Physics-Derived Approaches to Multi-physics Model Form Uncertainty Quantification: Application to Turbulent Combustion Modeling
Michael E. Mueller, Princeton University, USA

9:30-9:45 Aeroacoustics of Cavity Flow Analyzed with Multilevel Monte Carlo and Non-intrusive Polynomial Chaos Methods
Jakob Duerrwaechter, Thomas Kuhn, Fabian Meyer, Andrea Beck, and Christian Rohde, Universität Stuttgart, Germany; Claus-Dieter Munz, Institut fuer Aerodynamik und Gasdynamik (IAG), Germany

9:50-10:05 Application of Machine Learning Algorithms for the Classification of Regions of RANS Discrepancy
Aashwin A. Mishra, Stanford University/ NASA Ames, USA; Gianluca Iaccarino, Stanford University, USA

Tuesday, April 17

CP17

UQ in Chemical Kinetics and Molecular Systems

8:10 AM-9:30 AM

Room:Salon VIII - 2nd Floor

Chair: Matthew Dobson, University of Massachusetts, Amherst, USA

8:10-8:25 Providing Structure to Experimental Data: A Large-Scale Heterogeneous Database for Collaborative Model Validation
James Oreluk, Arun Hegde, Wenyu Li, Andrew Packard, and Michael Frenklach, University of California, Berkeley, USA

8:30-8:45 On the Fly Coarse-graining in Molecular Dynamics Simulations
Markus Schoeberl, Technische Universität München, Germany; Nicholas Zabaras, University of Notre Dame, USA; Phaedon S. Koutsourelakis, Technische Universität München, Germany

8:50-9:05 Addressing Global Sensitivity in Chemical Kinetic Models using Adaptive Sparse Grids
Sandra Döpking and Sebastian Matera, Freie Universität Berlin, Germany

9:10-9:25 On the Accuracy of Free Energy Defect Computations in Atomistic Systems
Matthew Dobson, University of Massachusetts, Amherst, USA; Hong Duong and Christoph Ortner, University of Warwick, United Kingdom

Tuesday, April 17

CP18

Inverse Problems and Data Assimilation II

8:10 AM-10:10 AM

Room:Salon V - 2nd Floor

Chair: Pulong Ma, University of Cincinnati, USA

8:10-8:25 Simulation-based Uncertainty Quantification for Atmospheric Remote Sensing Retrievals

Jonathan Hobbs, Amy Braverman, and Hai Nguyen, Jet Propulsion Laboratory, California Institute of Technology

8:30-8:45 Mean-based Preconditioning for the Helmholtz Equation in Random Media

Ivan G. Graham, *Owen R. Pembery*, and Euan Spence, University of Bath, United Kingdom

8:50-9:05 Inverse Uncertainty Quantification Applied to an Industrial Model with Measurement Data

Philipp Glaser, Kosmas Petridis, and Michael Schick, Robert Bosch GmbH, Germany; Vincent Heuveline, Universität Heidelberg, Germany

9:10-9:25 Spatial Statistical Downscaling for Constructing High-resolution Nature Runs in Global Observing System Simulation Experiments

Pulong Ma and Emily L. Kang, University of Cincinnati, USA; Amy Braverman and Hai Nguyen, Jet Propulsion Laboratory, California Institute of Technology

9:30-9:45 Bayesian Calibration of Expensive Computer Models with Input Dependent Parameters

Georgios Karagiannis, University of Durham, United Kingdom; Alex Konomi, University of Cincinnati, USA; Guang Lin, Purdue University, USA

9:50-10:05 Bayesian Calibration for Models with Nonlinear Inequality Parameter Constraints

Patrick Brewick and Kirubel Teferra, US Naval Research Laboratory, USA

Tuesday, April 17

CP19

Sensitivity Analysis II

8:10 AM-9:30 AM

Room:Salon VI - 2nd Floor

Chair: Humberto C. Godinez, Los Alamos National Laboratory, USA

8:10-8:25 Design of Experiments-based Geological Uncertainty Quantification of Co2-Assisted Gravity Drainage (gagd) Process in Heterogeneous Multilayer Reservoirs

Watheq J. Al-Mudhafar and Dandina N. Rao, Louisiana State University, USA

8:30-8:45 Derivative-based Expression of Sobol's Total Index

Matieyendou Lamboni, Université des Antilles et de la Guyane, Guyana

8:50-9:05 Sensitivity Analysis and Data Assimilation for Fracture Simulations Model

Humberto C. Godinez, Los Alamos National Laboratory, USA

9:10-9:25 Uncertainty Quantification of Textile Composites: A Multi-Scale Approach

Tanmoy Chatterjee, Rohit Raju Madke, and *Rajib Chowdhury*, Indian Institute of Technology Roorkee, India

Tuesday, April 17

CP20

Statistical Methods II

8:10 AM-10:10 AM

Room:Salon IV - 2nd Floor

Chair: Wenyu Li, University of California, Berkeley, USA

8:10-8:25 Evolutionary White-box Approach to Uncertainty Quantification

Marek A. Suchenek, California State University, Dominguez Hills, USA

8:30-8:45 Uniform Sampling of a Feasible Set of Model Parameters

Wenyu Li, Arun Hedge, James Oreluk, Michael Frenklach, and Andrew Packard, University of California, Berkeley, USA

8:50-9:05 Looking the Wrong Way: Beyond Principal Components in Computer Model Calibration

James M. Salter and Daniel Williamson, University of Exeter, United Kingdom

9:10-9:25 Fourier Decomposition Methods for Efficient Generation of Random Fields

Elmar Zander, Technische Universität Braunschweig, Germany

9:30-9:45 On the Quantification and Propagation of Imprecise Probabilities in High Dimensions with Dependencies

Jiaxin Zhang and Michael D. Shields, Johns Hopkins University, USA

9:50-10:05 Distribution Surrogates for Efficient UQ in Multi-physics Problems

Saideep Nannapaneni and Sankaran Mahadevan, Vanderbilt University, USA

Coffee Break

10:10 AM-10:40 AM

Room:Grand Ballroom Foyer - 1st Floor

Remarks

10:40 AM-10:45 AM

Room:Grand Ballroom ABCD - 1st Floor

Tuesday, April 17

IP3

A Contemporary View of High-dimensional Quasi Monte Carlo

10:45 AM-11:30 AM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Christoph Schwab, ETH Zürich, Switzerland

The numerical computation of expected values as high-dimensional integrals is a central task in uncertainty quantification. Quasi Monte Carlo (QMC) methods are deterministic numerical integration methods that aim for better efficiency (and hence lower cost) than traditional Monte Carlo methods. Originally they were designed with the sole aim of obtaining convergence rates close to $1/N$ (where N is the number of evaluations of the integrand) for smooth enough integrands, compared to the Monte Carlo rate of $1/\sqrt{N}$. But little or no attention was paid to the dependence of the error on s, where s is the number of variables, or the dimension. Nowadays, however, integrals with very large numbers of variables are being tackled, with s in the thousands or tens of thousands or more, and as a result there is as much concern about the dependence on s as on N. The aim of this talk is to present highlights of recent progress on QMC for high-dimensional problems. The highlights include algorithms and software for QMC rules tailored to solutions of elliptic PDE with random coefficients, with error bounds provably independent of the cutoff dimension in this infinite-dimensional problem. In a different direction, there are now high-order QMC rules, rules with potential convergence rates of order $1/N^2$ or even faster.

Ian H. Sloan
University of New South Wales, Australia

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

Tuesday, April 17

IP4

Model Uncertainty and Uncertainty Quantification

1:00 PM-1:45 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: David Higdon, Virginia Tech, USA

The Bayesian paradigm provides a coherent approach for quantifying uncertainty given available data and prior information. Aspects of uncertainty that arise in practice include uncertainty regarding parameters within a model, the choice of model, and propagation of uncertainty in parameters and models for predictions. In this talk I will present Bayesian approaches for addressing model uncertainty given a collection of competing models including model averaging and ensemble methods that potentially use all available models and will highlight computational challenges that arise in implementation of the paradigm.

Merlise Clyde
Duke University, USA

Intermission

1:45 PM-2:00 PM

Tuesday, April 17

MT4

Foundations of Compressed Sensing for Learning Sparsity of High-dimensional Problems

2:00 PM-4:00 PM

Room:Grand Ballroom G - 1st Floor

This tutorial will focus on compressed sensing approaches to sparse polynomial approximation of complex functions in high dimensions. Of particular interest to the UQ community is the parameterized PDE setting, where the target function is smooth, characterized by a rapidly decaying orthonormal expansion, whose most important terms are captured by a lower (or downward closed) set. By exploiting this fact, we will present and analyze several procedures for exactly reconstructing a set of (jointly) sparse vectors, from incomplete measurements. These include novel weighted ℓ_1 minimization, improved iterative hard thresholding, mixed convex relaxations, as well as nonconvex penalties. Theoretical recovery guarantees will also be presented based on improved bounds for the restricted isometry property, as well as unified null space properties that encompass all currently proposed nonconvex minimizations. Numerical examples are provided to support the theoretical results and demonstrate the computational efficiency of the described compressed sensing methods.

Organizer and Speaker:

Clayton G. Webster
University of Tennessee and Oak Ridge National Laboratory, USA

Tuesday, April 17

MS36

Controlled Interacting Particle Systems for Nonlinear Filtering

2:00 PM-4:00 PM

Room:Grand Ballroom ABCD - 1st Floor

A popular approach to nonlinear filtering is a Monte-Carlo approximation technique known as the particle filter. An alternative that has attracted growing interest can be regarded as a controlled interacting particle system, in which the importance sampling-resampling step in the traditional particle filter is replaced by a feedback control law designed to control the flow of particles. In numerical evaluations, it is often found that these control-based algorithms exhibit smaller simulation variance and better scaling properties with problem dimension when compared to the traditional methods. The difficulty has been that these algorithms require a numerical solution of the Poisson equation or a related pde. This has been the focus of recent research which has led to new connections with optimal transportation (e.g., ensemble transform) and the ensemble Kalman filter. This session will provide a self-contained introduction to these algorithms with two talks on the continuous-time feedback particle filter (Mehta and Meyn), a talk on discrete-time particle flow (Daum), and a talk on application and comparison of these algorithms (Pfister). Mehta will introduce the session and provide an overview of the area. Taken together, the four talks by leading researchers will highlight the state-of-the-art in theory and applications, open research problems, comparisons with importance sampling and ensemble Kalman filter, and relationship to related fields.

Organizer: Prashant G. Mehta

University of Illinois at Urbana-Champaign, USA

continued in next column

2:00-2:25 A Critical Overview of Controlled Interacting Particle Systems for Nonlinear Filtering

Prashant G. Mehta, University of Illinois at Urbana-Champaign, USA

2:30-2:55 Gromov's Method for Stochastic Particle Flow Nonlinear Filters

Fred Daum, Raytheon Missile Systems, USA

3:00-3:25 Feedback Particle Filter and the Poisson Equation

Sean Meyn, University of Florida, USA

3:30-3:55 The Neural Particle Filter: Scalability and Biological Implementation

Simone Carlo Surace, Jean-Pascal Pfister, and Anna Kutschireiter, University of Zurich and ETH Zurich, Switzerland

Tuesday, April 17

MS37

Optimal Experimental Design with Applications - Part II of II

2:00 PM-4:00 PM

Room:Grand Ballroom F - 1st Floor

For Part 1 see MS31

Optimal design of experiments deals with the problems of data acquisition in sciences and engineering. The designed experiments should generate the most informative data to achieve the research purpose. The design process is challenging from the perspective of numerical stability, computational efficiency, and data management. The mini-symposium will cover a broad spectrum of the methodologies and applications in the optimal design of experiments, for example, designs based on high-fidelity and large-scale PDE models, approaches which are pure data-driven, plans conditioned on the dynamic of sequential data, advanced optimization methods for the exploration of the design space, etc. We invite talks with the focus on methodologies and applications.

Organizer: Quan Long

United Technologies Research Center, USA

2:00-2:25 Optimal Experimental Design using Laplace Based Importance Sampling

Joakim Beck, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

2:30-2:55 Optimal Design of Experiments in the Chemical Industry

Georg Bock, Universität Heidelberg, Germany; Ekaterina Kostina, Fachbereich Mathematik und Informatik, Philipps-Universität Marburg, Germany

3:00-3:25 Optimal Experimental Design Problem as Mixed-integer Optimal Control Problem

Ekaterina Kostina, Fachbereich Mathematik und Informatik, Philipps-Universität Marburg, Germany

3:30-3:55 Generalized Laplace Method for Optimal Experimental Design for Non-Gaussian Posteriors

Quan Long, United Technologies Research Center, USA

Tuesday, April 17

MS38

Recent Advances in Inverse Problems and Uncertainty Quantification - Part I of II

2:00 PM-4:00 PM

Room:Garden 1 - 1st Floor

For Part 2 see MS52

Modern scientific analysis often relies on using noisy observations to infer additional information about system dynamics. The resulting inverse problem poses significant challenges in terms of confronting issues such as observability, computational complexity, unknown parameters, and model error. This minisymposium will focus on recent mathematical and computational advances in solving inverse problems and quantifying related uncertainties. Topics will include development of numerical methods, parameter estimation techniques, and data-driven approaches for a wide range of biological and physical applications.

Organizer: Andrea Arnold

Worcester Polytechnic Institute, USA

Organizer: Franz Hamilton

North Carolina State University, USA

2:00-2:25 Bayesian Filtering for Periodic, Time-varying Parameter Estimation

Andrea Arnold, Worcester Polytechnic Institute, USA

2:30-2:55 Uncertainty in Estimation using the Prohorov Metric Framework

H. T. Banks, North Carolina State University, USA

3:00-3:25 A Bayesian Framework for Strain Identification from Mixed Diagnostic Samples

Lars Ruthotto, Emory University, USA; *Lauri Mustonen*, Aalto University, Finland

3:30-3:55 Physical-model-based, Data-driven Approach Toward Noninvasive Prediction of Intracranial Pressure

Jian-Xun Wang and Jeffrey Pyne, University of California, Berkeley, USA; Xiao Hu, University of California, San Francisco, USA; Shawn Shadden, University of California, Berkeley, USA

Tuesday, April 17

MS39

Recent Advances in Model Reduction and Data-enabled Modeling - Part I of III

2:00 PM-4:00 PM

Room:Garden 2 - 1st Floor

For Part 2 see MS53

Despite the remarkable increase in computational power, most real-world systems are still too complex to simulate in full details. How to utilize available data to facilitate/accelerate the simulations becomes increasingly important in the recent years. Among all methods, model reduction and data-driven approaches prove themselves as indispensable algorithmic tools for real-time applications: (1) Model reduction provides good cheap low-dimensional approximations to the computationally expensive full systems without scarifying accuracy. (2) Data-enable modeling, including data-driven, data assimilation and physics-informed machine learning, dynamically extracts information of a significant amount of dynamic real data and provides guidance for system design, decision-making, etc. This minisymposium focuses on recent developments in algorithms and applications based model reduction and data-driven approaches. Topics include offline enhanced reduce models, physics-constrained reduced models or data-driven models based on machine learning, improved models based multi-fidelity data, etc.Applications include problems from aerospace, hydroscience and automobile industry.

Organizer: Jing Li

Pacific Northwest National Laboratory, USA

Organizer: Ling Guo

Shanghai Normal University, China

Organizer: Xueyu Zhu

University of Iowa, USA

continued in next column

2:00-2:25 MoriZwanzig Based Model Reduction for Uncertainty Quantification

Jing Li and Panos Stinis, Pacific Northwest National Laboratory, USA

2:30-2:55 Inverse Regression-based Uncertainty Quantification for High Dimensional Models

Weixuan Li, ExxonMobil, USA; Guang Lin, Purdue University, USA; Bing Li, Pennsylvania State University, USA

3:00-3:25 Data-driven and Reduced Order Modeling : An Attempt at a Taxonomy of Approaches

Karthik Duraisamy, University of Michigan, USA

3:30-3:55 Offline-enhanced Reduced Basis Method through Adaptive Construction of the Surrogate Training Set

Jiahua Jiang, University of Massachusetts, Dartmouth, USA; Akil Narayan, University of Utah, USA; Yanlai Chen, University of Massachusetts, Dartmouth, USA

Tuesday, April 17

MS40

Recent Advances in Computational Methods for High Dimensional Bayesian Inversion - Part III of III

2:00 PM-4:00 PM

Room:Garden 3 - 1st Floor

For Part 2 see MS33

In many practical Bayesian inverse problems, the parameters of interest are of very high dimensions. On the other hand, the relation between the parameters and the data is often described by computationally intensive mathematical models. Thus, developing efficient and accurate algorithms for such high dimensional problems poses a big challenge computationally. The purpose of that this minisymposium is bring researchers from different fields to discuss the recent advances in computational methods for such problems

Organizer: Jinglai Li

Shanghai Jiao Tong University, China

Organizer: Guang Lin

Purdue University, USA

Organizer: Qifeng Liao

ShanghaiTech University, China

2:00-2:25 Approximate Bayesian Inference under Reduced Model in Inverse Problem and Uncertainty Quantification

Nilabja Guha, Texas A&M University, USA

2:30-2:55 Bayesian Inference and Multiscale Model Reduction for Inverse Problems

Lijian Jiang, Los Alamos National Laboratory, USA; Yuming Ba and Na Ou, Hunan University, China

3:00-3:25 An Adaptive Reduced Basis Anova Method for High-dimensional Bayesian Inverse Problems

Qifeng Liao, ShanghaiTech University, China; Jinglai Li, Shanghai Jiao Tong University, China

3:30-3:55 Efficient Bathymetry Estimation in the Presence of Model and Observation Uncertainties

Hojat Ghorbanidehno, Stanford University, USA; Jonghyun Lee, University of Hawaii at Manoa, USA; Matthew Farthing, US Army Corps of Engineers, USA; Tyler Hesser, U.S. Army Research Development Engineering Command, USA; Peter K. Kitanidis and Eric F. Darve, Stanford University, USA

Tuesday, April 17

MS41

Advances in Numerical Techniques for the Study of Rare Events - Part I of III

2:00 PM-4:00 PM

Room:Garden 4 - 1st Floor

For Part 2 see MS55

Stochastic differential equations, where uncertainty accounting for random small continuous changes in the environment comes from the noise term, are often used for modeling physical, chemical, or biological systems. Often, events of interest in such systems happen rarely on the time-scale of the system that renders their study by direct simulations difficult. Contemporary methods for the study of rare events include path-based techniques, Hamilton-Jacobi-type solvers, as well as model reduction methods that allow one to use elliptic solvers for finding quantities characterizing the transition process. Furthermore, uncertainty in systems can come from unknown coefficients in the elliptic PDEs or stochastic stopping times. In this minisymposium, we are bringing together researchers to share advances in deterministic numerical techniques for analysis of such stochastic systems. Methods for finding the quasi-potential, the maximum likelihood transition paths, the transition rates and the committor functions will be presented. Talks featuring techniques for model reduction for high-dimensional systems, for dealing with elliptic PDEs will uncertainty, as well as an optimal control problem, will take place. Applications to some real-life systems, for example, genetic switches, will be demonstrated.

Organizer: Maria K. Cameron

University of Maryland, USA

Organizer: Xiang Zhou

City University of Hong Kong, Hong Kong

continued in next column

2:00-2:25 Ordered Line Integral Methods for Computing the Quasi-potential

Maria K. Cameron, University of Maryland, USA

2:30-2:55 Optimal and Robust Control for Piecewise-deterministic Processes.

Alexander Vladimirsky, Cornell University, USA

3:00-3:25 Rare Event Study on the Checkpoint Activation in the Budding Yeast Cell Cycle

Peijie Zhou, Peking University, China

3:30-3:55 Computing the Quasi-Potential in Systems with Anisotropic Diffusion

Daisy Dahiya, University of Maryland, USA

Tuesday, April 17

MS42

Sparse Approximations Algorithms for High-dimensional Problems in Uncertainty Quantification - Part III of III

2:00 PM-4:00 PM

Room:Pacific - 2nd Floor

For Part 2 see MS20

Many problems in uncertainty quantification rely on robust and efficient approximations of parametric variability. A large number of parameters raises the challenge of high-dimensional approximation. One of the more successful approaches to address this challenge seeks sparse or compressible representations of parametric variation. Such an approach is flexible enough to exploit structure such as smoothness, sparsity, low-rank manifolds, or low intrinsic dimensionality. This minisymposium highlights recent advances in theory and algorithms for sparse approximation as applied to problems in uncertainty quantification, and brings together researchers from across the applied and computational mathematics community to discuss and collaborate on novel theoretical and computational advances in sparse approximation strategies, and to discuss future directions for research.

Organizer: Akil Narayan

University of Utah, USA

Organizer: Ben Adcock

Simon Fraser University, Canada

continued in next column

2:00-2:25 Compressive Sensing with Cross-validation and Stop-sampling for Sparse Polynomial Chaos Expansions

Xun Huan, Cosmin Safta, Khachik Sargsyan, Zachary Vane, Guilhem Lacaze, Joseph C. Oefelein, and Habib N. Najm, Sandia National Laboratories, USA

2:30-2:55 Enhanced Sparse Recovery of Polynomial Chaos Expansions Using Dimension Adaptation and Near-optimal Sampling

Negin Alemazkoor and *Hadi Meidani*, University of Illinois at Urbana-Champaign, USA

3:00-3:25 Time and Frequency Domain Methods for Sparse Basis Selections in Random Linear Dynamical Systems

Roland Pulch, University of Greifswald, Germany; John D. Jakeman, Sandia National Laboratories, USA

3:30-3:55 High-dimensional Function Approximation Via Weighted L1 Minimization with Gradient-augmented Samples

Yi Sui and Ben Adcock, Simon Fraser University, Canada

Tuesday, April 17

MS43

Multilevel and Multifidelity Bayesian Methods for Inverse Problems and Beyond - Part II of III

2:00 PM-4:00 PM

Room:Harbor - 2nd Floor

For Part 1 see MS34
For Part 3 see MS57

Exploring the posterior distribution in Bayesian inverse problems can quickly exceed available computationally resources if each forward-model solve is computationally demanding. In many situations, however, there is not only the expensive high-fidelity forward model available. Rather, there are several models that describe the same phenomenon as the high-fidelity model but with varying costs and fidelities. For example, there are often coarse-grid approximations, projection-based reduced models, data-fit models, and simplified-physics models. This minisymposium presents multilevel and multifidelity methods that leverage these low-cost low-fidelity models to speedup the exploration of the posterior distribution.

Organizer: Tiangang Cui

Monash University, Australia

Organizer: Benjamin Peherstorfer

University of Wisconsin, Madison, USA

2:00-2:25 Multilevel Sequential^2 Monte Carlo for Bayesian Inverse Problems

Jonas Latz, Iason Papaioannou, and Elisabeth Ullmann, Technische Universität München, Germany

2:30-2:55 Multi-reduction MCMC Methods for Bayesian Inverse Problem

Tan Bui-Thanh, University of Texas at Austin, USA; Viet Ha Hoang, Nanyang Technological University, Singapore

3:00-3:25 Multilevel Ensemble Transform Methods for Bayesian Inference

Alastair Gregory, Imperial College London, United Kingdom

3:30-3:55 Multilevel DILI

Gianluca Detommaso, University of Bath, United Kingdom; Tiangang Cui, Monash University, Australia; Robert Scheichl, University of Bath, United Kingdom

Tuesday, April 17

MS44

Data-driven Discovery for Dynamical Systems

2:00 PM-4:00 PM

Room:Salon I - 2nd Floor

Data-driven methods have begun to play a vital role in the discovery of new mechanisms, models and control laws in the engineering, physical and biological sciences. Particularly, machine learning, dimensionality reduction and sparsity-promoting techniques have been leveraged to characterize, model and control high-dimensional, nonlinear, stochastic dynamical systems. This minisymposium brings together experts working at the forefront of data-driven approaches to explore challenges and solutions to the complex task of discovering knowledge from data.

Organizer: Travis Askham

University of Washington, USA

Organizer: Eurika Kaiser

University of Washington, USA

2:00-2:25 Improving Sub-grid-scale Approximations in Global Atmospheric Models using Data-driven Techniques

Noah D. Brenowitz, Pornampai Narenpitak, and Christopher Bretherton, University of Washington, USA

2:30-2:55 Parsimonious Model Selection using Genomic Data for Outbreak Intervention

Kyle B. Gustafson and Joshua L. Proctor, Institute for Disease Modeling, USA

3:00-3:25 Improving Accuracy and Robustness of Artificial Neural Networks to Discover Dynamical Systems from Data

Shaowu Pan, University of Michigan, Ann Arbor, USA; Karthik Duraisamy, University of Michigan, USA

3:30-3:55 Data-driven Determination of Koopman Eigenfunctions using Delay Coordinates

Suddhasattwa Das and Dimitrios Giannakis, Courant Institute of Mathematical Sciences, New York University, USA

Tuesday, April 17

MS45

UQ for Kinetic Equations - Part I of III

2:00 PM-3:30 PM

Room:Salon II - 2nd Floor

For Part 2 see MS59

The aim of this minisymposium is to bring together researchers with an interest in stochastic kinetic equations and uncertainty quantification. Kinetic equations with random inputs are a relatively new subject in the context of uncertainty quantification, but the number of researchers who are working on kinetic or transport equations in the presence of uncertainties has been increasing recently. This minisymposium hence serves as a forum for the exchange of ideas as well as new problems and helps shape future research directions in this growing area. The focus is on kinetic equations with random inputs. Theoretic aspects such as existence, uniqueness, regularity, hypocoercivity, and sensitivity analysis are discussed as well as the development of numerical methods such as stochastic Galerkin, stochastic collocation, and (multi-level) Monte Carlo specialized for transport equations. Bayesian estimation for transport equations is also discussed. Applications include all areas where kinetic equations have been proven useful, such as engineering, biology, and also economy. The main model equations are the Boltzmann equation and derived equations.

Organizer: Clemens Heitzinger

Vienna University of Technology, Austria

2:00-2:25 Hypocoercivity Based Sensitivity Analysis and Spectral Convergence of the Stochastic Galerkin Approximation to Collisional Kinetic Equations with Multiple Scales and Random Inputs

Liu Liu, University of Texas at Austin, USA

2:30-2:55 Sensitivity Analysis for Flocking and Synchronization Models

Seung Yeal Ha, Seoul National University, South Korea

3:00-3:25 Bayesian Estimation for Transport Equations for Nanocapacitors

Benjamin Stadlbauer, Leila Taghizadeh, Jose A. Morales Escalante, and Clemens Heitzinger, Vienna University of Technology, Austria; Andrea Cossettini and Luca Selmi, Università di Udine, Italy

continued in next column

Tuesday, April 17

MS46

Exploiting Structure in Optimization under Uncertainty - Part I of II

2:00 PM-4:00 PM

Room:Salon VIII - 2nd Floor

For Part 2 see MS60

Uncertainty arises everywhere in engineering and the natural sciences. It is therefore crucial that engineering optimization and optimal control problems are developed in such a way that the optimal controls, parameters or designs are robust to uncertainty. Stochastic programming and risk management provide several techniques, which yield robust or risk-averse solutions; for example, by using risk measures, stochastic orders, or robust optimization techniques. This session seeks to bring together researchers in PDE-constrained and stochastic optimization with practitioners in several branches of engineering in order to foster and exchange new ideas. An emphasis is placed on theoretical and algorithmic approaches for risk-averse optimization, especially for the development of new structure-exploiting numerical solution techniques.

Organizer: Drew P. Kouri
Sandia National Laboratories, USA

Organizer: Denis Ridzal
Sandia National Laboratories, USA

Organizer: Harbir Antil
George Mason University, USA

Organizer: Thomas M. Surowiec
Philipps-Universität Marburg, Germany

continued in next column

2:00-2:25 Two Basic Hierarchical Structures Making Stochastic Programming What It Is
Ruediger Schultz, University of Duisburg-Essen, Germany

2:30-2:55 Estimation of Tail Distributions Using Quantile and Superquantile (CVaR) Values
Stan Uryasev, University of Florida, USA

3:00-3:25 Optimal Approximation of Spectral Risk Measures with Application to PDE-constrained Optimization
Drew P. Kouri, Sandia National Laboratories, USA

3:30-3:55 Weighted Reduced Order Methods for Parametrized PDEs with Random Inputs
Francesco Ballarin, SISSA-ISAS International School for Advanced Studies, Italy; Davide Torlo, Universität Zürich, Switzerland; Luca Venturi, Courant Institute of Mathematical Sciences, New York University, USA; Gianluigi Rozza, SISSA, International School for Advanced Studies, Trieste, Italy

Tuesday, April 17

MS47

Undergraduate Research in Uncertainty Quantification

2:00 PM-4:00 PM

Room:Salon V - 2nd Floor

This minisymposium will highlight undergraduate research in uncertainty quantification. A variety of topics will be explored, including reduced-order modeling, data assimilation, stochastic modeling, and Bayesian inference.

Organizer: Matthew Parno
US Army Cold Regions Research and Engineering Lab (CRREL), USA

Organizer: Katherine Kavanagh
North Carolina State University, USA

2:00-2:15 Reduced-order Stochastic Modeling and Non-Gaussian Data Assimilation for Marine Ecosystems
Christiane Adcock, Massachusetts Institute of Technology, USA

2:20-2:35 Statistical Modelling of Breast Cancer Risk for Greater Predictive Accuracy
Alyssa Columbus, University of California, Irvine, USA

2:40-2:55 Dynamic Sequential Filtering in Association with Joint State-parameter Estimation
Louis Nass, Marquette University, USA

3:00-3:15 Subsurface Impedance Characterization with Bayesian Inference
Cassie Lumbrazo, Clarkson University, USA

3:20-3:35 Low-rank Spectral Representations for Solutions of Elliptic PDEs with Random Coefficients Functions
William Reese, North Carolina State University, USA

3:40-3:55 Eulerian vs Lagrangian Data Assimilation
Diego Rios, New Jersey Institute of Technology, USA

Tuesday, April 17

MS48

Sensitivity Analysis: Beyond the Quadratic

2:00 PM-4:00 PM

Room:Salon VI - 2nd Floor

A classical problem in the study of computer code experiments is the evaluation of the relative influence of the input variables on some numerical result obtained by a computer code. In this context, the output is seen as a function f of random inputs (generally assumed independent) and a sensitivity analysis is performed using the so-called Hoeffding decomposition. In this functional decomposition, f is expanded as an L^2-sum of uncorrelated functions involving only a part of the random inputs. This leads to the Sobol index that measures the amount of randomness (the part of the variance) of the output due to one or more input variables. It remains then to estimate these Sobol indices to rank the variables with respect to their influence on the output. Nevertheless, the Sobol indices and their Monte-Carlo estimation are order two methods: thus they are well adapted to measure the contribution of an input on the deviation around the output mean and it seems very intuitive that the sensitivity of an extreme quantile of the output could depend on sets of variables that cannot be captured using only the variances. One may generalize them with higher order methods. Indices based on contrast functions depending on the quantity of interest is a nice alternative when one considers quantiles or medians. Another promising possibility consists in defining indices depending on the whole distribution of the output conditioned by the input whose influence must be quantified.

Organizer: Agnès Lagnoux

Université of Toulouse, France

continued in next column

2:00-2:25 Sensitivity Analysis Based on Cramér Von Mises Distance

Agnès Lagnoux, Université of Toulouse, France; Fabrice Gamboa, Institut de Mathématiques de Toulouse, France; Thierry Klein, Université of Toulouse, France

2:30-2:55 Goal Oriented Sensitivity Indices and Sensitivity Indices Based on Wasserstein Costs

Thierry Klein, Université of Toulouse, France

3:00-3:25 Statistical Methodology for Second Level Sensitivity Analysis with Dependence Measures for Numerical Simulators

Anouar Meynaoui, CEA, DEN, SRMP, France; Amandine Marrel, CEA, France; *Béatrice Laurent*, Institut de Mathématiques de Toulouse, France

3:30-3:55 Sensitivity Indices for Outputs on a Riemannian Manifold

Leonardo Moreno, Universidad de la República, Uruguay

Coffee Break

4:00 PM-4:30 PM

Room:Grand Ballroom Foyer - 1st Floor

Tuesday, April 17

MS49

Nonlinear Filtering and Data Assimilation in Complex Dynamical Systems - Part I of III

4:30 PM-6:30 PM

Room:Grand Ballroom ABCD - 1st Floor

For Part 2 see MS63

Data assimilation and filtering play a crucial role in variable estimation with noisy partial observations, which can be further used as initializations for real-time predictions. Many complex dynamical systems in geophysical and engineering turbulence, neuroscience and material science involve nonlinear structures, non-Gaussian statistics and high dimensionality that require the development and improvement of effective nonlinear data assimilation methods. This minisymposium focuses on ideas and advanced techniques for nonlinear data assimilation. Topics include ensemble and particle filters, variational methods, localization techniques, sequential Monte Carlo approaches, hybrid strategies and efficient numerical approximations etc. Applications of these methods in both climate science, inverse problems and engineering turbulence is another focus of this minisymposium.

Organizer: Nan Chen

New York University, USA

Organizer: Xin T. Tong

National University of Singapore, Singapore

4:30-4:55 Model Parameter Estimation using Nonlinear Ensemble Algorithms

Derek J. Posselt, Jet Propulsion Laboratory, California Institute of Technology; Craig Bishop, Naval Research Laboratory, USA

5:00-5:25 Localization for MCMC – Sampling High-dimensional Posterior Distributions with Banded Structure

Matthias Morzfeld, University of Arizona, USA

5:30-5:55 Ensemble Filtering with One-step-ahead Smoothing

Naila Raboudi, Boujemaa Ait-El-Fquih, and *Ibrahim Hoteit*, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

6:00-6:25 Non-Gaussian Data Assimilation through Kernel Density Estimation

Yoonsang Lee, Lawrence Berkeley National Laboratory, USA

Tuesday, April 17

MS50

Hierarchical Bayesian Inference - Part I of II

4:30 PM-6:30 PM

Room:Grand Ballroom G - 1st Floor

For Part 2 see MS90

In many Bayesian inference problems, the specification of the prior distribution and/or the data likelihood involves another set of unknown hyper-parameters, leading to a hierarchical representation of the posterior. This minisymposium will focus on recent advances in hierarchical Bayesian inference, in the case where the unknown to be inferred is high or infinite dimensional. Specific topics to be addressed are the analysis of hierarchical Gaussian processes, the use of functions as hyper-parameters, efficient methods for sampling and optimising the hyper-parameters and connections to parameter selection in large scale optimisation problems.

Organizer: Claudia Schillings

Universitaet Mannheim, Germany

Organizer: Aretha L. Teckentrup

University of Edinburgh, United Kingdom

4:30-4:55 Hierarchical Gaussian Processes in Bayesian Inverse Problem

Aretha L. Teckentrup, University of Edinburgh, United Kingdom; Andrew Stuart, California Institute of Technology, USA

5:00-5:25 Hierarchical Bayesian Sparsity: ℓ_2 Magic

Daniela Calvetti, Case Western Reserve University, USA

5:30-5:55 Hierarchical Stochastic Partial Differential Equations for Bayesian Inverse Problems

Lassi Roininen, University of Oulu, Finland; Karla Monterrubio Gómez, University of Warwick, United Kingdom; Sari Lasanen, University of Oulu, Finland

6:00-6:25 Large Scale Spatial Statistics with SPDEs, GMRFs, and Multi-scale Component Models

Finn Lindgren, University of Edinburgh, United Kingdom

Tuesday, April 17

MS51

Model-based Optimal Experimental Design - Part I of III

4:30 PM-6:30 PM

Room:Grand Ballroom F - 1st Floor

For Part 2 see MS64

The challenge of acquiring the most valuable data from experiments---for the purpose of inference, prediction, classification, design, control, etc.---has received substantial attention in major research fields of statistics, applied math, engineering, and many more. These questions can be formalized through the framework of optimal experimental design (OED). Models describing experimental conditions and processes, both physical and statistical, can be particularly useful for arriving at these optimal designs. However, model-based OED faces many challenges, such as formulational difficulties, choices of optimality and their tradeoffs, computation of information metrics, nonlinear relationships and responses, propagation and sampling of non-Gaussian distributions, high-dimensional parameter and design spaces, expensive and dynamically evolving models, and optimization in the presence of uncertainty and with probabilistic and PDE constraints. This minisymposium invites speakers working on tackling challenges related to model-based optimal experimental design, in the broad areas of theoretical, algorithmic, computational, and applications-oriented developments.

Organizer: Xun Huan

Sandia National Laboratories, USA

Organizer: David Woods

University of Southampton, United Kingdom

Organizer: Youssef M. Marzouk

Massachusetts Institute of Technology, USA

4:30-4:55 Optimal Experimental Design for RKHS Based Correction of Mis-specified Dynamic Models

Lior Horesh, IBM Research, USA; Gal Shulkind, Massachusetts Institute of Technology, USA; Haim Avron, Tel Aviv University, Israel

5:00-5:25 Goal-oriented Optimal Design of Experiments for Bayesian Inverse Problems

Ahmed Attia, Argonne National Laboratory, USA; Alen Alexanderian and Arvind Saibaba, North Carolina State University, USA

5:30-5:55 Subspace-driven Observation Selection Strategies for Linear Bayesian Inverse Problems

Jayanth Mohan and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

6:00-6:25 Bayesian Experimental Design for Stochastic Biochemical Systems

Fei He, Imperial College London, United Kingdom; Juliane Liepe, Max Planck Institute for Biophysical Chemistry, Germany; Sarah Filippi and Michael Stumpf, Imperial College London, United Kingdom

continued in next column

Tuesday, April 17

MS52

Recent Advances in Inverse Problems and Uncertainty Quantification - Part II of II

4:30 PM-6:30 PM

Room:Garden 1 - 1st Floor

For Part 1 see MS38

Modern scientific analysis often relies on using noisy observations to infer additional information about system dynamics. The resulting inverse problem poses significant challenges in terms of confronting issues such as observability, computational complexity, unknown parameters, and model error. This minisymposium will focus on recent mathematical and computational advances in solving inverse problems and quantifying related uncertainties. Topics will include development of numerical methods, parameter estimation techniques, and data-driven approaches for a wide range of biological and physical applications.

Organizer: Andrea Arnold

Worcester Polytechnic Institute, USA

Organizer: Franz Hamilton

North Carolina State University, USA

4:30-4:55 Filtering Without a Model and Without an Observation Function: Data-driven Filtering

Franz Hamilton, North Carolina State University, USA

5:00-5:25 Nonlinear Kalman Filtering for Parameter Estimation with Censored Observations

Hien Tran, North Carolina State University, USA

5:30-5:55 Sensitivity of Network Dynamics Reconstruction

Timothy Sauer, George Mason University, USA

6:00-6:25 Parameter Estimation using Linear Response Statistics - Theory and Numerical Scheme

He Zhang, John Harlim, and Xiantao Li, Pennsylvania State University, USA

Tuesday, April 17

MS53

Recent Advances in Model Reduction and Data-enabled Modeling - Part II of III

4:30 PM-6:30 PM

Room:Garden 2 - 1st Floor

For Part 1 see MS39
For Part 3 see MS66

Despite the remarkable increase in computational power, most real-world systems are still too complex to simulate in full details. How to utilize available data to facilitate/accelerate the simulations becomes increasingly important in the recent years. Among all methods, model reduction and data-driven approaches prove themselves as indispensable algorithmic tools for real-time applications: (1) Model reduction provides good cheap low-dimensional approximations to the computationally expensive full systems without scarifying accuracy. (2) Data-enable modeling, including data-driven, data assimilation and physics-informed machine learning, dynamically extracts information of a significant amount of dynamic real data and provides guidance for system design, decision-making, etc. This minisymposium focuses on recent developments in algorithms and applications based model reduction and data-driven approaches. Topics include offline enhanced reduce models, physics-constrained reduced models or data-driven models based on machine learning, improved models based multi-fidelity data, etc.Applications include problems from aerospace, hydroscience and automobile industry.

Organizer: Jing Li

Pacific Northwest National Laboratory, USA

Organizer: Ling Guo

Shanghai Normal University, China

Organizer: Xueyu Zhu

University of Iowa, USA

4:30-4:55 Model Form Uncertainty Quantification using Physical Constraints

Yanyan He, New Mexico Institute of Mining and Technology, USA; Dongbin Xiu, Ohio State University, USA

5:00-5:25 A Data Driven Approach for Uncertainty Quantification with High Dimensional Arbitrary Random Data

Huan Lei, Jing Li, and Nathan Baker, Pacific Northwest National Laboratory, USA

5:30-5:55 Bi-directional Coupling between a PDE-domain and an Adjacent Data-domain Equipped with Multi-fidelity Sensors

Dongkun Zhang, Yang Liu, and George Em Karniadakis, Brown University, USA

6:00-6:25 Multi-fidelity Uncertainty Propagation of Physics-based Nondestructive Measurement Simulations using Co-kriging

Leifsson Leifur and Xiaosong Du, Iowa State University, USA

continued in next column

Tuesday, April 17

MS54

Dimension Reduction in Bayesian Inference - Part I of III

4:30 PM-6:30 PM

Room:Garden 3 - 1st Floor

For Part 2 see MS67

Non-standard and high-dimensional distributions naturally arise from the Bayesian formulation of statistical inference problems. The ultimate tractability of such distributions in practical problems is dictated by the availability of efficient and accurate sampling or quadrature strategies. This task becomes more and more challenging as distributions depart from standard ones and as their dimensionalities increase. However, many high-dimensional Bayesian models have an underlying low-dimensional structure (e.g., Markov structure, marginal independence, low rank, regularity, sparsity) that can be leveraged by appropriately designed algorithms. This minisymposium aims to provide a venue for the interaction between active researchers in dimensionality reduction with a focus on specific aspects arising in Bayesian inference.

Organizer: Daniele Bigoni
Massachusetts Institute of Technology, USA

Organizer: Olivier Zahm
Massachusetts Institute of Technology, USA

Organizer: Paul Constantine
Colorado School of Mines, USA

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

continued in next column

4:30-4:55 Certified Dimension Reduction for Nonlinear Bayesian Inverse Problems

Olivier Zahm and Alessio Spantini, Massachusetts Institute of Technology, USA; Tiangang Cui, Monash University, Australia; Kody Law, Oak Ridge National Laboratory, USA; *Youssef M. Marzouk*, Massachusetts Institute of Technology, USA

5:00-5:25 Adaptive Dimension Reduction to Accelerate Infinite-dimensional Geometric MCMC

Shiwei Lan, California Institute of Technology, USA

5:30-5:55 Exploiting Ridge Approximations for Bayesian Inference

Jeffrey M. Hokanson and Paul Constantine, University of Colorado Boulder, USA

6:00-6:25 Dimension Reduction for Remote Sensing and Data Fusion

Marko Laine, Finnish Meteorological Institute, Helsinki, Finland

Tuesday, April 17

MS55

Advances in Numerical Techniques for the Study of Rare Events - Part II of III

4:30 PM-6:30 PM

Room:Garden 4 - 1st Floor

For Part 1 see MS41
For Part 3 see MS68

Stochastic differential equations, where uncertainty accounting for random small continuous changes in the environment comes from the noise term, are often used for modeling physical, chemical, or biological systems. Often, events of interest in such systems happen rarely on the time-scale of the system that renders their study by direct simulations difficult. Contemporary methods for the study of rare events include path-based techniques, Hamilton-Jacobi-type solvers, as well as model reduction methods that allow one to use elliptic solvers for finding quantities characterizing the transition process. Furthermore, uncertainty in systems can come from unknown coefficients in the elliptic PDEs or stochastic stopping times. In this minisymposium, we are bringing together researchers to share advances in deterministic numerical techniques for analysis of such stochastic systems. Methods for finding the quasi-potential, the maximum likelihood transition paths, the transition rates and the committor functions will be presented. Talks featuring techniques for model reduction for high-dimensional systems, for dealing with elliptic PDEs will uncertainty, as well as an optimal control problem, will take place. Applications to some real-life systems, for example, genetic switches, will be demonstrated.

Organizer: Maria K. Cameron
University of Maryland, USA

Organizer: Xiang Zhou
City University of Hong Kong, Hong Kong

continued on next page

4:30-4:55 Model Reduction for Diffusion-like Processes near Low-dimensional Manifolds in High Dimensions
Mauro Maggioni, Johns Hopkins University, USA

5:00-5:25 A Multilevel Approach Towards Unbiased Sampling of Random Elliptic Partial Differential Equations
Xiaoou Li, University of Minnesota, USA; *Jingchen Liu* and Shun Xu, Columbia University, USA

5:30-5:55 Rare Event Analysis on Random Elliptic PDEs with Small Noise
Xiaoou Li, University of Minnesota, USA; Jingchen Liu, Columbia University, USA; Xiang Zhou, City University of Hong Kong, Hong Kong; Jianfeng Lu, Duke University, USA

6:00-6:25 Point Cloud Discretization of Fokker-Planck Operators for Committor Functions
Rongjie Lai, Rensselaer Polytechnic Institute, USA; Jianfeng Lu, Duke University, USA

Tuesday, April 17

MS56

Advances in Sparse Polynomial Approximations with Applications to Complex Stochastic Modeling - Part I of III

4:30 PM-6:30 PM

Room:Pacific - 2nd Floor

For Part 2 see MS69

The approximations of high-dimensional systems from a limited amount of data play a pivotal role in uncertainty quantification. For such systems, constructing the quantities of interest often requires repeated expensive measurements, i.e., an ensemble of complex numerical simulations or time-consuming physical experiments. This minisymposium aims at documenting recent advances in exploring and exploiting sparse structures in parameterized PDEs driven by complex stochastic modeling applications, to provide low-cost, reliable approximations and mitigate the computational burden. The presentations will cover latest developments on sparse approximation techniques, including interpolation, least-squares, compressed sensing, multilevel and ensemble methods, as well as their applications to several types of complex problems, such as PDEs with lognormal coefficients, multi-scale equations, and turbulence models.

Organizer: Hoang A. Tran
Oak Ridge National Laboratory, USA

Organizer: Guannan Zhang
Oak Ridge National Laboratory, USA

4:30-4:55 Convergence of Sparse Polynomial Collocation in Infinite Dimensions
Oliver G. Ernst, Technische Universitat Chemnitz, Germany

5:00-5:25 Polynomial Approximation of High-dimensional Functions on Irregular Domains
Ben Adcock, Simon Fraser University, Canada; Daan Huybrechs, KU Leuven, Belgium

5:30-5:55 A Domain-decomposition-based Approximation Technique for Convection-dominated PDEs with Random Velocity Fields
Guannan Zhang and Lin Mu, Oak Ridge National Laboratory, USA

6:00-6:25 Optimal Weighted Least-squares Methods for Approximation in High Dimension
Giovanni Migliorati and Albert Cohen, Université Pierre et Marie Curie, France

continued in next column

Tuesday, April 17

MS57

Multilevel and Multifidelity Bayesian Methods for Inverse Problems and Beyond - Part III of III

4:30 PM-6:30 PM

Room:Harbor - 2nd Floor

For Part 2 see MS43

Exploring the posterior distribution in Bayesian inverse problems can quickly exceed available computationally resources if each forward-model solve is computationally demanding. In many situations, however, there is not only the expensive high-fidelity forward model available. Rather, there are several models that describe the same phenomenon as the high-fidelity model but with varying costs and fidelities. For example, there are often coarse-grid approximations, projection-based reduced models, data-fit models, and simplified-physics models. This minisymposium presents multilevel and multifidelity methods that leverage these low-cost low-fidelity models to speedup the exploration of the posterior distribution.

Organizer: Tiangang Cui

Monash University, Australia

Organizer: Benjamin Peherstorfer

University of Wisconsin, Madison, USA

4:30-4:55 Iterative Update of Modeling Error in Computational Inverse Problems

Erkki Somersalo, Case Western Reserve University, USA

5:00-5:25 Numerical Posterior Distribution Error Control and Bayes Factors in the Bayesian Uncertainty Quantification of Inverse Problems

J. Andrés Christen, Marcos A. Capistran, and Miguel A. Moreles, CIMAT, Mexico

continued in next column

5:30-5:55 Inferring on the Parameters of a Microscopic Model from the Estimated Parameters of a Macroscopic One

Daniela Calvetti, *Margaret Callahan*, and Erkki Somersalo, Case Western Reserve University, USA

6:00-6:25 Multilevel Sparse Leja Approximations in Bayesian Inversion

Ionut-Gabriel Farcas, Jonas Latz, Elisabeth Ullmann, Tobias Neckel, and Hans-Joachim Bungartz, Technische Universität München, Germany

Tuesday, April 17

MS58

Model Error and Model Selection: Bayesian Approaches - Part I of III

4:30 PM-6:30 PM

Room:Salon I - 2nd Floor

For Part 2 see MS71

Probabilistic approaches to model error and selection are becoming increasingly prevalent in computational science. While model improvement is an enterprise that is continuously enabled by the availability of cost-effective high-performance computing infrastructure, model error is unavoidable in many situations. This problem is attributed to the incomplete understanding of the underlying physics and/or the need for simpler models in many stages of engineering analysis and design. The notion that multiple models may provide reasonable approximations compounds the difficulty of model validation and uncertainty quantification. To that effect, model correction approaches and model selection techniques increase the range of applicability of models that suffer from model form error. The popularity of the Bayesian paradigm stems from its natural integration of measurement and model uncertainties. It enables the incorporation of uncertain hidden variables, with stochasticity introduced through, e.g. modeling error, uncertain model parameters, initial/boundary conditions, and/or numerical approximations. In a Bayesian setting, the solution to an inverse problem is the probability distribution of the quantities of interest, including model error and hyper-parameters. Quantifying the uncertainty and determining the validity of these models in predictive settings is an active area of research. This minisymposium focuses on Bayesian model selection and model correction techniques.

Organizer: Kathryn Maupin

Sandia National Laboratories, USA

Organizer: Mohammad Khalil

Sandia National Laboratories, USA

continued on next page

4:30-4:55 Embedded Model Error and Bayesian Model Selection for Material Variability

Mohammad Khalil, Francesco Rizzi, Ari Frankel, Coleman Alleman, Jeremy Templeton, Jakob Ostien, Brad Boyce, and Reese Jones, Sandia National Laboratories, USA

5:00-5:25 A Stochastic Operator Approach to Representing Model Inadequacy

Teresa Portone, Damon McDougall, Robert D. Moser, and Todd A. Oliver, University of Texas at Austin, USA

5:30-5:55 Physics-constrained Data-driven Modeling of Computational Physics

Anand Pratap Singh and Karthik Duraisamy, University of Michigan, USA

6:00-6:25 Model Error in Co2 Retrievals for the Oco-2 Satellite

Jenny Brynjarsdottir, Case Western Reserve University, USA

Tuesday, April 17

MS59

UQ for Kinetic Equations - Part II of III

4:30 PM-6:30 PM

Room:Salon II - 2nd Floor

For Part 1 see MS45
For Part 3 see MS72

The aim of this minisymposium is to bring together researchers with an interest in stochastic kinetic equations and uncertainty quantification. Kinetic equations with random inputs are a relatively new subject in the context of uncertainty quantification, but the number of researchers who are working on kinetic or transport equations in the presence of uncertainties has been increasing recently. This minisymposium hence serves as a forum for the exchange of ideas as well as new problems and helps shape future research directions in this growing area. The focus is on kinetic equations with random inputs. Theoretic aspects such as existence, uniqueness, regularity, hypocoercivity, and sensitivity analysis are discussed as well as the development of numerical methods such as stochastic Galerkin, stochastic collocation, and (multi-level) Monte Carlo specialized for transport equations. Bayesian estimation for transport equations is also discussed. Applications include all areas where kinetic equations have been proven useful, such as engineering, biology, and also economy. The main model equations are the Boltzmann equation and derived equations.

Organizer: Clemens Heitzinger

Vienna University of Technology, Austria

4:30-4:55 Maximum-principle-satisfying Second-order Intrusive Polynomial Moment Scheme

Jonas Kusch and Martin Frank, Karlsruhe Institute of Technology, Germany; Graham Alldredge, Freie Universität Berlin, Germany

continued in next column

5:00-5:25 Sensitivity Analysis and High Dimensional Kinetic Equation with Uncertainty

Yuhua Zhu, University of Wisconsin, Madison, USA; Shi Jin, Shanghai Jiao Tong University, China, and the University of Wisconsin, USA

5:30-5:55 Calibration, Compensation, Parameter Estimation, and Uncertainty Quantification for Nanoelectrode Array Biosensors

Andrea Cossettini and Paolo Scarbolo, Università di Udine, Italy; Jose Escalante and Benjamin Stadlbauer, Vienna University of Technology, Austria; Naseer Muhammad, Università di Udine, Italy; Leila Taghizadeh and Clemens Heitzinger, Vienna University of Technology, Austria; Luca Selmi, Università di Udine, Italy

6:00-6:25 Optimal Multi-level Monte Carlo and Adaptive Grid Refinement for the Stochastic Drift-diffusion-poisson System

Amirreza Khodadadian, Vienna University of Technology, Austria; Maryam Parvzi, Universität Wien, Austria; Clemens Heitzinger, Vienna University of Technology, Austria

Tuesday, April 17

MS60

Exploiting Structure in Optimization under Uncertainty - Part II of II

4:30 PM-6:30 PM

Room:Salon VIII - 2nd Floor

For Part 1 see MS46

Uncertainty arises everywhere in engineering and the natural sciences. It is therefore crucial that engineering optimization and optimal control problems are developed in such a way that the optimal controls, parameters or designs are robust to uncertainty. Stochastic programming and risk management provide several techniques, which yield robust or risk-averse solutions; for example, by using risk measures, stochastic orders, or robust optimization techniques. This session seeks to bring together researchers in PDE-constrained and stochastic optimization with practitioners in several branches of engineering in order to foster and exchange new ideas. An emphasis is placed on theoretical and algorithmic approaches for risk-averse optimization, especially for the development of new structure-exploiting numerical solution techniques.

Organizer: Drew P. Kouri
Sandia National Laboratories, USA

Organizer: Denis Ridzal
Sandia National Laboratories, USA

Organizer: Harbir Antil
George Mason University, USA

Organizer: Thomas M. Surowiec
Philipps-Universität Marburg, Germany

4:30-4:55 Sparse Solutions in Optimal Control of PDEs with Uncertain Coefficients
Georg Stadler, Courant Institute of Mathematical Sciences, New York University, USA

5:00-5:25 An Adaptive Local Reduced Basis Trust-region Method for Risk-averse PDE-constrained Optimization
Wilkins Aquino, Duke University, USA

5:30-5:55 Scalable Algorithms and Software for PDE-constrained Optimization under Uncertainty
Denis Ridzal and Drew P. Kouri, Sandia National Laboratories, USA

6:00-6:25 Risk-averse Topology Optimization
Boyan S. Lazarov, University of Manchester, United Kingdom

continued in next column

Tuesday, April 17

MS61

IGA and Other Spline-based Methods in UQ and High-dimensional Problems - Part I of II

4:30 PM-6:30 PM

Room:Salon V - 2nd Floor

For Part 2 see MS74

The use of spline techniques in Uncertainty Quantification (UQ) is largely unexplored, although standard in many closely related branches of science and engineering such as interpolation/ data fitting and Computer-Aided Design (CAD). High-dimensional and UQ problems involving splines emerge e.g. in shape optimization under uncertainty and problems with random domains. The use of splines of arbitrary polynomial order and continuity is one of the main ingredients of Isogeometric Analysis (IGA), an alternative to standard Finite Element Analysis (FEA), that was originally proposed to improve the interaction with CAD software and has shown other computational advantages such as increasing the accuracy-to-degrees-of-freedom ratio, and simplifying the solution of high-order PDEs or PDEs on manifold. Finally, splines represent an alternative to Lagrangian and orthonormal polynomials for high-dimensional functional approximation. The aim of this minisymposium is to gather scientists using splines-based methods in the context of UQ and high-dimensional problems and discuss the possible advantages.

Organizer: Joakim Beck
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Lorenzo Tamellini
Istituto di Matematica Applicata e Tecnologie Informatiche-CNR, Italy

continued on next page

4:30-4:55 IGA-based Multi-index Stochastic Collocation
Joakim Beck, King Abdullah University of Science & Technology (KAUST), Saudi Arabia; *Lorenzo Tamellini*, Istituto di Matematica Applicata e Tecnologie Informatiche-CNR, Italy

5:00-5:25 B-splines on Sparse Grids for Stochastic Collocation
Michael F. Rehme and Fabian Franzelin, Universität Stuttgart, Germany; Dirk Pflüger, Technische Universität München, Germany

5:30-5:55 An Adaptive Multi-fidelity Metamodel for UQ and Optimization Based on Polyharmonic Spline
Matteo Diez, CNR-INSEAN, Italy; Riccardo Pellegrini and Andrea Serani, CNR-INSEAN, National Research Council-Marine Technology Research Institute, Italy

6:00-6:25 Soft Information in Uncertainty Quantifications
Johannes O. Royset, Naval Postgraduate School, USA

Tuesday, April 17

MS62

Recent Advances in Surrogate-based Uncertainty Quantification Methods for Extreme-scale Scientific Computing

4:30 PM-6:30 PM

Room:Salon VI - 2nd Floor

Uncertainty quantification methods have seen tremendous use throughout the computational science community for enabling rigorous predictive simulation. In this minisymposium, recent advances in surrogate-based uncertainty quantification methods will be presented, focusing on local and adaptive methods applicable to problems involving localized behavior or discontinuities; methods adapted for large-scale problems implemented on emerging extreme scale computer architectures; and the use of surrogate methods in Bayesian inversion.

Organizer: Eric Phipps
Sandia National Laboratories, USA

Organizer: Mohamed S. Ebeida
Sandia National Laboratories, USA

4:30-4:55 Adaptive Sampling for Efficient UQ using Voronoi Piecewise Surrogates
Ahmad A. Rushdi, Northrop Grumman Corporation, USA; Marta D'Elia, Laura Swiler, Eric Phipps, and *Mohamed S. Ebeida*, Sandia National Laboratories, USA

5:00-5:25 An Ensemble Generation Method for Efficient UQ Based on Local Surrogate Models
Ahmad A. Rushdi, Northrop Grumman Corporation, USA; Laura Swiler, Eric Phipps, Marta D'Elia, and Mohamed S. Ebeida, Sandia National Laboratories, USA

continued in next column

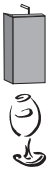
5:30-5:55 On the Ensemble Propagation for Efficient Uncertainty Quantification of Mechanical Contact Problems
Kim Liegeois and Romain Boman, Université de Liège, Belgium; Eric Phipps and Tobias A. Wiesner, Sandia National Laboratories, USA; Maarten Arnst, Université de Liège, Belgium

6:00-6:25 Convergence of Consistent Bayesian Inversion using Surrogates
Troy Butler, University of Colorado, Denver, USA; Tim Wildey and John D. Jakeman, Sandia National Laboratories, USA

Intermission

6:30 PM-6:45 PM

SIAG/UQ Business Meeting



6:45 PM-7:45 PM

Room:Grand Ballroom ABCD - 1st Floor

Complimentary beer and wine will be served.

Wednesday, April 18

Registration

7:45 AM-5:00 PM

Room:Grand Ballroom E - 1st Floor

MT5

Stochastic Multiscale Space-time Modelling and Practical Bayesian Inference

8:10 AM-10:10 AM

Room:Grand Ballroom G - 1st Floor

For large scale environmental statistical data problems with uneven observation coverage, we face challenges both in constructing realistically complex models that can capture the observed phenomena, and in getting reasonably fast parameter estimates and process value estimates or samples. In this minitutorial we will show how both of these challenges can be approach by combining techniques from classical geostatistics, Gaussian processes, and Markov random fields, with numerical methods for stochastic PDEs and MCMC-free Bayesian inference.

Organizers and Speakers:

Finn Lindgren
University of Edinburgh, United Kingdom

Daniel Simpson
University of Toronto, Canada

Wednesday, April 18

MS63

Nonlinear Filtering and Data Assimilation in Complex Dynamical Systems - Part II of III

8:10 AM-10:10 AM

Room:Grand Ballroom ABCD - 1st Floor

For Part 1 see MS49
For Part 3 see MS76

Data assimilation and filtering play a crucial role in variable estimation with noisy partial observations, which can be further used as initializations for real-time predictions. Many complex dynamical systems in geophysical and engineering turbulence, neuroscience and material science involve nonlinear structures, non-Gaussian statistics and high dimensionality that require the development and improvement of effective nonlinear data assimilation methods. This minisymposium focuses on ideas and advanced techniques for nonlinear data assimilation. Topics include ensemble and particle filters, variational methods, localization techniques, sequential Monte Carlo approaches, hybrid strategies and efficient numerical approximations etc. Applications of these methods in both climate science, inverse problems and engineering turbulence is another focus of this minisymposium.

Organizer: Nan Chen

New York University, USA

Organizer: Xin T. Tong

National University of Singapore, Singapore

8:10-8:35 A Conditional Gaussian Framework for Filtering and Predicting Complex Nonlinear Dynamical Systems

Nan Chen, New York University, USA; Andrew Majda, Courant Institute of Mathematical Sciences, New York University, USA; Xin T. Tong, National University of Singapore, Singapore

continued in next column

8:40-9:05 A Class of Nonlinear Filters Induced by Local Couplings

Alessio Spantini and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

9:10-9:35 Particle Filters for Spatially Extended Systems

Alexandre H. Thiery, National University of Singapore, Singapore

9:40-10:05 More Data is not Always Better: Why and How Feature-based Data Assimilation can be Useful

Spencer C. Lunderman and Matthias Morzfeld, University of Arizona, USA

Wednesday, April 18

MS64

Model-based Optimal Experimental Design - Part II of III

8:10 AM-10:10 AM

Room:Grand Ballroom F - 1st Floor

For Part 1 see MS51
For Part 3 see MS77

The challenge of acquiring the most valuable data from experiments---for the purpose of inference, prediction, classification, design, control, etc.---has received substantial attention in major research fields of statistics, applied math, engineering, and many more. These questions can be formalized through the framework of optimal experimental design (OED). Models describing experimental conditions and processes, both physical and statistical, can be particularly useful for arriving at these optimal designs. However, model-based OED faces many challenges, such as formulational difficulties, choices of optimality and their tradeoffs, computation of information metrics, nonlinear relationships and responses, propagation and sampling of non-Gaussian distributions, high-dimensional parameter and design spaces, expensive and dynamically evolving models, and optimization in the presence of uncertainty and with probabilistic and PDE constraints. This minisymposium invites speakers working on tackling challenges related to model-based optimal experimental design, in the broad areas of theoretical, algorithmic, computational, and applications-oriented developments.

Organizer: Xun Huan
Sandia National Laboratories, USA

Organizer: David Woods
University of Southampton, United Kingdom

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

8:10-8:35 Scalable Methods for Bayesian Optimal Experimental Design, with Applications to Inverse Scattering

Omar Ghattas and Umberto Villa, University of Texas at Austin, USA

8:40-9:05 Towards Exascale Computing: Optimal Parallelization of Experimental Design

Udo von Toussaint, Roland Preuss, and *Dirk Nille*, Max Planck Institute for Plasma Physics, Germany

9:10-9:35 Bayesian Optimization using Stacked Gaussian Processes

Kareem Abdelfatah and Gabriel Terejanu, University of South Carolina, USA

9:40-10:05 Extending the use of Statistical Emulators in Bayesian Experimental Design

James McGree, Queensland University of Technology, Australia; Antony Overstall, University of Southampton, United Kingdom

continued in next column

Wednesday, April 18

MS65

Data and UQ: Bayesian Learning - Part I of III

8:10 AM-10:10 AM

Room:Garden 1 - 1st Floor

For Part 2 see MS78

The amount of data in existence is growing exponentially. This has lead to the development of an unavoidable basin of attraction in the scientific landscape, whose effect is apparent across the spectrum of applied math. The area of UQ is no exception -- indeed data itself is often subject to some level of uncertainty. Learning from this abundant data may involve either inverting or assimilating it into a complex model, for example derived from physical laws, or it may involve inversion of data alone, for example to learn a complex model in a context where no first principles exist. Ultimately this intelligence will be used for decision making and planning. Both model-based or purely data-driven inference strategies may be considered either from a classical perspective, with the objective of obtaining a point estimate, and possibly some quantification of error, or from a probabilistic or statistical perspective, with the objective of complete quantification of uncertainty through the recovery of a posterior distribution. This minisymposium aims to explore recent advances at this interesting and fertile interface.

Organizer: Matthew M. Dunlop
California Institute of Technology, USA

Organizer: Kody Law
Oak Ridge National Laboratory, USA

8:10-8:35 On the Construction of Probabilistic Newton-type Algorithms

Thomas Schön, Uppsala University, Sweden; Adrian G. Wills, University of New Castle, NSW, Australia

continued on next page

Wednesday, April 18

MS65

Data and UQ: Bayesian Learning - Part I of III

8:10 AM-10:10 AM

continued

8:40-9:05 Spatiotemporal Pattern Extraction with Operator-valued Kernels

Dimitrios Giannakis, Courant Institute of Mathematical Sciences, New York University, USA; Abbas Ourmazd and Joanna Slawinska, University of Wisconsin, USA; Zhizhen Zhao, University of Illinois, USA

9:10-9:35 Data-driven Discovery of Dynamical Systems and Uncertainty in Model Selection

Nathan Kutz, University of Washington, USA

9:40-10:05 A Bayesian Topological Framework for the Identification and Reconstruction of Subcellular Motion

Vasileios Maroulas, University of Tennessee, Knoxville, USA

Wednesday, April 18

MS66

Recent Advances in Model Reduction and Data-enabled Modeling - Part III of III

8:10 AM-10:10 AM

Room:Garden 2 - 1st Floor

For Part 2 see MS53

Despite the remarkable increase in computational power, most real-world systems are still too complex to simulate in full details. How to utilize available data to facilitate/accelerate the simulations becomes increasingly important in the recent years. Among all methods, model reduction and data-driven approaches prove themselves as indispensable algorithmic tools for real-time applications: (1) Model reduction provides good cheap low-dimensional approximations to the computationally expensive full systems without scarifying accuracy. (2) Data-enable modeling, including data-driven, data assimilation and physics-informed machine learning, dynamically extracts information of a significant amount of dynamic real data and provides guidance for system design, decision-making, etc. This minisymposium focuses on recent developments in algorithms and applications based model reduction and data-driven approaches. Topics include offline enhanced reduce models, physics-constrained reduced models or data-driven models based on machine learning, improved models based multi-fidelity data, etc.Applications include problems from aerospace, hydroscience and automobile industry.

Organizer: Jing Li
Pacific Northwest National Laboratory, USA

Organizer: Ling Guo
Shanghai Normal University, China

Organizer: Xueyu Zhu
University of Iowa, USA

8:10-8:35 Sequential Data Assimilation with Multiple Nonlinear Models and Applications to Subsurface Flow

Peng Wang, Beihang University, China; Akil Narayan, University of Utah, USA; Lun Yang, Beihang University, China

8:40-9:05 Hybrid Data Assimilation for Aerosol Parameter Estimation

William Rosenthal, Pacific Northwest National Laboratory, USA

9:10-9:35 Probabilistic Machine Learning for Fluid Flows

Yang Zeng and Jinlong Wu, Virginia Tech, USA; Feng Bao, University of Tennessee, Chattanooga, USA; Hu Wang, Hunan University, China; Heng Xiao, Virginia Tech, USA

9:40-10:05 A Deep Learning Approach in Traffic Prediction for Autonomous Driving

Qi Kong, Baidu, USA

continued in next column

Wednesday, April 18

MS67

Dimension Reduction in Bayesian Inference - Part II of III

8:10 AM-10:10 AM

Room:Garden 3 - 1st Floor

For Part 1 see MS54
For Part 3 see MS80

Non-standard and high-dimensional distributions naturally arise from the Bayesian formulation of statistical inference problems. The ultimate tractability of such distributions in practical problems is dictated by the availability of efficient and accurate sampling or quadrature strategies. This task becomes more and more challenging as distributions depart from standard ones and as their dimensionalities increase. However, many high-dimensional Bayesian models have an underlying low-dimensional structure (e.g., Markov structure, marginal independence, low rank, regularity, sparsity) that can be leveraged by appropriately designed algorithms. This minisymposium aims to provide a venue for the interaction between active researchers in dimensionality reduction with a focus on specific aspects arising in Bayesian inference.

Organizer: Daniele Bigoni
Massachusetts Institute of Technology, USA

Organizer: Olivier Zahm
Massachusetts Institute of Technology, USA

Organizer: Paul Constantine
Colorado School of Mines, USA

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

continued in next column

8:10-8:35 Graph-based Bayesian Learning: Continuum Limits and Algorithms

Daniel Sanz-Alonso, Nicolas Garcia Trillos, Zachary Kaplan, and Thabo Samakhoana, Brown University, USA

8:40-9:05 Conditional Density Estimation, Filtering and Clustering using Optimal Transport

Giulio Trigila, Baruch College, CUNY, USA

9:10-9:35 A 4D-Var Method with Flow-dependent Background Covariances

Daniel Paulin and Ajay Jasra, National University of Singapore, Singapore; Dan Crisan, Imperial College London, United Kingdom; Alexandros Beskos, University College London, United Kingdom

9:40-10:05 Dimension Reduction in Optimization-based Sampling

Zheng Wang and Youssef M. Marzouk, Massachusetts Institute of Technology, USA; Tiangang Cui, Monash University, Australia

Wednesday, April 18

MS68

Advances in Numerical Techniques for the Study of Rare Events - Part III of III

8:10 AM-10:10 AM

Room:Garden 4 - 1st Floor

For Part 2 see MS55

Stochastic differential equations, where uncertainty accounting for random small continuous changes in the environment comes from the noise term, are often used for modeling physical, chemical, or biological systems. Often, events of interest in such systems happen rarely on the time-scale of the system that renders their study by direct simulations difficult. Contemporary methods for the study of rare events include path-based techniques, Hamilton-Jacobi-type solvers, as well as model reduction methods that allow one to use elliptic solvers for finding quantities characterizing the transition process. Furthermore, uncertainty in systems can come from unknown coefficients in the elliptic PDEs or stochastic stopping times. In this minisymposium, we are bringing together researchers to share advances in deterministic numerical techniques for analysis of such stochastic systems. Methods for finding the quasi-potential, the maximum likelihood transition paths, the transition rates and the committor functions will be presented. Talks featuring techniques for model reduction for high-dimensional systems, for dealing with elliptic PDEs will uncertainty, as well as an optimal control problem, will take place. Applications to some real-life systems, for example, genetic switches, will be demonstrated.

Organizer: Maria K. Cameron
University of Maryland, USA

Organizer: Xiang Zhou
City University of Hong Kong, Hong Kong

continued on next page

Wednesday, April 18

MS68

Advances in Numerical Techniques for the Study of Rare Events - Part III of III

8:10 AM-10:10 AM

continued

8:10-8:35 An Improved Adaptive Minimum Action Method for Non-gradient System

Xiang Zhou, City University of Hong Kong, Hong Kong

8:40-9:05 A Laguerre Spectral Minimum Action Method for Finding the Most Probable Path

Haijun Yu, Institute of Computational Mathematics, China

9:10-9:35 Minimum Action Method for Systems with Delays

Jiayu Zhai and Xiaoliang Wan, Louisiana State University, USA

9:40-10:05 Modeling Rare Events in Complex Systems

Weiqing Ren, National University of Singapore and IHPC, Singapore

Wednesday, April 18

MS69

Advances in Sparse Polynomial Approximations with Applications to Complex Stochastic Modeling - Part II of III

8:10 AM-10:10 AM

Room:Pacific - 2nd Floor

For Part 1 see MS56
For Part 3 see MS82

The approximations of high-dimensional systems from a limited amount of data play a pivotal role in uncertainty quantification. For such systems, constructing the quantities of interest often requires repeated expensive measurements, i.e., an ensemble of complex numerical simulations or time-consuming physical experiments. This minisymposium aims at documenting recent advances in exploring and exploiting sparse structures in parameterized PDEs driven by complex stochastic modeling applications, to provide low-cost, reliable approximations and mitigate the computational burden. The presentations will cover latest developments on sparse approximation techniques, including interpolation, least-squares, compressed sensing, multilevel and ensemble methods, as well as their applications to several types of complex problems, such as PDEs with lognormal coefficients, multi-scale equations, and turbulence models.

Organizer: Hoang A. Tran
Oak Ridge National Laboratory, USA

Organizer: Guannan Zhang
Oak Ridge National Laboratory, USA

8:10-8:35 Unified Null Space Conditions for Sparse Approximations via Nonconvex Minimizations

Hoang A. Tran, Oak Ridge National Laboratory, USA; Clayton G. Webster, University of Tennessee and Oak Ridge National Laboratory, USA

8:40-9:05 A Generalized Sampling and Weighted Approach for Sparse Approximation of Polynomial Chaos Expansions

Tao Zhou, Chinese Academy of Sciences, China

9:10-9:35 A Stochastic Shape Control method for Optimal Solar Panel Design Problems

Junshan Lin and Yanzhao Cao, Auburn University, USA

9:40-10:05 Sparse Grid Quadratures from Conformal Mappings

Peter Jantsch, Texas A&M University, USA; Clayton G. Webster, University of Tennessee and Oak Ridge National Laboratory, USA

continued in next column

Wednesday, April 18

MS70

Advances in Multi-level and Multi-fidelity Methods for Uncertainty Quantification - Part I of II

8:10 AM-10:10 AM

Room:Harbor - 2nd Floor

For Part 2 see MS83

A modern computational mainstay is the multi-fidelity and multi-level challenge: make efficient and robust predictions given several competing models each having its own degree of trust. The abstract concept of "fidelity" or "level" -- faithfulness to physics, experimental observations, and/or idealized mathematical formulations -- arises because different simulation suites utilize different discretization types and scales and make dissimilar simplifications of underlying physics. This minisymposium aims to highlight recent advances in algorithms and applications that make optimal use of models with differing fidelities or levels. The challenges include resource distribution among models, identification and learning of model hierarchy and levels, as well as convergence analysis of the multi-fidelity or multi-level solutions. Applications of such tools to both forward uncertainty propagation and inverse problems are of interest to this minisymposium.

Organizer: Alireza Doostan
University of Colorado Boulder, USA

Organizer: Akil Narayan
University of Utah, USA

8:10-8:35 Uncertainty Quantification via a Bi-fidelity Low-rank Approximation Technique

Alireza Doostan, Jerrad Hampton, and Hillary Fairbanks, University of Colorado Boulder, USA; Akil Narayan, University of Utah, USA

8:40-9:05 Adaptive Refinement Strategies for Multilevel Polynomial Expansions

Michael S. Eldred, Gianluca Geraci, Alex Gorodetsky, and John D. Jakeman, Sandia National Laboratories, USA

9:10-9:35 A Multi-fidelity Stochastic Collocation Method for Time-dependent Problems

Xueyu Zhu, University of Iowa, USA; Dongbin Xiu, Ohio State University, USA

9:40-10:05 Multifidelity Robust Optimization

Anirban Chaudhuri and Karen E. Willcox, Massachusetts Institute of Technology, USA

continued in next column

Wednesday, April 18

MS71

Model Error and Model Selection: Bayesian Approaches - Part II of III

8:10 AM-10:10 AM

Room:Salon I - 2nd Floor

For Part 1 see MS58
For Part 3 see MS84

Probabilistic approaches to model error and selection are becoming increasingly prevalent in computational science. While model improvement is an enterprise that is continuously enabled by the availability of cost-effective high-performance computing infrastructure, model error is unavoidable in many situations. This problem is attributed to the incomplete understanding of the underlying physics and/or the need for simpler models in many stages of engineering analysis and design. The notion that multiple models may provide reasonable approximations compounds the difficulty of model validation and uncertainty quantification. To that effect, model correction approaches and model selection techniques increase the range of applicability of models that suffer from model form error. The popularity of the Bayesian paradigm stems from its natural integration of measurement and model uncertainties. It enables the incorporation of uncertain hidden variables, with stochasticity introduced through, e.g. modeling error, uncertain model parameters, initial/boundary conditions, and/or numerical approximations. In a Bayesian setting, the solution to an inverse problem is the probability distribution of the quantities of interest, including model error and hyper-parameters. Quantifying the uncertainty and determining the validity of these models in predictive settings is an active area of research. This minisymposium focuses on Bayesian model selection and model correction techniques.

continued on next page

Wednesday, April 18

MS71

Model Error and Model Selection: Bayesian Approaches - Part II of III

8:10 AM-10:10 AM

continued

Organizer: Kathryn Maupin
Sandia National Laboratories, USA

Organizer: Mohammad Khalil
Sandia National Laboratories, USA

8:10-8:35 Conditioning Multi-model Ensembles for Disease Forecasting
Jaideep Ray, Lynne Burks, and Katherine Cauthen, Sandia National Laboratories, USA

8:40-9:05 Dynamic Bayesian Influenza Forecasting in the United States with Hierarchical Discrepancy
Dave Osthus and James Gattiker, Los Alamos National Laboratory, USA; Reid Priedhorsky and Sara Del Valle, Los Alamos National Laboratory, USA

9:10-9:35 Selection, Calibration, and Validation of Models in the Presence of Uncertainty: Applications to Modeling Tumor Growth
Ernesto A. B. F. Lima, J. T. Oden, D. A. Hormuth II, T. E. Yankeelov, and A. Shahmoradi, University of Texas at Austin, USA; B. Wohlmuth and L. Scarabosio, Technische Universität München, Germany

9:40-10:05 Multi-physics Model Error Calibration
Abhinav Subramanian, Vanderbilt University, USA

Wednesday, April 18

MS72

UQ for Kinetic Equations - Part III of III

8:10 AM-9:10 AM

Room:Salon II - 2nd Floor

For Part 2 see MS59

The aim of this minisymposium is to bring together researchers with an interest in stochastic kinetic equations and uncertainty quantification. Kinetic equations with random inputs are a relatively new subject in the context of uncertainty quantification, but the number of researchers who are working on kinetic or transport equations in the presence of uncertainties has been increasing recently. This minisymposium hence serves as a forum for the exchange of ideas as well as new problems and helps shape future research directions in this growing area. The focus is on kinetic equations with random inputs. Theoretic aspects such as existence, uniqueness, regularity, hypocoercivity, and sensitivity analysis are discussed as well as the development of numerical methods such as stochastic Galerkin, stochastic collocation, and (multi-level) Monte Carlo specialized for transport equations. Bayesian estimation for transport equations is also discussed. Applications include all areas where kinetic equations have been proven useful, such as engineering, biology, and also economy. The main model equations are the Boltzmann equation and derived equations.

Organizer: Clemens Heitzinger
Vienna University of Technology, Austria

8:10-8:35 A Bayesian Approach to Quantifying Uncertainty Divergence Free Flows
Nathan Glatt-Holtz, Tulane University, USA

8:40-9:05 Uncertainty Quantification for the Boltzmann - Poisson System
Jose A. Morales Escalante and Clemens Heitzinger, Vienna University of Technology, Austria

Wednesday, April 18

MS73

Efficient Uncertainty Quantification for Simulation and Optimisation of Industrial Applications

8:10 AM-10:10 AM

Room:Salon VIII - 2nd Floor

This minisymposium deals with methodologies for the simulation and robust optimization of industrial processes under uncertainty. The focus is on how to improve the efficiency of non-intrusive uncertainty quantification methods towards high numbers of uncertainties, in combination with computationally expensive mathematical models. Innovative tools are discussed for sensitivity analysis, sparse and multilevel sampling, surrogate modelling and the reduced basis approach. Applications will be considered from computational fluid dynamics, aerodynamics, structural engineering and process technology.

Organizer: Stefan Vandewalle
KU Leuven, Belgium

Organizer: Catherine Gorlé
Stanford University, USA

8:10-8:35 Multilevel and Multi-index Sampling for the Forward Propagation of Many Uncertainties in Industrial Applications
Pieterjan Robbe, Dirk Nuyens, and Stefan Vandewalle, KU Leuven, Belgium

8:40-9:05 Quantifying Structural Uncertainty in Reynolds-averaged Navier-stokes Turbulence Models for Simulations of Heat Exchangers
Zengrong Hao and Catherine Gorle, Stanford University, USA

9:10-9:35 Reduced Basis Approach using Sparse Polynomial Chaos Expansions in Computational Fluid Dynamics Applications
Simon Abraham, Panagiotis Tsirikoglou, Francesco Contino, and Ghader Ghorbaniasl, Vrije Universiteit Brussel, Belgium

9:40-10:05 Robust PDE Constrained Optimization with Multilevel Monte Carlo Methods
Andreas Van Barel, Katholieke Universiteit Leuven, Belgium

Wednesday, April 18

MS74

IGA and Other Spline-based Methods in UQ and High-dimensional Problems - Part II of II

8:10 AM-10:10 AM

Room:Salon V - 2nd Floor

For Part 1 see MS61

The use of spline techniques in Uncertainty Quantification (UQ) is largely unexplored, although standard in many closely related branches of science and engineering such as interpolation/ data fitting and Computer-Aided Design (CAD). High-dimensional and UQ problems involving splines emerge e.g. in shape optimization under uncertainty and problems with random domains. The use of splines of arbitrary polynomial order and continuity is one of the main ingredients of Isogeometric Analysis (IGA), an alternative to standard Finite Element Analysis (FEA), that was originally proposed to improve the interaction with CAD software and has shown other computational advantages such as increasing the accuracy-to-degrees-of-freedom ratio, and simplifying the solution of high-order PDEs or PDEs on manifold. Finally, splines represent an alternative to Lagrangian and orthonormal polynomials for high-dimensional functional approximation. The aim of this minisymposium is to gather scientists using splines-based methods in the context of UQ and high-dimensional problems and discuss the possible advantages.

Organizer: Joakim Beck
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Lorenzo Tamellini
Istituto di Matematica Applicata e Tecnologie Informatiche-CNR, Italy

8:10-8:35 Adaptive Low-rank Separated Representations Based on Mapped Tensor-product B-splines

Joseph Benzaken and John A. Evans, University of Colorado Boulder, USA

8:40-9:05 Propagating Fuzzy Uncertainties with Hierarchical B-splines on Sparse Grids

Julian Valentin, Universität Stuttgart, Germany; Dirk Pflüger, Technische Universität München, Germany

9:10-9:35 Minimum Spanning Trees and Support Vector Machines for High-dimensional and Discontinuous Spline-based Surrogate Models

Yous van Halder, Centrum voor Wiskunde en Informatica (CWI), Netherlands

9:40-10:05 IsoGeometric Splines for Smoothing on Surfaces

Matthieu Wilhelm, University of Neuchatel, Switzerland; Luca Dede' and Laura M. Sangalli, Politecnico di Milano, Italy; Pierre Wilhelm, École Polytechnique Fédérale de Lausanne, Switzerland

continued in next column

Wednesday, April 18

MS75

Reduced Order Modeling for Uncertainty Quantification Targeting Exascale Computing Applications

8:10 AM-10:10 AM

Room:Salon VI - 2nd Floor

High-performance computing (HPC) systems are expected to reach exascale performance, i.e. 10^18 calculations per second, in the near future. These HPC systems, which will be at least 50 times faster than the current fastest HPC system in the U.S., will inspire a new generation of simulation tools and introduce new challenges that arise from the highly-distributed nature of exascale systems. Among the simulation tools that will change are reduced order models, which can facilitate new scientific discoveries, enable uncertainty quantification, and yield new physical insights. Reduced order models are fast to evaluate, but can require the dedication of a large amount of computational resources to train and update, and thus have the potential to benefit from exascale computing resources. This minisymposium will explore reduced order modeling techniques applicable to uncertainty quantification of exascale applications that require scaling across many thousands of cores. Talks that address topics in stochastic optimization, dimension reduction, or surrogate modeling, or contain applications targeting exascale computing resources are encouraged.

Organizer: Matthew Reynolds
National Renewable Energy Laboratory, USA

Organizer: Ryan King
National Renewable Energy Laboratory, USA

Organizer: Wesley Jones
National Renewable Energy Laboratory, USA

continued on next page

Wednesday, April 18

MS75

Reduced Order Modeling for Uncertainty Quantification Targeting Exascale Computing Applications

8:10 AM-10:10 AM

continued

8:10-8:35 Sampling Techniques for Stochastic Economic Dispatch of Large Electrical Grids

Matthew Reynolds, Ryan King, Wesley Jones, and Devon Sigler, National Renewable Energy Laboratory, USA

8:40-9:05 Data-driven Reduced Order Modeling for High Fidelity Simulations of Wind Plants

Ryan King, Michael Sprague, and Jennifer Annoni, National Renewable Energy Laboratory, USA

9:10-9:35 Towards Reduced Order Modeling of Liquid-fueled Rocket Combustion Dynamics

Cheng Huang, University of Michigan, Ann Arbor, USA; Karthik Duraisamy, University of Michigan, USA; Jiayang Xu, University of Michigan, Ann Arbor, USA

9:40-10:05 Matrix Decomposition Algorithms for Large-scale Data Compression

Alec M. Dunton, University of Colorado, USA; Lluis Jofre-Cruanyes, Stanford University, USA; Alireza Doostan, University of Colorado Boulder, USA

Coffee Break

10:10 AM-10:40 AM

Room:Grand Ballroom Foyer - 1st Floor

Remarks

10:40 AM-10:45 AM

Room:Grand Ballroom ABCD - 1st Floor

Wednesday, April 18

IP5

Three Principles of Data Science: Predictability, Stability, and Computability

10:45 AM-11:30 AM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Michael Stein, University of Chicago, USA

In this talk, I'd like to discuss the intertwining importance and connections of three principles of data science in the title in data-driven decisions. Making prediction as its central task and embracing computation as its core, machine learning has enabled wide-ranging data-driven successes. Good prediction implicitly assumes stability between past and future. Stability (relative to data and model perturbations) is also a minimum requirement for interpretability and reproducibility of data driven results (cf. Yu, "Stability" in Bernnouli, 2013). It is closely related to uncertainty assessment. The three principles will be demonstrated in the context of two neuroscience projects and through analytical connections. In particular, the first project adds stability to predictive modeling used for reconstruction of movies from fMRI brain signlas to gain interpretability of the predictive model. The second project uses predictive transfer learning that combines AlexNet, GoogleNet and VGG with single V4 neuron data for state-of-the-art prediction performance. It provides stable function characterization of neurons via (manifold) deep dream images from the predictive models in the difficult primate visual cortex V4 and such images are good candidates for follow-up experiments to probe the neurons for confirmation. Our V4 results lend support, to a certain extent, to the resemblance of these CNNs to a primate brain.

Bin Yu

University of California, Berkeley, USA

Wednesday, April 18

Lunch Break

11:30 AM-1:00 PM

Attendees on their own

PD1

Forward Looking Panel: Emerging Issues in UQ

11:45 AM-12:45 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Dave Higdon, Virginia Tech, USA

This session will be a panel discussion of distinguished scholars with a broad range of interests in UQ and related fields addressing future prospects in UQ and its connections to other disciplines. After brief statements from all panel members, there will be an open discussion among the panelists and members of the audience.

Panelists:

Daniela Calvetti
Case Western Reserve University, USA

Peter Challenor
University of Exeter, United Kingdom

Roger Ghanem
University of Southern California, USA

Bin Yu
University of California, Berkeley, USA

Wednesday, April 18

IP6

Multi-level and Multi-index Monte Carlo Methods in Practice

1:00 PM-1:45 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Ralph Smith, North Carolina State University, USA

The multilevel Monte Carlo method has proven to be very powerful to compute expectations of output quantities of a stochastic model governed by differential equations. It exploits several discretization levels of the underlying equation to dramatically reduce the overall complexity with respect to a standard Monte Carlo method. However, its practical implementation in complex engineering problems affected by a large number of uncertain parameters still presents considerable challenges. We overview in this talk recent improvements and extensions of the MLMC idea, to include concurrent types of discretization (multi-index Monte Carlo method) and to compute derived quantities such as central moments, quantiles, or cdfs of output quantities. We illustrate then the power of the MLMC method on applications such as compressible aerodynamics, shape optimization under uncertainty, ensemble Kalman filter and data assimilation.

Fabio Nobile
École Polytechnique Fédérale de Lausanne, Switzerland

Intermission

1:45 PM-2:00 PM

Wednesday, April 18

MT6

Low-rank Tensor Methods

2:00 PM-4:00 PM

Room:Grand Ballroom G - 1st Floor

In many problems, the quantity of interest can be naturally represented by a tensor, and how to explore its potential low-rank structure oftentimes is the key to effective solution to these problems. However, there are several fundamental challenges in doing so because of the delicacy associated with the decomposition of higher order tensors. In this minitutorial, we shall review some of the recently developed techniques to address these challenges, from both computational and probabilistic perspectives.

Organizer and Speaker:

Ming Yuan
Columbia University, USA

Wednesday, April 18

MS76

Nonlinear Filtering and Data Assimilation in Complex Dynamical Systems - Part III of III

2:00 PM-4:00 PM

Room:Grand Ballroom ABCD - 1st Floor

For Part 2 see MS63

Data assimilation and filtering play a crucial role in variable estimation with noisy partial observations, which can be further used as initializations for real-time predictions. Many complex dynamical systems in geophysical and engineering turbulence, neuroscience and material science involve nonlinear structures, non-Gaussian statistics and high dimensionality that require the development and improvement of effective nonlinear data assimilation methods. This minisymposium focuses on ideas and advanced techniques for nonlinear data assimilation. Topics include ensemble and particle filters, variational methods, localization techniques, sequential Monte Carlo approaches, hybrid strategies and efficient numerical approximations etc. Applications of these methods in both climate science, inverse problems and engineering turbulence is another focus of this minisymposium.

Organizer: Nan Chen
New York University, USA

Organizer: Xin T. Tong
National University of Singapore, Singapore

2:00-2:25 On the Stability and the Uniform Propagation of Chaos Properties of Ensemble Kalman-Bucy Filters

Pierre Del Moral, Inria and University of Bordeaux, France

continued on next page

Wednesday, April 18

MS76

Nonlinear Filtering and Data Assimilation in Complex Dynamical Systems - Part III of III

2:00 PM-4:00 PM

continued

2:30-2:55 Convergence Analysis of Ensemble Kalman Inversion

Claudia Schillings, Universitaet Mannheim, Germany; Andrew Stuart, California Institute of Technology, USA

3:00-3:25 Long-time Stability and Accuracy of Interacting Particle Filters

Jana de Wiljes, Universität Potsdam, Germany; Sebastian Reich, Universität Potsdam, Germany and University of Reading, United Kingdom; Wilhelm Stannat, Technische Universität Berlin, Germany

3:30-3:55 Multilevel Monte Carlo for Data Assimilation

Kody Law, Oak Ridge National Laboratory, USA

Wednesday, April 18

MS77

Model-based Optimal Experimental Design - Part III of III

2:00 PM-4:00 PM

Room:Grand Ballroom F - 1st Floor

For Part 2 see MS64

The challenge of acquiring the most valuable data from experiments---for the purpose of inference, prediction, classification, design, control, etc.---has received substantial attention in major research fields of statistics, applied math, engineering, and many more. These questions can be formalized through the framework of optimal experimental design (OED). Models describing experimental conditions and processes, both physical and statistical, can be particularly useful for arriving at these optimal designs. However, model-based OED faces many challenges, such as formulational difficulties, choices of optimality and their tradeoffs, computation of information metrics, nonlinear relationships and responses, propagation and sampling of non-Gaussian distributions, high-dimensional parameter and design spaces, expensive and dynamically evolving models, and optimization in the presence of uncertainty and with probabilistic and PDE constraints. This minisymposium invites speakers working on tackling challenges related to model-based optimal experimental design, in the broad areas of theoretical, algorithmic, computational, and applications-oriented developments.

Organizer: Xun Huan
Sandia National Laboratories, USA

Organizer: David Woods
University of Southampton, United Kingdom

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

2:00-2:25 Experimental Design in Diffuse Tomography

Nuutti Hyvonen and Juha-Pekka Puska, Aalto University, Finland; Aku Seppanen, University of Eastern Finland, Finland; Stratos Staboulis, Technical University of Denmark, Denmark

2:30-2:55 Planning Sensitivity Tests using Mutual Information

Brian Weaver, Los Alamos National Laboratory, USA; Isaac Michaud, North Carolina State University, USA

3:00-3:25 Optimal Design of High-speed Wind Tunnel Instrumentation for Aero-thermal-structural Model Calibration

Benjamin P. Smarslok, Air Force Research Laboratory, USA; Gregory Bartram, Zachary Riley, and Ricardo Perez, Universal Technology Corporation, USA

3:30-3:55 Bayesian Design for Stochastic Models with Application to Models of Infectious Disease Dynamics

Joshua Ross, University of Adelaide, Australia; David Price, University of Cambridge, United Kingdom; Jono Tuke and Nigel Bean, University of Adelaide, Australia

continued in next column

Wednesday, April 18

MS78

Data and UQ: Bayesian Learning - Part II of III

2:00 PM-4:00 PM

Room:Garden 1 - 1st Floor

For Part 1 see MS65
For Part 3 see MS92

The amount of data in existence is growing exponentially. This has lead to the development of an unavoidable basin of attraction in the scientific landscape, whose effect is apparent across the spectrum of applied math. The area of UQ is no exception -- indeed data itself is often subject to some level of uncertainty. Learning from this abundant data may involve either inverting or assimilating it into a complex model, for example derived from physical laws, or it may involve inversion of data alone, for example to learn a complex model in a context where no first principles exist. Ultimately this intelligence will be used for decision making and planning. Both model-based or purely data-driven inference strategies may be considered either from a classical perspective, with the objective of obtaining a point estimate, and possibly some quantification of error, or from a probabilistic or statistical perspective, with the objective of complete quantification of uncertainty through the recovery of a posterior distribution. This minisymposium aims to explore recent advances at this interesting and fertile interface.

Organizer: Matthew M. Dunlop

California Institute of Technology, USA

Organizer: Kody Law

Oak Ridge National Laboratory, USA

2:00-2:25 Uncertainty Quantification in Graph-based Learning

Xiyang Luo, University of California, Los Angeles, USA

2:30-2:55 Semi-supervised Learning using Bayesian Hierarchical Methods

Victor L. Chen and Matthew M. Dunlop, California Institute of Technology, USA; Omiros Papaspiliopoulos, Universitat Pompeu Fabra, Spain; Andrew Stuart, California Institute of Technology, USA

3:00-3:25 Robust UQ in Graph-based Bayesian Semi-supervised Learning and Inverse Problems

Nicolas Garcia Trillos, Brown University, USA

3:30-3:55 Large-data and Zero-noise Limits of Graph-based Semi-supervised Learning Algorithms

Matthew M. Dunlop, California Institute of Technology, USA; Dejan Slepcev, Carnegie Mellon University, USA; Andrew Stuart, California Institute of Technology, USA; Matthew Thorpe, University of Cambridge, United Kingdom

continued in next column

Wednesday, April 18

MS79

Reduced-order Modeling Techniques for Large-scale UQ Problems - Part I of II

2:00 PM-4:00 PM

Room:Garden 2 - 1st Floor

For Part 2 see MS93

The efficient solution of uncertainty-quantification problems---including data assimilation, uncertainty propagation, parameter estimation, and optimization under uncertainty---involving PDE models still poses many outstanding challenges, especially in the presence of large-scale computational models, high-dimensional parameter spaces, and time-to-solution constraints imposed by realistic applications. Recent advances in reduced order modeling (ROM) techniques allow practitioners to successfully tackle some of these problems by reducing the complexity of individual PDE solves while preserving high levels of accuracy. The purpose of this minisymposium is to bring together researchers who have contributed to the advancement of ROM techniques in UQ, to present novel and promising methods, and to discuss future trends for research in this area.

Organizer: Kevin T. Carlberg

Sandia National Laboratories, USA

Organizer: Andrea Manzoni

École Polytechnique Fédérale de Lausanne, Switzerland

2:00-2:25 Certified Reduced Basis Method for Nonlocal Diffusion Equations with Application to Uncertainty Quantification

Yanlai Chen, University of Massachusetts, Dartmouth, USA; Harbir Antil, George Mason University, USA; Akil Narayan, University of Utah, USA

continued on next page

Wednesday, April 18

MS79

Reduced-order Modeling Techniques for Large-scale UQ Problems - Part I of II

2:00 PM-4:00 PM

continued

2:30-2:55 Stochastic Sub-modeling under Heterogeneous Input Uncertainty with Application to Coronary Artery Disease

Justin Tran, Stanford University, USA; Daniele E. Schiavazzi, University of Notre Dame, USA; Alison Marsden, Stanford University, USA

3:00-3:25 Statistical Modeling of ROM State-space Errors by the ROMES Method

Stefano Pagani, École Polytechnique Fédérale de Lausanne, Switzerland; Kevin T. Carlberg, Sandia National Laboratories, USA; Andrea Manzoni, École Polytechnique Fédérale de Lausanne, Switzerland

3:30-3:55 Dynamical Low Rank Approximation of Time Dependent Random PDEs

Fabio Nobile and Eleonora Musharbash, École Polytechnique Fédérale de Lausanne, Switzerland

Wednesday, April 18

MS80

Dimension Reduction in Bayesian Inference - Part III of III

2:00 PM-4:00 PM

Room:Garden 3 - 1st Floor

For Part 2 see MS67

Non-standard and high-dimensional distributions naturally arise from the Bayesian formulation of statistical inference problems. The ultimate tractability of such distributions in practical problems is dictated by the availability of efficient and accurate sampling or quadrature strategies. This task becomes more and more challenging as distributions depart from standard ones and as their dimensionalities increase. However, many high-dimensional Bayesian models have an underlying low-dimensional structure (e.g., Markov structure, marginal independence, low rank, regularity, sparsity) that can be leveraged by appropriately designed algorithms. This minisymposium aims to provide a venue for the interaction between active researchers in dimensionality reduction with a focus on specific aspects arising in Bayesian inference.

Organizer: Daniele Bigoni
Massachusetts Institute of Technology, USA

Organizer: Olivier Zahm
Massachusetts Institute of Technology, USA

Organizer: Paul Constantine
Colorado School of Mines, USA

Organizer: Youssef M. Marzouk
Massachusetts Institute of Technology, USA

continued in next column

2:00-2:25 Low-rank Approximations for Efficient MCMC Sampling in Hierarchical Bayesian Inverse Problems

Johnathan M. Bardsley, University of Montana, USA

2:30-2:55 Randomized Iterative Methods for Bayesian Inverse Problems

Julianne Chung, *Joseph T. Slagel*, and Matthias Chung, Virginia Tech, USA

3:00-3:25 Methodologies for Enabling Bayesian Calibration in Land-ice Modeling Towards Probabilistic Projections of Sea-level Change

Irina K. Tezaur, John D. Jakeman, and *Mauro Perego*, Sandia National Laboratories, USA; Stephen Price, Los Alamos National Laboratory, USA

3:30-3:55 Large-p Small-n Nonparametric Regression and Additive-interactive Response Functions

Surya Tokdar, Duke University, USA

Wednesday, April 18

MS81

Theory and Simulation of Failure Probabilities and Rare Events - Part I of III

2:00 PM-4:00 PM

Room:Garden 4 - 1st Floor

For Part 2 see MS95

The evaluation of failure probabilities is a fundamental problem in reliability analysis and risk management of systems with uncertain inputs. We consider systems described by PDEs with random coefficients together with efficient approximation schemes. This includes stochastic finite elements, collocation, reduced basis, and advanced Monte Carlo methods. Efficient evaluation and updating of small failure probabilities and rare events remains a significant computational challenge. This minisymposium brings together tools from applied probability, numerical analysis, and computational science and engineering. We showcase advances in analysis and computational treatment of rare events and failure probabilities, including variance reduction, advanced meta-models, and active learning.

Organizer: Elisabeth Ullmann
Technische Universität München, Germany

Organizer: Iason Papaioannou
Technische Universität München, Germany

Organizer: Michael D. Shields
Johns Hopkins University, USA

2:00-2:25 MCMC and Nested Extreme Risks

Emmanuel Gobet, École Polytechnique, France

2:30-2:55 Bayesian Subset Simulation Tutorial

Emmanuel Vazquez and Julien Bect, CentraleSupélec, France

3:00-3:25 Ensemble MCMC Samplers for Failure Probability Estimation with Subset Simulation

Michael D. Shields, Johns Hopkins University, USA; V.S. Sundar, University of California, San Diego, USA; Jiaxin Zhang and Dimitris Giovanis, Johns Hopkins University, USA

3:30-3:55 Hamiltonian Monte Carlo-Subset Simulation (HMC-SS) Method for Failure Probabilities and Rare Events Estimation in Non-Gaussian Spaces.

Marco Broccardo, ETH Zürich, Switzerland; Ziqi Wang, Guangzhou University, China; Junho Song, Seoul National University, South Korea

continued in next column

Wednesday, April 18

MS82

Advances in Sparse Polynomial Approximations with Applications to Complex Stochastic Modeling - Part III of III

2:00 PM-4:00 PM

Room:Pacific - 2nd Floor

For Part 2 see MS69

The approximations of high-dimensional systems from a limited amount of data play a pivotal role in uncertainty quantification. For such systems, constructing the quantities of interest often requires repeated expensive measurements, i.e., an ensemble of complex numerical simulations or time-consuming physical experiments. This minisymposium aims at documenting recent advances in exploring and exploiting sparse structures in parameterized PDEs driven by complex stochastic modeling applications, to provide low-cost, reliable approximations and mitigate the computational burden. The presentations will cover latest developments on sparse approximation techniques, including interpolation, least-squares, compressed sensing, multilevel and ensemble methods, as well as their applications to several types of complex problems, such as PDEs with lognormal coefficients, multi-scale equations, and turbulence models.

Organizer: Hoang A. Tran
Oak Ridge National Laboratory, USA

Organizer: Guannan Zhang
Oak Ridge National Laboratory, USA

continued on next page

Wednesday, April 18

MS82

Advances in Sparse Polynomial Approximations with Applications to Complex Stochastic Modeling - Part III of III

2:00 PM-4:00 PM

continued

2:00-2:25 Regression Based Methods for Computing Low-rank Tensor-decompositions

John D. Jakeman, Sandia National Laboratories, USA

2:30-2:55 Multilevel Higher-order Quasi-Monte Carlo Bayesian Estimation for PDEs with Random Coefficients

Quoc T. Le Gia and Josef Dick, University of New South Wales, Australia; Robert N. Gantner and Christoph Schwab, ETH Zürich, Switzerland

3:00-3:25 Multi-scale Sampling Methods for Partial Differential Equations with Gaussian Markov Random Field Inputs

Hans-Werner Van Wyk, Auburn University, USA

3:30-3:55 Estimation of Exciton Diffusion Lengths of Organic Semiconductors in Random Domains

Zhongjian Wang and Zhiwen Zhang, University of Hong Kong, Hong Kong; Jingrun Chen, Soochow University, China; Xiang Zhou, City University of Hong Kong, Hong Kong; Ling Lin, Sun Yat-sen University, China

Wednesday, April 18

MS83

Advances in Multi-level and Multi-fidelity Methods for Uncertainty Quantification - Part II of II

2:00 PM-3:30 PM

Room:Harbor - 2nd Floor

For Part 1 see MS70

A modern computational mainstay is the multi-fidelity and multi-level challenge: make efficient and robust predictions given several competing models each having its own degree of trust. The abstract concept of "fidelity" or "level" -- faithfulness to physics, experimental observations, and/or idealized mathematical formulations -- arises because different simulation suites utilize different discretization types and scales and make dissimilar simplifications of underlying physics. This minisymposium aims to highlight recent advances in algorithms and applications that make optimal use of models with differing fidelities or levels. The challenges include resource distribution among models, identification and learning of model hierarchy and levels, as well as convergence analysis of the multi-fidelity or multi-level solutions. Applications of such tools to both forward uncertainty propagation and inverse problems are of interest to this minisymposium.

Organizer: Alireza Doostan
University of Colorado Boulder, USA

Organizer: Akil Narayan
University of Utah, USA

2:00-2:25 Time Discretization Bi-fidelity Modeling

Robert M. Kirby and Akil Narayan, University of Utah, USA

2:30-2:55 A Multifidelity Cross-entropy Method for Rare Event Simulation

Benjamin Peherstorfer, University of Wisconsin, Madison, USA; Boris Kramer and Karen E. Willcox, Massachusetts Institute of Technology, USA

3:00-3:25 Polynomial Chaos Basis Reduction for Uncertainty Quantification -- A Bi-fidelity Approach

Felix Newberry, Alireza Doostan, and Michaela Farr, University of Colorado Boulder, USA

Wednesday, April 18

MS84

Model Error and Model Selection: Bayesian Approaches - Part III of III

2:00 PM-4:00 PM

Room:Salon I - 2nd Floor

For Part 2 see MS71

Probabilistic approaches to model error and selection are becoming increasingly prevalent in computational science. While model improvement is an enterprise that is continuously enabled by the availability of cost-effective high-performance computing infrastructure, model error is unavoidable in many situations. This problem is attributed to the incomplete understanding of the underlying physics and/or the need for simpler models in many stages of engineering analysis and design. The notion that multiple models may provide reasonable approximations compounds the difficulty of model validation and uncertainty quantification. To that effect, model correction approaches and model selection techniques increase the range of applicability of models that suffer from model form error. The popularity of the Bayesian paradigm stems from its natural integration of measurement and model uncertainties. It enables the incorporation of uncertain hidden variables, with stochasticity introduced through, e.g. modeling error, uncertain model parameters, initial/boundary conditions, and/or numerical approximations. In a Bayesian setting, the solution to an inverse problem is the probability distribution of the quantities of interest, including model error and hyper-parameters. Quantifying the uncertainty and determining the validity of these models in predictive settings is an active area of research. This minisymposium focuses on Bayesian model selection and model correction techniques.

Organizer: Kathryn Maupin
Sandia National Laboratories, USA

Organizer: Mohammad Khalil
Sandia National Laboratories, USA

continued on next page

2:00-2:25 Calibration and Propagation of Model Discrepancy Across Experiments

Kathryn Maupin and Laura Swiler, Sandia National Laboratories, USA

2:30-2:55 Multi-level Uncertainty Aggregation with Bayesian Model Error Calibration and Validation

Sankaran Mahadevan, Vanderbilt University, USA

3:00-3:25 Bayesian Inference of Subsurface Stratification

Honglei Sun, Zhejiang University, China

3:30-3:55 Bayesian Model Reduction using Automatic Relevance Determination (ARD): Observations and Improvements

Abhijit Sarkar and Rimple Sandhu, Carleton University, Canada; Chris Pettit, United States Naval Academy, USA; Mohammad Khalil, Sandia National Laboratories, USA; Dominique Poirel, Royal Military College, Canada

Wednesday, April 18

MS85

Uncertainty Quantification for Nonlinear Transport Problems

2:00 PM-4:00 PM

Room:Salon II - 2nd Floor

Many physical problems in computational fluid dynamics and porous media are described by nonlinear transport equations that are uncertain due to lack of data or modelling errors. Efficient forward propagation of uncertainty for realistic transport problems is challenging, and includes handling of high-dimensional stochastic input parameters and non-smooth dependence of quantities of interest on the input parameters. The traveling-wave nature of the problems may admit localization in physical and stochastic space as well as in time, but with the overall high stochastic dimensionality intact. Non-smooth solution features make spectral expansions, e.g. polynomial chaos, challenging, and careful treatment of discontinuities is essential. Sampling based uncertainty quantification methods such as Monte Carlo methods can be accelerated with, e.g., multi-level or multi-fidelity approaches but solution smoothness may impact the performance. The aim of this minisymposium is to bring together and discuss research on numerical methods for non-smooth stochastic hyperbolic or mixed-type problems.

Organizer: Per Pettersson

Uni Research CIPR, Norway

2:00-2:25 Data-driven Uncertainty Quantification for Transport Problems in Heterogeneous Porous Media

Per Pettersson, Uni Research CIPR, Norway; Anna Nissen, KTH Royal Institute of Technology, Sweden

2:30-2:55 Multilevel/Multifidelity Monte Carlo for Wave Propagation in Heterogeneous Media

Gianluca Geraci and Michael S. Eldred, Sandia National Laboratories, USA; Gianluca Iaccarino, Stanford University, USA

3:00-3:25 Numerical Methods for Hyperbolic Systems of PDEs with Uncertainties

Alina Chertock, North Carolina State University, USA

3:30-3:55 Efficient Stochastic Galerkin Methods for Uncertainty Quantification of CO2 Storage in Saline Aquifers

Daniel Olderkjær and Per Pettersson, Uni Research CIPR, Norway

continued in next column

Wednesday, April 18

MS86

Machine Learning Approaches for Uncertainty Quantification in Porous Media Flow Applications - Part I of III

2:00 PM-4:00 PM

Room:Salon VIII - 2nd Floor

For Part 2 see MS100

Machine learning have contributed significantly to recent advances in image and signal processing, pattern recognition, recommendation systems, natural language processing and machine translation. Most of these machine learning techniques, could be adapted for a wide range of applications in porous media flow problems. This minisymposium covers recent applications of machine learning algorithms for multi-scale modeling, reduced order modeling and uncertainty quantification (UQ) in various porous media flow applications. Targeted topics includes: (1) Machine Learning assisted Uncertainty Quantification (2) ML accelerated statistical model calibration against multiple data sources (production, seismic, outcrops, experts) (4) Quantitative risk assessment using data-driven approaches (5) Stochastic model generation using machine learning. Also of relevance are Bayesian approaches, compressed sensing and sparse reconstruction methods, reduced-order parameterization, physical model cross-validation techniques, and response surface proxies.

Organizer: Ahmed H. ElSheikh

Heriot-Watt University, United Kingdom

Organizer: Hector Klie

DeepCast.ai, USA

2:00-2:25 A Data-driven Multiscale Finite Volume Method for Uncertainty Quantification

Ahmed H. ElSheikh and Shing Chan, Heriot-Watt University, United Kingdom

2:30-2:55 Data-space Inversion for Uncertainty Quantification in Reservoir Simulation and Carbon Storage Applications

Louis J. Durlofsky, Wenyue Sun, and Su Jiang, Stanford University, USA

3:00-3:25 Learning Complex Geologic Patterns for Subsurface Flow Model Calibration

Azarang Golmohammadi and *Behnam Jafarpour*, University of Southern California, USA

3:30-3:55 Ultra-fast Reactive Transport Simulations using Machine Learning

Allan Leal, ETH Zürich, Switzerland; Dmitrii Kulik, Paul Scherrer Institut, Switzerland; Martin Saar, ETH Zürich, Switzerland

continued in next column

Wednesday, April 18

MS87

Stochastic Modeling and Methods in Scientific Computing - Part I of III

2:00 PM-4:00 PM

Room:Salon V - 2nd Floor

For Part 2 see MS101

In this minisymposium, we will highlight recent developments of stochastic modeling and methods in various areas such as solution of deterministic PDEs, linear algebra, uncertainty, machine learning, and CFD. Applications in material sciences, meta-materials, data sciences and machine learning will be considered. We shall bring together researchers from across the scientific computing community to discuss and collaborate on Stochastic modeling and methods, and to discuss future directions for research.

Organizer: Wei Cai

Southern Methodist University, USA

Organizer: Tao Zhou

Chinese Academy of Sciences, China

2:00-2:25 Computational Geometry Aspects of Monte Carlo Approaches to PDE Problems in Biology, Chemistry, and Materials

Michael Mascagni, Florida State University, USA

2:30-2:55 Distributed Learning

Ding Xuan Zhou, City University of Hong Kong, Hong Kong

3:00-3:25 Variational Reformulation of the Uncertainty Propagation Problem using Probabilistic Numerics

Ilias Bilionis, Purdue University, USA; Panagiotis Tsilifis, University of Southern California, USA

3:30-3:55 Uncertainty Quantification for Kinetic Equations

Shi Jin, Shanghai Jiao Tong University, China, and the University of Wisconsin, USA

Wednesday, April 18

MS88

Software for UQ - Part I of IV

2:00 PM-4:00 PM

Room:Salon VI - 2nd Floor

For Part 2 see MS102

With the growing importance of UQ in various disciplines and fields, software solutions and libraries for UQ problems get more and more important. This raises interesting questions for the UQ community such as: What are the current properties of available tools? For which classes of problems have they been developed? What methods or algorithms do they provide? What are challenges for UQ software and which resources are required? What are recent improvements? What are the next steps and the long-term goals of the development? This minisymposium brings together experts for different software in the context of UQ, ranging from tools that ease up individual tasks of UQ up to whole frameworks for solving UQ problems.

Organizer: Tobias Neckel
Technische Universität München, Germany

Organizer: Dirk Pflüger
Technische Universität München, Germany

2:00-2:25 Data-driven, Adaptive Sparse Grids for UQ in SG++
Fabian Franzelin, Universität Stuttgart, Germany; *Dirk Pflüger*, Technische Universität München, Germany

2:30-2:55 Dakota: Explore and Predict with Confidence
Brian M. Adams, Patricia D. Hough, and J. Adam Stephens, Sandia National Laboratories, USA

3:00-3:25 The Openturns Uncertainty Quantification Software
Michael Baudin, Anne-Laure Popelin, Anthony Geay, Ovidiu Mirescu, and Anne Dutfoy, EDF, France

3:30-3:55 MIT Uncertainty Quantification (MUQ): Bayesian Computation for Statistical and Physical Problems
Andrew D. Davis and Youssef M. Marzouk, Massachusetts Institute of Technology, USA; Matthew Parno and *Arnold Song*, US Army Cold Regions Research and Engineering Lab (CRREL), USA

Wednesday, April 18

Coffee Break

4:00 PM-4:30 PM

Room:Grand Ballroom Foyer - 1st Floor

MS89

Data Assimilation applications to Earth-System Models

4:30 PM-6:30 PM

Room:Grand Ballroom ABCD - 1st Floor

An important component of modeling with Earth-System models is the development of an objective methodology to update estimates of its state variables and their associated uncertainties based on information extracted from real-world measurements. Ensemble-based data assimilation techniques have become a promising computationally feasible approach for system state estimation and uncertainty quantification of high-order non-linear models. In this session, we present four talks detailing the application of ensemble-based data assimilation techniques to estimate the state and uncertainty of several Earth-System models. In particular, we discuss the quantification of forecast sensitivity to the observations being assimilated and how this information may be used to improve data assimilation techniques in the future. Forecast experiments are presented for several systems whose uncertainty is driven by intrinsically different sources, including numerical weather forecasting for the ionosphere, the troposphere. These are examples of systems that respectively exhibit compliant dynamics, where uncertainty largely arises from external forcing, and persistent dynamics, where uncertainty largely results from chaotic divergence due to the misspecification of initial conditions. These novel techniques for state and parameter estimation are highly portable may be readily applicable to state estimation and prediction problems in other domains.

continued in next column

Organizer: Juan Durazo
Arizona State University, USA

Organizer: Eric J. Kostelich
Arizona State University, USA

Organizer: A. Mahalov
Arizona State University, USA

4:30-4:55 Targeted Observation Strategy for Space-weather Forecasting During a Geomagnetic Storm
Juan Durazo, Arizona State University, USA

5:00-5:25 Data Assimilation for Irradiance Forecasting
Travis M. Harty, Matthias Morzfeld, *William Holmgren*, and Antonio Lorenzo, University of Arizona, USA

5:30-5:55 Forecast Sensitivity to Observation Impact and Effect of Uncertainty Estimation
Kayo Ide, University of Maryland, College Park, USA

6:00-6:25 Targeting a Constrained Traveling Observer by Ensemble Kalman Filter Techniques
Thomas Bellsky, University of Maine, USA

Wednesday, April 18

MS90

Hierarchical Bayesian Inference - Part II of II

4:30 PM-6:30 PM

Room:Grand Ballroom G

For Part 1 see MS50

In many Bayesian inference problems, the specification of the prior distribution and/or the data likelihood involves another set of unknown hyper-parameters, leading to a hierarchical representation of the posterior. This minisymposium will focus on recent advances in hierarchical Bayesian inference, in the case where the unknown to be inferred is high or infinite dimensional. Specific topics to be addressed are the analysis of hierarchical Gaussian processes, the use of functions as hyper-parameters, efficient methods for sampling and optimising the hyper-parameters and connections to parameter selection in large scale optimisation problems.

Organizer: Claudia Schillings

Universitaet Mannheim, Germany

Organizer: Aretha L. Teckentrup

University of Edinburgh, United Kingdom

4:30-4:55 Bilevel Parameter Learning in Inverse Imaging Problems

Carola-Bibiane Schönlieb, University of Cambridge, United Kingdom

5:00-5:25 Sampling Hyperparameters in Hierarchical Models

Colin Fox, University of Otago, New Zealand

5:30-5:55 Bayesian Computation in Hierarchical Models Using Marginal Local Approximation MCMC

Andrew D. Davis, Massachusetts Institute of Technology, USA

6:00-6:25 Hierarchical Priors in Atmospheric Tomography

Tapio Helin, University of Helsinki, Finland; Stefan Kindermann, Johannes Kepler University, Austria; Jonatan Lehtonen, University of Helsinki, Finland; Ronny Ramlau, Johannes Kepler Universität, Linz, Austria

Wednesday, April 18

MS91

Design and Analysis for Statistical Uncertainty Quantification - Part I of III

4:30 PM-6:30 PM

Room:Grand Ballroom F

For Part 2 see MS104

Statistical methods such as Gaussian process and reproducing kernel Hilbert space predictors have become important tools to use after a designed experiment on either a computer model or a physical system. In this session, we will gather junior and senior researchers from various communities to discuss novel contributions on experimental design, sensitivity analysis, variable selection, emulation, calibration, uncertainty propagation and sequential strategies.

Organizer: Xu He

Chinese Academy of Sciences, China

Organizer: Matthew Plumlee

University of Michigan, USA

4:30-4:55 Calibration for Computer Experiments with Binary Responses

Chih-Li Sung, Georgia Institute of Technology, USA; Ying Hung, Rutgers University, USA; William Rittase, Cheng Zhu, and C. F. Jeff Wu, Georgia Institute of Technology, USA

5:00-5:25 Calibration with Frequentist Coverage and Consistency

Matthew Plumlee, University of Michigan, USA

5:30-5:55 Variable Selection Based on a Bayesian Composite Gaussian Process Model

Thomas Santner, Ohio State University, USA; Casey Davis, Merck & Co., Inc., USA; Christopher Hans, Iowa State University, USA

6:00-6:25 Decomposing Functional Model Inputs for Variance-based Sensitivity Analysis

Max D. Morris, Iowa State University, USA

Wednesday, April 18

MS92

Data and UQ: Bayesian Learning - Part III of III

4:30 PM-6:30 PM

Room:Garden 1 - 1st Floor

For Part 2 see MS78

The amount of data in existence is growing exponentially. This has lead to the development of an unavoidable basin of attraction in the scientific landscape, whose effect is apparent across the spectrum of applied math. The area of UQ is no exception -- indeed data itself is often subject to some level of uncertainty. Learning from this abundant data may involve either inverting or assimilating it into a complex model, for example derived from physical laws, or it may involve inversion of data alone, for example to learn a complex model in a context where no first principles exist. Ultimately this intelligence will be used for decision making and planning. Both model-based or purely data-driven inference strategies may be considered either from a classical perspective, with the objective of obtaining a point estimate, and possibly some quantification of error, or from a probabilistic or statistical perspective, with the objective of complete quantification of uncertainty through the recovery of a posterior distribution. This minisymposium aims to explore recent advances at this interesting and fertile interface.

Organizer: Matthew M. Dunlop

California Institute of Technology, USA

Organizer: Kody Law

Oak Ridge National Laboratory, USA

4:30-4:55 Bayesian Generative Models for Quantifying Input Uncertainty using Limited Realizations

Nicholas Zabaras and Yinhao Zhu, University of Notre Dame, USA

continued on next page

5:00-5:25 Bayesian Deep Neural Networks for Surrogate Modeling

Yinhao Zhu and Nicholas Zabaras, University of Notre Dame, USA

5:30-5:55 Learning Sparse Non-Gaussian Graphical Models from Data

Rebecca Morrison, Massachusetts Institute of Technology, USA

6:00-6:25 Data-driven Correction of Model and Representation Error in Data Assimilation

Tyrus Berry, George Mason University, USA; John Harlim, Pennsylvania State University, USA; Franz Hamilton, North Carolina State University, USA; Timothy Sauer, George Mason University, USA

Wednesday, April 18

MS93

Reduced-order Modeling Techniques for Large-scale UQ Problems - Part II of II

4:30 PM-6:30 PM

Room:Garden 2 - 1st Floor

For Part 1 see MS79

The efficient solution of uncertainty-quantification problems---including data assimilation, uncertainty propagation, parameter estimation, and optimization under uncertainty---involving PDE models still poses many outstanding challenges, especially in the presence of large-scale computational models, high-dimensional parameter spaces, and time-to-solution constraints imposed by realistic applications. Recent advances in reduced order modeling (ROM) techniques allow practitioners to successfully tackle some of these problems by reducing the complexity of individual PDE solves while preserving high levels of accuracy. The purpose of this minisymposium is to bring together researchers who have contributed to the advancement of ROM techniques in UQ, to present novel and promising methods, and to discuss future trends for research in this area.

Organizer: Kevin T. Carlberg
Sandia National Laboratories, USA

Organizer: Andrea Manzoni
École Polytechnique Fédérale de Lausanne, Switzerland

continued in next column

4:30-4:55 Dimension Reduction of the Input Parameter Space of Vector-valued Functions

Olivier Zahm, Massachusetts Institute of Technology, USA

5:00-5:25 Efficient PDE-constrained Optimization under Uncertainty using Adaptive Model Reduction and Sparse Grids

Matthew J. Zahr, University of California, Berkeley and Lawrence Berkeley National Laboratory, USA; Kevin T. Carlberg and Drew P. Kouri, Sandia National Laboratories, USA

5:30-5:55 Statistical Error Modeling for Approximate Solutions to Parameterized Systems of Nonlinear Equations using Machine Learning

Brian A. Freno and Kevin T. Carlberg, Sandia National Laboratories, USA

6:00-6:25 Quantifying Unresolved Effects in Reduced Order Models using the Mori-Zwanzig Formalism and Variational Multiscale Method

Eric Parish, Chris Wentland, and Karthik Duraisamy, University of Michigan, USA

Wednesday, April 18

MS94

Efficient Sampling Methods for Bayesian Inference in Computational Problems - Part I of II

4:30 PM-6:30 PM

Room:Garden 3 - 1st Floor

For Part 2 see MS107

Computational challenges arise in Bayesian inference when the underlying parameter space is high-dimensional, the resulting posterior is highly concentrated, or the computational model under consideration is computationally expensive. However, such situations are of particular interest in modern uncertainty quantification. High-dimensional problems arise in Bayesian inference with PDE models where for example the permeability is the quantity of interest. Concentrated posteriors are related to large and/or informative data sets. Calibrating the inflow conditions in expensive computational fluid dynamics problems yields a computationally challenging posterior. This minisymposium focuses on various novel techniques to solve such problems. The main goal is to efficiently draw samples from the resulting posterior by applying recent sampling methods (such as MCMC and particle methods) tailored to the specifics of the problem or numerically approximating underlying models such that naive methods become tractable.

Organizer: Laurent van den Bos

Centrum voor Wiskunde en Informatica (CWI), Netherlands

Organizer: Claudia Schillings

Universitaet Mannheim, Germany

Organizer: Björn Sprungk

University of Mannheim, Germany

Organizer: Michele Ottobre

Imperial College London, United Kingdom

continued in next column

4:30-4:55 Irreversible Langevin Samplers, Variance Reduction and MCMC

Michele Ottobre, Imperial College London, United Kingdom; *Konstantinos Spiliopoulos*, Boston University, USA

5:00-5:25 Noise-robust Metropolis-Hastings Algorithms for Bayesian Inverse Problems

Björn Sprungk, University of Mannheim, Germany

5:30-5:55 Tuning Asymptotically Biased Samplers with Diffusion Based Stein Operators

Andrew Duncan, University of Sussex, United Kingdom

6:00-6:25 Constructing Dimension-independent Particle Filters for High-dimensional Geophysical Problems

Peter Jan van Leeuwen, University of Reading, United Kingdom

Wednesday, April 18

MS95

Theory and Simulation of Failure Probabilities and Rare Events - Part II of III

4:30 PM-6:30 PM

Room:Garden 4 - 1st Floor

For Part 1 see MS81
For Part 3 see MS108

The evaluation of failure probabilities is a fundamental problem in reliability analysis and risk management of systems with uncertain inputs. We consider systems described by PDEs with random coefficients together with efficient approximation schemes. This includes stochastic finite elements, collocation, reduced basis, and advanced Monte Carlo methods. Efficient evaluation and updating of small failure probabilities and rare events remains a significant computational challenge. This minisymposium brings together tools from applied probability, numerical analysis, and computational science and engineering. We showcase advances in analysis and computational treatment of rare events and failure probabilities, including variance reduction, advanced meta-models, and active learning.

Organizer: Elisabeth Ullmann

Technische Universität München, Germany

Organizer: Iason Papaioannou

Technische Universität München, Germany

Organizer: Michael D. Shields

Johns Hopkins University, USA

4:30-4:55 Importance Sampling with Stochastic Computer Models

Eunshin Byon, University of Michigan, USA

5:00-5:25 Modified Cross Entropy Based Importance Sampling with a Flexible Mixture Model for Rare Event Estimation

Iason Papaioannou, Sebastian Geyer, and Daniel Straub, Technische Universität München, Germany

5:30-5:55 Adaptive Point Selection for Global vs. Local Surrogate Models

Laura Swiler, Mohamed S. Ebeida, Kathryn Maupin, and Brian M. Adams, Sandia National Laboratories, USA

6:00-6:25 Non-Gaussian Models for Extremes

Mircea Grigoriu, Cornell University, USA

Wednesday, April 18

MS96

Low-rank Approximations for the Forward- and the Inverse Problems - Part I of III

4:30 PM-6:30 PM

Room:Pacific - 2nd Floor

For Part 2 see MS109

Sparse approximations, especially in the form of low-rank methods, have become essential in the solution and representation of high-dimensional stochastic problems. Identification in the form of Bayesian inverse problems - in particular when performed repeatedly or sequentially for dynamical systems - requires the efficient solution and representation of high-dimensional stochastic forward problems. Additionally it seems advantageous if the Bayesian update can take advantage of such sparse representations, and produce the update also in sparse form. An emergent idea is the use of inverse methods to solve the forward problem. The minisymposium will focus on sparse techniques for the representation and solution of high-dimensional problems, and their interplay with Bayesian inverse problems and Bayesian inversion.

Organizer: Alexander Litvinenko
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Martin Eigel
WIAS, Berlin, Germany

Organizer: Hermann Matthies
Technische Universität Braunschweig, Germany

Organizer: Bojana Rosic
Technische Universität Braunschweig, Germany

Organizer: Reinhold Schneider
Technische Universität Berlin, Germany

Organizer: Mike Espig
RWTH Aachen University, Germany

4:30-4:55 Compressed Sparse Tensor Based Approximation for Vibrational Quantum Mechanics Integrals

Prashant Rai, Khachik Sargsyan, and Habib N. Najm, Sandia National Laboratories, USA

5:00-5:25 Parameter Identification with the Parallel Hierarchical Matrix Technique

Alexander Litvinenko, David E. Keyes, Marc Genton, and Ying Sun, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

5:30-5:55 Linear Bayesian Inference via Multi-Fidelity Modeling

Hillary Fairbanks and Alireza Doostan, University of Colorado Boulder, USA

6:00-6:25 Analysis of Sparse Approximations in Bayesian Filtering

Ricardo Baptista and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

continued in next column

Wednesday, April 18

MS97

Advances in Uncertainty Quantification and Optimization for Multiphysics/scale Applications - Part I of II

4:30 PM-6:30 PM

Room:Harbor - 2nd Floor

For Part 2 see MS110

Many problems in science and engineering are described by multiphysics models that interact on a wide range of length and time scales and are subject to various sources of uncertainty, such as unknown material properties, approximate boundary conditions, and inadequate model descriptions. Ongoing efforts seek to develop mathematical and numerical tools that incorporate information from relevant spatial and temporal scales, integrate experimental data in a consistent manner, and make credible predictions with quantified error and uncertainty. Providing accurate estimates of probabilistic quantities of interest is challenging for large-scale multiphysics applications where the number of uncertain parameters may be immense, the budget of high-fidelity model evaluations may be limited, and the available data may be sparse and corrupted by significant noise. This task is especially difficult if an optimal solution under uncertainty is desired. The goal of this minisymposium is to provide an opportunity for researchers to present recent work and exchange ideas on novel methods for optimization problems, sensitivity analysis, and uncertainty quantification in the context of multiphysics and multiscale formulations.

continued on next page

Wednesday, April 18

MS97

Advances in Uncertainty Quantification and Optimization for Multiphysics/scale Applications - Part I of II

4:30 PM-6:30 PM

continued

Organizer: Bart G. Van Bloemen Waanders
Sandia National Laboratories, USA

Organizer: Tim Wildey
Sandia National Laboratories, USA

Organizer: Daniel T. Seidl
Sandia National Laboratories, USA

4:30-4:55 Smoothing Techniques for PDE-Constrained Optimization under Uncertainty

Thomas M. Surowiec, Philipps-Universität Marburg, Germany; Drew P. Kouri, Sandia National Laboratories, USA

5:00-5:25 The Role of Variational Multiscale Method in Uncertainty Quantification

Jason Li, Onkar Sahni, and *Assad Oberai*, Rensselaer Polytechnic Institute, USA

5:30-5:55 Scalable Approximation of PDE-Constrained Optimization under Uncertainty: Application to Turbulent Jet Flow

Peng Chen, Umberto Villa, and Omar Ghattas, University of Texas at Austin, USA

6:00-6:25 Multiscale Optimization and UQ for Additive Manufacturing

Bart G. Van Bloemen Waanders, Timothy Wildey, Daniel T. Seidl, and Laura Swiler, Sandia National Laboratories, USA

Wednesday, April 18

MS98

Characterizing Model Inadequacy in Bayesian Inference - Part I of III

4:30 PM-6:30 PM

Room:Salon I - 2nd Floor

For Part 2 see MS111

Models of complex physical systems are often formulated based on approximations and assumptions that may be in error in some situations. In other cases, the highest fidelity model of the system may be intractable or too computationally expensive for its intended use. In these cases the models are often replaced with less expensive lower fidelity models, which necessarily introduce additional errors. When such inadequate models are used to make predictions, the errors introduce uncertainties in those predictions. Characterization of uncertainties due to model inadequacy introduces formulation and algorithmic challenges. Of particular interest are inadequacy representations that allow characterizing uncertainties in the predictions, thus informing consequential decisions or enabling multi-fidelity approaches. To this aim, it is often helpful to embed inadequacy in the models and to formulate them based on knowledge about the physical system. This introduces additional algorithmic challenges when the model is formulated in terms of ordinary or partial differential equations, since inadequacy representation is often in terms of an infinite dimensional uncertainty. This minisymposium brings together researchers from diverse fields to discuss advances in treatment of model errors, with particular focus on physics-based representation of inadequacy, including the incorporation of stochastic terms in the model equations, and Bayesian calibration of the resulting stochastic models.

continued in next column

Organizer: Umberto Villa
University of Texas at Austin, USA

Organizer: Todd A. Oliver
University of Texas at Austin, USA

Organizer: Noemi Petra
University of California, Merced, USA

Organizer: Omar Ghattas
University of Texas at Austin, USA

Organizer: Robert D. Moser
University of Texas at Austin, USA

4:30-4:55 Analysis of Inadequacy in Simplified Models of Supercapacitor Charge/discharge Cycles

Todd A. Oliver, Danial Faghihi, and Robert D. Moser, University of Texas at Austin, USA

5:00-5:25 A Bayesian Framework for Robust Decisions in the Presence of Unobserved Heterogeneity

Chi Feng and Youssef M. Marzouk, Massachusetts Institute of Technology, USA

5:30-5:55 Use of the Bayesian Approximation Error Approach to Account for Model Discrepancy: The Robin Problem Revisited

Ruanui Nicholson, University of Auckland, New Zealand

6:00-6:25 Bayesian Analysis of Boundary Data in EIT: Discrete vs Continuous

Sumanth Reddy NakkiReddy and Daniela Calvetti, Case Western Reserve University, USA

Wednesday, April 18

MS99

Data Sources and Modeling of Uncertainties in Geophysical Hazards - Part I of II

4:30 PM-6:30 PM

Room:Salon II - 2nd Floor

For Part 2 see MS112

UQ for geophysical hazards like tsunamis, lahars, volcanoes, hurricanes etc. is becoming increasingly relevant due to the inherent lacunae in the multi-physics modeling of such complex phenomena. Further challenges arise from the heavy computational cost of both the deterministic forward model simulations and the probabilistic ensemble based methods. Proper identification, characterization and reduction of the high-dimensional model parameter uncertainties is another hurdle. Thus, there is a requirement for robust methods that account for multiple sources in uncertainties, sparse data and coarse model resolutions. Statistical emulation that captures the relevant non-linearities in the model coupled with strategic design of numerical experiment is an important step in this direction. Efficient data assimilation integrated with the models helps reduce the uncertainty in the model parameters. Physics based novel parameterizations pave the way for rapid hazard assessment. Sparse grid methods and accurate multi-dimensional parameter distribution approximations essentially make the simulations and calibrations tractable. Hence, this minisymposium brings together researchers working on recent advances in statistical surrogates, sequential design, data assimilation, sparse grid methods, probabilistic geo-hazard assessment, rapid uncertainty propagation and high dimensional parameter estimation.

continued in next column

Organizer: Devaraj Gopinathan

University College London, United Kingdom

Organizer: Mengyang Gu

Johns Hopkins University, USA

4:30-4:55 UQ and Parameter Estimation for Coastal Ocean Hazard Modeling

Clint Dawson, University of Texas at Austin, USA; Troy Butler, University of Colorado, Denver, USA; Don Estep, Colorado State University, USA; Joannes Westerink, University of Notre Dame, USA; Lindley C. Graham, Florida State University, USA

5:00-5:25 Probabilistic Tsunami Hazard Assessments with Consideration of Uncertain Earthquake Characteristics

Ignacio Sepulveda, Cornell University, USA; Philip L.-F. Liu, National University of Singapore, Singapore; Mircea Grigoriu and Matthew Pritchard, Cornell University, USA

5:30-5:55 Earthquake Source Dimension Reduction with Gaussian Process Emulation: Quantification of Tsunami Hazard

Devaraj Gopinathan and Serge Guillas, University College London, United Kingdom

6:00-6:25 Bayesian Inference of Earthquake Parameters for the Chile 2010 Event using Polynomial Chaos-based Surrogate and Buoy Data

Loïc Giraldi, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Wednesday, April 18

MS100

Machine Learning Approaches for Uncertainty Quantification in Porous Media Flow Applications - Part II of III

4:30 PM-6:00 PM

Room:Salon VIII - 2nd Floor

For Part 1 see MS86
For Part 3 see MS113

Machine learning have contributed significantly to recent advances in image and signal processing, pattern recognition, recommendation systems, natural language processing and machine translation. Most of these machine learning techniques, could be adapted for a wide range of applications in porous media flow problems. This minisymposium covers recent applications of machine learning algorithms for multi-scale modeling, reduced order modeling and uncertainty quantification (UQ) in various porous media flow applications. Targeted topics includes: (1) Machine Learning assisted Uncertainty Quantification (2) ML accelerated statistical model calibration against multiple data sources (production, seismic, outcrops, experts) (4) Quantitative risk assessment using data-driven approaches (5) Stochastic model generation using machine learning. Also of relevance are Bayesian approaches, compressed sensing and sparse reconstruction methods, reduced-order parameterization, physical model cross-validation techniques, and response surface proxies.

Organizer: Ahmed H. ElSheikh

Heriot-Watt University, United Kingdom

Organizer: Hector Klie

DeepCast.ai, USA

4:30-4:55 Deep Learning and Dynamic Mode Decomposition for Modeling the Dynamics of Oil & Gas Problems

Hector Klie, DeepCast.ai, USA

continued on next page

Wednesday, April 18

MS100

Machine Learning Approaches for Uncertainty Quantification in Porous Media Flow Applications - Part II of III

4:30 PM-6:00 PM

continued

5:00-5:25 Deep Residual Recurrent Neural Network for Model Reduction

J.Nagoor Kani and Ahmed H. ElSheikh, Heriot-Watt University, United Kingdom

5:30-5:55 Identification of Primary Flow Regions Through Three-dimensional Discrete Fracture Networks using Supervised Classification and Graph-based Representations

Jeffrey Hyman and Aric Hagberg, Los Alamos National Laboratory, USA; Manuel Valera, San Diego State University, USA; Allon Percus, Claremont Graduate University, USA; Hari Viswanathan and Gowri Srinivasan, Los Alamos National Laboratory, USA

Wednesday, April 18

MS101

Stochastic Modeling and Methods in Scientific Computing - Part II of III

4:30 PM-6:30 PM

Room:Salon V - 2nd Floor

For Part 1 see MS87
For Part 3 see MS114

In this minisymposium, we will highlight recent developments of stochastic modeling and methods in various areas such as solution of deterministic PDEs, linear algebra, uncertainty, machine learning, and CFD. Applications in material sciences, meta-materials, data sciences and machine learning will be considered. We shall bring together researchers from across the scientific computing community to discuss and collaborate on Stochastic modeling and methods, and to discuss future directions for research.

Organizer: Wei Cai

Southern Methodist University, USA

Organizer: Tao Zhou

Chinese Academy of Sciences, China

4:30-4:55 Inferring the Biological Networks via Information Theoretic Approaches

Tiejun Li, Peking University, China

5:00-5:25 A Robust Stochastic Galerkin Method for the Compressible Euler Equations with Uncertainty

Jingwei Hu, Purdue University, USA

5:30-5:55 Analysis and Application of Stochastic Collocation Method for Maxwell's Equations with Random Coefficients

Jichun Li and Zhiwei Fang, University of Nevada, Las Vegas, USA

6:00-6:25 Stochastic Methods for the Design of Random Meta-materials under Geometric Constraints

Ivi C. Tsantili, Beijing Computational Science Research Center, China; Min Hyung Cho, University of Massachusetts, Lowell, USA; Wei Cai, Southern Methodist University, USA; George Em Karniadakis, Brown University, USA

Wednesday, April 18

MS102

Software for UQ - Part II of IV

4:30 PM-6:30 PM

Room:Salon VI - 2nd Floor

For Part 1 see MS88
For Part 3 see MS115

With the growing importance of UQ in various disciplines and fields, software solutions and libraries for UQ problems get more and more important. This raises interesting questions for the UQ community such as: What are the current properties of available tools? For which classes of problems have they been developed? What methods or algorithms do they provide? What are challenges for UQ software and which resources are required? What are recent improvements? What are the next steps and the long-term goals of the development? This minisymposium brings together experts for different software in the context of UQ, ranging from tools that ease up individual tasks of UQ up to whole frameworks for solving UQ problems.

Organizer: Tobias Neckel

Technische Universität München, Germany

Organizer: Dirk Pflüger

Technische Universität München, Germany

4:30-4:55 URANIE: The Uncertainty and Optimization Platform

Fabrice Gaudier, Gilles Arnaud, *Jean-Baptiste Blanchard*, and Jean-Marc Martinez, CEA, France

5:00-5:25 Foqus-PSUADE: A Framework for Uncertainty Quantification and Optimization

Charles Tong, Lawrence Livermore National Laboratory, USA

5:30-5:55 Cossan Software: Recent Advancements and Case Studies

Edoardo Patelli and Dominic Calleja, University of Liverpool, United Kingdom

6:00-6:25 Mystic: Rigorous Model Certification and Engineering Design under Uncertainty

Michael McKerns, Stony Brook University, USA

Thursday, April 19

Registration

7:45 AM-3:00 PM

Room:Grand Ballroom E - 1st Floor

MT7

Particle and Ensemble Kalman Filters for Nonlinear Filtering Problems

8:10 AM-10:10 AM

Room:Grand Ballroom G - 1st Floor

Abstract Lecture 1: Introduction to Data Assimilation The first part of the minitutorial provides an introduction to the mathematical and algorithmic aspects of data assimilation, i.e. the estimation of an unknown state from partial and noisy observational data. We will formulate the state estimation problem for dynamical systems in the framework of Bayesian inference and discuss basic properties. Furthermore, various algorithms will be described: the Kalman filter for linear, Gaussian problems, extension to the nonlinear setting such as the Ensemble Kalman filter (EnKF) and particle methods for general nonlinear dynamical systems.

Abstract Lecture 2: Interacting Particle Filters and a Hybrid Ansatz In the second part of the minitutorial we will focus on methods that are particularly useful in the context of high-dimensional, nonlinear filtering problems. More specifically we will introduce filters that are not restricted to Gaussian assumptions and discuss hybrid formulations.

Organizers and Speakers:

Claudia Schillings
Universitaet Mannheim, Germany

Jana de Wiljes
Universität Potsdam, Germany

Thursday, April 19

MS103

Dynamics with Inherent Noise: Stochastic Modelling and Simulation - Part I of II

8:10 AM-9:40 AM

Room:Grand Ballroom ABCD - 1st Floor

For Part 2 see MS116

Inherent noise is ubiquitous in complex systems such as physics, chemistry, engineering and system biology. Numerical simulations based on stochastic models provide an important tool to understand the influence of noise and the dynamic properties of these systems beyond equilibrium. Synergy of stochastic modelling and numerical solutions techniques often leads to novel ideas and promote applications of stochastic models and solvers. In this minisymposium, we focus on both stochastic modelling and numerical methods with emphasis on the interaction of the-state-of-art computational techniques with applications in modelling dynamic process of complex systems. We invite speakers from both communities and expect them to have fruitful discussion. The speakers will address stochastic modelling problems and numerical techniques to solve stochastic equations arising in various applications. Specific topics includes stochastic dynamics modelled by Markov processes with applications to biology and chemical reaction systems, numerical techniques such as singular perturbation methods, surrogate model methods, long time integration of nonlinear SDE, model reduction methods, etc..

Organizer: Huan Lei

Pacific Northwest National Laboratory, USA

Organizer: Zhongqiang Zhang

Worcester Polytechnic Institute, USA

continued in next column

8:10-8:35 Reduced Order Models for Uncertainty Quantification of Time-dependent Problems

Panos Stinis and Jing Li, Pacific Northwest National Laboratory, USA

8:40-9:05 Mixed Finite Element Methods for the Stochastic Cahn-Hilliard Equation with Gradient-type Multiplicative Noises

Xiaobing H. Feng, University of Tennessee, USA; *Yukun Li,* Ohio State University, USA; Yi Zhang, University of Notre Dame, USA

9:10-9:35 Long Term Integration of Burgers Equation with Rough Noise

Yuchen Dong, Worcester Polytechnic Institute, USA

Thursday, April 19

MS104

Design and Analysis for Statistical Uncertainty Quantification - Part II of III

8:10 AM-10:10 AM

Room:Grand Ballroom F - 1st Floor

For Part 1 see MS91
For Part 3 see MS117

Statistical methods such as Gaussian process and reproducing kernel Hilbert space predictors have become important tools to use after a designed experiment on either a computer model or a physical system. In this session, we will gather junior and senior researchers from various communities to discuss novel contributions on experimental design, sensitivity analysis, variable selection, emulation, calibration, uncertainty propagation and sequential strategies.

Organizer: Xu He

Chinese Academy of Sciences, China

Organizer: Matthew Plumlee

University of Michigan, USA

8:10-8:35 Robust Designs for Gaussian Process Modeling of Computer Experiments

Simon Mak, Georgia Institute of Technology, USA

8:40-9:05 Replication or Exploration? Sequential Design for Stochastic Simulation Experiments

Robert Gramacy, Virginia Tech, USA

9:10-9:35 Leverage Values of Gaussian Process Regression and Sequential Sampling

Lulu Kang, Illinois Institute of Technology, USA

9:40-10:05 Interleaved Lattice-based Minimax Distance Designs

Xu He, Chinese Academy of Sciences, China

Thursday, April 19

MS105

Machine Learning Aided Uncertainty Quantification Methods for High-dimensional Sampling, Uncertainty Propagation, Design and Inverse Problems - Part I of II

8:10 AM-9:40 AM

Room:Garden 1 - 1st Floor

For Part 2 see MS118

Even though the science of the uncertainty quantification (UQ) evolved remarkably over the recent years, there exist significant computational challenges and mathematical complexities in a few research areas such as sampling, uncertainty propagation, design under uncertainty and inverse problems in high-dimensions. Recent advancements in machine learning (ML) methods such as manifold learning techniques have shown a promising way to address these complexities by learning from the proxy and noisy data. The probability distribution functions delineated on the manifolds built based on the data were shown to be efficient for sampling, robust design and surrogate construction. Also, there is a considerable amount of research focused on discovering governing equations from data using ML and probabilistic inversion. With the advancement of data procurement methods, storage facility and improved computational resources such as multi-core CPUs and GPUs, ML methods can guide to attain efficient UQ methods. This minisymposium brings together experts from the ML and UQ domain to discuss the ML aided UQ methods to solve high-dimensional UQ problems in several real-world applications.

continued in next column

Organizer: Charanraj Thimmisetty

Lawrence Livermore National Laboratory, USA

Organizer: Ramakrishna Tipireddy

Pacific Northwest National Laboratory, USA

8:10-8:35 Stochastic Dimension Reduction using Basis Adaptation and Spatial Domain Decomposition for PDEs with Random Coefficients

Ramakrishna Tipireddy, Panos Stinis, and Alexander Tartakovsky, Pacific Northwest National Laboratory, USA

8:40-9:05 A Spectral Approach for the Design of Experiments: Design, Analysis and Algorithms

Bhavya Kailkhur, Jayaraman Thiagarajan, and Peer-Timo Bremer, Lawrence Livermore National Laboratory, USA

9:10-9:35 Optimal Information Acquisition Algorithms for Inferring the Order of Sensitivity Indices

Piyush Pandita, Purdue University, USA; Jesper Kristensen, Cornell University, USA; Ilias Bilionis, Purdue University, USA

Thursday, April 19

MS106

Advances in Reduced Order Modeling for Uncertainty Quantification - Part I of II

8:10 AM-10:10 AM

Room:Garden 2 - 1st Floor

For Part 2 see MS119

Reduced order Modeling (ROM) has emerged in recent years as critical computational tools for accelerating the solution of dynamic and parametric PDEs. By exploiting the intrinsic structure and low dimensionality of the PDE solution manifold, ROM can achieve considerable speedups while retaining certified approximation accuracy. In fact, it has been proven in many cases that ROM leads to optimal approximation in terms of Kolmogorov widths. By reducing PDE solution time from as much as hours on supercomputers to seconds or less on a single CPU core, ROM makes real-time or many-query simulations feasible. In particular, uncertainty quantification (UQ), which is often prohibitive for complex problems, can become tractable with ROM. In this minisymposium, leading experts will present recent research advances in developing and applying ROM for UQ. We focus on the following themes: (1) tackling the curse of dimensionality by ROM for high-dimensional UQ problems; (2) applying ROM to UQ problems governed by more challenging models, including multiphysics, multiscale, and fractional PDE problems; and (3) ROM to facilitate optimal design and control under uncertainty, Bayesian inverse problems, and data assimilation.

continued in next column

Organizer: Peng Chen
University of Texas at Austin, USA

Organizer: Gianluigi Rozza
SISSA, International School for Advanced Studies, Trieste, Italy

Organizer: Omar Ghattas
University of Texas at Austin, USA

8:10-8:35 Reduced Order Models for CVaR Estimation and Risk Averse Optimization

Matthias Heinkenschloss, Rice University, USA

8:40-9:05 Padé Approximation for Helmholtz Frequency Response Problems with Stochastic Wavenumber

Francesca Bonizzoni, University of Vienna, Austria; Fabio Nobile, École Polytechnique Fédérale de Lausanne, Switzerland; Davide Pradovera, EPFL, Switzerland; Ilaria Perugia, University of Vienna, Austria

9:10-9:35 Low-rank Methods for Approximations of Posterior Covariance Matrix of Linear Bayesian Inverse Problems

Peter Benner and *Yue Qiu*, Max Planck Institute for Dynamics of Complex Technical Systems, Germany; Martin Stoll, Max Planck Institute, Magdeburg, Germany

9:40-10:05 Multifidelity Dimension Reduction via Active Subspaces

Remi Lam and K. Willcox, Massachusetts Institute of Technology, USA

Thursday, April 19

MS107

Efficient Sampling Methods for Bayesian Inference in Computational Problems - Part II of II

8:10 AM-10:10 AM

Room:Garden 3 - 1st Floor

For Part 1 see MS94

Computational challenges arise in Bayesian inference when the underlying parameter space is high-dimensional, the resulting posterior is highly concentrated, or the computational model under consideration is computationally expensive. However, such situations are of particular interest in modern uncertainty quantification. High-dimensional problems arise in Bayesian inference with PDE models where for example the permeability is the quantity of interest. Concentrated posteriors are related to large and/or informative data sets. Calibrating the inflow conditions in expensive computational fluid dynamics problems yields a computationally challenging posterior. This minisymposium focuses on various novel techniques to solve such problems. The main goal is to efficiently draw samples from the resulting posterior by applying recent sampling methods (such as MCMC and particle methods) tailored to the specifics of the problem or numerically approximating underlying models such that naive methods become tractable.

Organizer: Laurent van den Bos
Centrum voor Wiskunde en Informatica (CWI), Netherlands

Organizer: Claudia Schillings
Universitaet Mannheim, Germany

Organizer: Björn Sprungk
University of Mannheim, Germany

Organizer: Michele Ottobre
Imperial College London, United Kingdom

continued on next page

Thursday, April 19

MS107

Efficient Sampling Methods for Bayesian Inference in Computational Problems - Part II of II

8:10 AM-10:10 AM

contniued

8:10-8:35 Bayesian Modeling of Mixed Aleatory and Epistemic Uncertainty in CFD

Laurent van den Bos and Benjamin Sanderse, Centrum voor Wiskunde en Informatica (CWI), Netherlands

8:40-9:05 Bayesian Algorithms for Data-driven Turbulence Modelling

Richard P. Dwight, Technische Universität Delft, Germany

9:10-9:35 Constitutive Modeling of Turbulence with Physics-informed Machine Learning

Jinlong Wu, Carlos Michelen, and *Heng Xiao*, Virginia Tech, USA

9:40-10:05 Uncertainty Propagation in RANS Simulations via Multi-level Monte Carlo Method

Prashant Kumar, Centrum voor Wiskunde en Informatica (CWI), Netherlands; Martin Schmelzer and Richard P. Dwight, Technische Universität Delft, Germany

Thursday, April 19

MS108

Theory and Simulation of Failure Probabilities and Rare Events - Part III of III

8:10 AM-10:10 AM

Room:Garden 4 - 1st Floor

For Part 2 see MS95

The evaluation of failure probabilities is a fundamental problem in reliability analysis and risk management of systems with uncertain inputs. We consider systems described by PDEs with random coefficients together with efficient approximation schemes. This includes stochastic finite elements, collocation, reduced basis, and advanced Monte Carlo methods. Efficient evaluation and updating of small failure probabilities and rare events remains a significant computational challenge. This minisymposium brings together tools from applied probability, numerical analysis, and computational science and engineering. We showcase advances in analysis and computational treatment of rare events and failure probabilities, including variance reduction, advanced meta-models, and active learning.

Organizer: Elisabeth Ullmann
Technische Universität München, Germany

Organizer: Iason Papaioannou
Technische Universität München, Germany

Organizer: Michael D. Shields
Johns Hopkins University, USA

8:10-8:35 A Unified Approach on Active Learning Methods for Reliability Analysis

Stefano Marelli, Moustapha Maliki, Roland Schöbi, and *Bruno Sudret*, ETH Zürich, Switzerland

8:40-9:05 Rare Event Simulation Through Metamodel-driven Sequential Stochastic Sampling

Jize Zhang and Alexandros A. Taflanidis, University of Notre Dame, USA

9:10-9:35 Rare Event Probability Estimation using Adaptive Support Vector Regression - Importance of Kernels and their Proper Tuning

Jean-Marc Bourinet, Université Clermont Auvergne, France

9:40-10:05 Sequential Designs of Surrogate Models for Reliability Analysis

Max Ehre, Iason Papaioannou, and Daniel Straub, Technische Universität München, Germany

continued in next column

Thursday, April 19

MS109

Low-rank Approximations for the Forward- and the Inverse Problems - Part II of III

8:10 AM-10:10 AM

Room:Pacific - 2nd Floor

For Part 1 see MS96
For Part 3 see MS122

Sparse approximations, especially in the form of low-rank methods, have become essential in the solution and representation of high-dimensional stochastic problems. Identification in the form of Bayesian inverse problems - in particular when performed repeatedly or sequentially for dynamical systems - requires the efficient solution and representation of high-dimensional stochastic forward problems. Additionally it seems advantageous if the Bayesian update can take advantage of such sparse representations, and produce the update also in sparse form. An emergent idea is the use of inverse methods to solve the forward problem. The minisymposium will focus on sparse techniques for the representation and solution of high-dimensional problems, and their interplay with Bayesian inverse problems and Bayesian inversion.

Organizer: Alexander Litvinenko
King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Martin Eigel
WIAS, Berlin, Germany

Organizer: Hermann Matthies
Technische Universität Braunschweig, Germany

Organizer: Bojana Rosic
Technische Universität Braunschweig, Germany

Organizer: Reinhold Schneider
Technische Universität Berlin, Germany

Organizer: Mike Espig
RWTH Aachen University, Germany

8:10-8:35 Principal Component Analysis and Active Learning in Tree Tensor Networks

Anthony Nouy, Ecole Centrale de Nantes, France

8:40-9:05 Sparse Multifidelity Approximations for Forward UQ with Application to Scramjet Combustor Computations

Cosmin Safta, Sandia National Laboratories, USA; Gianluca Geraci, Stanford University, USA; Michael S. Eldred and Habib N. Najm, Sandia National Laboratories, USA

9:10-9:35 Multilevel Monte Carlo Computation of Seismic Wave Propagation with Random Lamé Parameters

Anamika Pandey, King Abdullah University of Science & Technology (KAUST), Saudi Arabia

9:40-10:05 Bayesian Inverse Problems and Low-rank Approximations

Hermann Matthies, Technische Universität Braunschweig, Germany

continued in next column

Thursday, April 19

MS110

Advances in Uncertainty Quantification and Optimization for Multiphysics/scale Applications - Part II of II

8:10 AM-10:10 AM

Room:Harbor - 2nd Floor

For Part 1 see MS97

Many problems in science and engineering are described by multiphysics models that interact on a wide range of length and time scales and are subject to various sources of uncertainty, such as unknown material properties, approximate boundary conditions, and inadequate model descriptions. Ongoing efforts seek to develop mathematical and numerical tools that incorporate information from relevant spatial and temporal scales, integrate experimental data in a consistent manner, and make credible predictions with quantified error and uncertainty. Providing accurate estimates of probabilistic quantities of interest is challenging for large-scale multiphysics applications where the number of uncertain parameters may be immense, the budget of high-fidelity model evaluations may be limited, and the available data may be sparse and corrupted by significant noise. This task is especially difficult if an optimal solution under uncertainty is desired. The goal of this minisymposium is to provide an opportunity for researchers to present recent work and exchange ideas on novel methods for optimization problems, sensitivity analysis, and uncertainty quantification in the context of multiphysics and multiscale formulations.

continued on next page

Thursday, April 19

MS110

Advances in Uncertainty Quantification and Optimization for Multiphysics/scale Applications - Part II of II

8:10 AM-10:10 AM

continued

Organizer: Bart G. Van Bloemen Waanders
Sandia National Laboratories, USA

Organizer: Tim Wildey
Sandia National Laboratories, USA

Organizer: Daniel T. Seidl
Sandia National Laboratories, USA

8:10-8:35 A Data-oriented Approach to Statistical Inverse Problems

Brad Marvin, University of Texas at Austin, USA; Tim Wildey, Sandia National Laboratories, USA; Tan Bui-Thanh, University of Texas at Austin, USA

8:40-9:05 Optimization with Fractional PDEs

Harbir Antil, George Mason University, USA

9:10-9:35 Safe Designs via Robust Geometric Programming

Ali Saab and Edward Burnell, Massachusetts Institute of Technology, USA; Warren Hoburg, NASA, USA

9:40-10:05 An Uncertainty-weighted ADMM Method for Multiphysics Parameter Estimation

Samy Wu Fung and Lars Ruthotto, Emory University, USA

Thursday, April 19

MS111

Characterizing Model Inadequacy in Bayesian Inference - Part II of III

8:10 AM-10:10 AM

Room:Salon I - 2nd Floor

For Part 1 see MS98
For Part 3 see MS124

Models of complex physical systems are often formulated based on approximations and assumptions that may be in error in some situations. In other cases, the highest fidelity model of the system may be intractable or too computationally expensive for its intended use. In these cases the models are often replaced with less expensive lower fidelity models, which necessarily introduce additional errors. When such inadequate models are used to make predictions, the errors introduce uncertainties in those predictions. Characterization of uncertainties due to model inadequacy introduces formulation and algorithmic challenges. Of particular interest are inadequacy representations that allow characterizing uncertainties in the predictions, thus informing consequential decisions or enabling multi-fidelity approaches. To this aim, it is often helpful to embed inadequacy in the models and to formulate them based on knowledge about the physical system. This introduces additional algorithmic challenges when the model is formulated in terms of ordinary or partial differential equations, since inadequacy representation is often in terms of an infinite dimensional uncertainty. This minisymposium brings together researchers from diverse fields to discuss advances in treatment of model errors, with particular focus on physics-based representation of inadequacy, including the incorporation of stochastic terms in the model equations, and Bayesian calibration of the resulting stochastic models.

continued in next column

Organizer: Umberto Villa
University of Texas at Austin, USA

Organizer: Todd A. Oliver
University of Texas at Austin, USA

Organizer: Noemi Petra
University of California, Merced, USA

Organizer: Omar Ghattas
University of Texas at Austin, USA

Organizer: Robert D. Moser
University of Texas at Austin, USA

8:10-8:35 Stochastic Inadequacy Models for Chemical Kinetics

David Sondak, Harvard University, USA; Todd A. Oliver, Chris Simmons, and Robert D. Moser, University of Texas at Austin, USA

8:40-9:05 Inadequacy Representation of Flamelet-based RANS Model with a Physics-based Stochastic PDE

Myoungkyu Lee, Todd A. Oliver, and Robert D. Moser, University of Texas at Austin, USA

9:10-9:35 Embedded Model Error Quantification and Propagation

Khachik Sargsyan, Xun Huan, and Habib N. Najm, Sandia National Laboratories, USA

9:40-10:05 Bayesian Calibration of Rheological Closure Relations for Computational Models of Turbidity Currents

Fernando A. Rochinha, Zio Souleymane, Henrique Costa, and Gabriel Guerra, COPPE/Universidade Federal do Rio e Janeiro, Brazil

Thursday, April 19

MS112

Data Sources and Modeling of Uncertainties in Geophysical Hazards - Part II of II

8:10 AM-10:10 AM

Room:Salon II - 2nd Floor

For Part 1 see MS99

UQ for geophysical hazards like tsunamis, lahars, volcanoes, hurricanes etc. is becoming increasingly relevant due to the inherent lacunae in the multi-physics modeling of such complex phenomena. Further challenges arise from the heavy computational cost of both the deterministic forward model simulations and the probabilistic ensemble based methods. Proper identification, characterization and reduction of the high-dimensional model parameter uncertainties is another hurdle. Thus, there is a requirement for robust methods that account for multiple sources in uncertainties, sparse data and coarse model resolutions. Statistical emulation that captures the relevant non-linearities in the model coupled with strategic design of numerical experiment is an important step in this direction. Efficient data assimilation integrated with the models helps reduce the uncertainty in the model parameters. Physics based novel parameterizations pave the way for rapid hazard assessment. Sparse grid methods and accurate multi-dimensional parameter distribution approximations essentially make the simulations and calibrations tractable. Hence, this minisymposium brings together researchers working on recent advances in statistical surrogates, sequential design, data assimilation, sparse grid methods, probabilistic geo-hazard assessment, rapid uncertainty propagation and high dimensional parameter estimation.

continued in next column

Organizer: Devaraj Gopinathan
University College London, United Kingdom

Organizer: Mengyang Gu
Johns Hopkins University, USA

8:10-8:35 Modeling of Geophysical Flows - Analysis of Models and Modeling Assumptions using UQ

Abani Patra, Andrea Bevilacqua, and Ali Safei, State University of New York, Buffalo, USA

8:40-9:05 Sequential Surrogate-based Optimization: Application to Storm Surge Modelling

Theodoros Mathikolonis and Serge Guillas, University College London, United Kingdom

9:10-9:35 Multi-fidelity Sparse-grid-based Uncertainty Quantification Applied to Tsunami Runup

Stephen G. Roberts, Australian National University, Australia

9:40-10:05 Emulation of Computer Models with Multivariate Output

Ksenia N. Kyzyurova, King Abdullah University of Science & Technology (KAUST), Saudi Arabia; James Berger and Robert L. Wolpert, Duke University, USA

Thursday, April 19

MS113

Machine Learning Approaches for Uncertainty Quantification in Porous Media Flow Applications - Part III of III

8:10 AM-10:10 AM

Room:Salon VIII - 2nd Floor

For Part 2 see MS100

Machine learning have contributed significantly to recent advances in image and signal processing, pattern recognition, recommendation systems, natural language processing and machine translation. Most of these machine learning techniques, could be adapted for a wide range of applications in porous media flow problems. This minisymposium covers recent applications of machine learning algorithms for multi-scale modeling, reduced order modeling and uncertainty quantification (UQ) in various porous media flow applications. Targeted topics includes: (1) Machine Learning assisted Uncertainty Quantification (2) ML accelerated statistical model calibration against multiple data sources (production, seismic, outcrops, experts) (4) Quantitative risk assessment using data-driven approaches (5) Stochastic model generation using machine learning. Also of relevance are Bayesian approaches, compressed sensing and sparse reconstruction methods, reduced-order parameterization, physical model cross-validation techniques, and response surface proxies.

Organizer: Ahmed H. ElSheikh
Heriot-Watt University, United Kingdom

Organizer: Hector Klie
DeepCast.ai, USA

continued on next page

Thursday, April 19

MS113

Machine Learning Approaches for Uncertainty Quantification in Porous Media Flow Applications - Part III of III

8:10 AM-9:40 AM

continued

8:10-8:35 Novel Robust Machine Learning Methods for Identification and Extraction of Unknown Features in Complex Real-world Data Sets

Velimir V. Vesselinov, Los Alamos National Laboratory, USA

8:40-9:05 Parametrization and Generation of Geological Models with Generative Adversarial Networks

Shing Chan and Ahmed H. ElSheikh, Heriot-Watt University, United Kingdom

9:10-9:35 Prediction of Permeability from Digital Images of Reservoir Rocks

Mauricio Araya-Polo, Faruk O. Alpak, Nishank Saxena, and Sander Hunter, Shell International Exploration and Production, USA

Thursday, April 19

MS114

Stochastic Modeling and Methods in Scientific Computing - Part III of III

8:10 AM-10:10 AM

Room:Salon V - 2nd Floor

For Part 2 see MS101

In this minisymposium, we will highlight recent developments of stochastic modeling and methods in various areas such as solution of deterministic PDEs, linear algebra, uncertainty, machine learning, and CFD. Applications in material sciences, meta-materials, data sciences and machine learning will be considered. We shall bring together researchers from across the scientific computing community to discuss and collaborate on Stochastic modeling and methods, and to discuss future directions for research.

Organizer: Wei Cai

Southern Methodist University, USA

Organizer: Tao Zhou

Chinese Academy of Sciences, China

8:10-8:35 Numerical Methods for Hyperbolic Systems of PDEs with Uncertainties

Alexander Kurganov, Tulane University, USA

8:40-9:05 Analysis of UQ in Computational Method for some Kinetic and Hyperbolic Equations

Jian-guo Liu, Duke University, USA

9:10-9:35 Asymptotically Efficient Simulations of Elliptic Problems with Small Random Forcing

Xiaoliang Wan, Louisiana State University, USA; Xiang Zhou, City University of Hong Kong, Hong Kong

9:40-10:05 Discovering Variable Fractional Orders of Advection-dispersion Equations from Field Data using Multi-fidelity Bayesian Optimization

Guofei Pang and George E. Karniadakis, Brown University, USA; Paris Perdikaris, Massachusetts Institute of Technology, USA; Wei Cai, Southern Methodist University, USA

Thursday, April 19

MS115

Software for UQ - Part III of IV

8:10 AM-10:10 AM

Room:Salon VI - 2nd Floor

For Part 2 see MS102
For Part 4 see MS128

With the growing importance of UQ in various disciplines and fields, software solutions and libraries for UQ problems get more and more important. This raises interesting questions for the UQ community such as: What are the current properties of available tools? For which classes of problems have they been developed? What methods or algorithms do they provide? What are challenges for UQ software and which resources are required? What are recent improvements? What are the next steps and the long-term goals of the development? This minisymposium brings together experts for different software in the context of UQ, ranging from tools that ease up individual tasks of UQ up to whole frameworks for solving UQ problems.

Organizer: Tobias Neckel

Technische Universität München, Germany

Organizer: Dirk Pflüger

Technische Universität München, Germany

8:10-8:35 Markov Chain Monte Carlo Sampling using GPU Accelerated Sparse Grids Surrogate Models

Miroslav Stoyanov, Oak Ridge National Laboratory, USA

8:40-9:05 UQLaB: What's Next?

Stefano Marelli and Bruno Sudret, ETH Zürich, Switzerland

9:10-9:35 QUESO: A Parallel C++ Library for Quantifying Uncertainty in Estimation, Simulation, and Optimisation

Damon McDougall, University of Texas at Austin, USA

9:40-10:05 Integrating SNOWPAC in Dakota with Application to a Scramjet

Friedrich Menhorn, Technische Universität München, Germany; Florian Augustin and Youssef M. Marzouk, Massachusetts Institute of Technology, USA; Michael S. Eldred, Sandia National Laboratories, USA

Thursday, April 19

Coffee Break

10:10 AM-10:40 AM

Room:Grand Ballroom Foyer - 1st Floor

Closing Remarks

10:40 AM-10:45 AM

Room:Grand Ballroom ABCD - 1st Floor

SP1

SIAG/Uncertainty Quantification Early Career Prize Lecture - Multilevel Markov Chain Monte Carlo Methods for Uncertainty Quantification

10:45 AM-11:15 AM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Roger Ghanem, University of Southern California, USA

Multilevel Monte Carlo methods have become increasingly popular over the last decade, due to their simplicity and their ability to significantly outperform standard Monte Carlo approaches in complex simulation tasks. In this talk, we will discuss how the multilevel methodology can be applied in the context of Markov chain Monte Carlo sampling. The general algorithm will be demonstrated on the particular example of sampling from the posterior distribution in a Bayesian inverse problem, where the goal is to infer the coefficient of an elliptic partial differential equation given observations of the solution. Numerical experiments confirm that the multilevel methodology reduces the computational effort to achieve a given tolerance by several orders of magnitude.

Aretha L. Teckentrup
University of Edinburgh, United Kingdom

Thursday, April 19

IP7

Data Assimilation and Uncertainty Quantification — A Lagrangian Interacting Particle Perspective

11:15 AM-12:00 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Daniela Calvetti, Case Western Reserve University, USA

The assimilation of data into computational models and the quantification of forecast uncertainties is central to many application areas including meteorology, hydrology, seismology, power networks etc. Broadly speaking, currently used data assimilation techniques fall into one of the following three categories: (i) variational methods, (ii) Markov chain Monte Carlo methods, and (iii) sequential particle filters. Among sequential particle filters, the ensemble Kalman filter (EnKF) has become very popular but its wider application has been limited by its inherent Gaussian distributional/ linearity assumptions. In my talk, I will focus on recent particle filter extensions of the EnKF to high-dimensional problems with non-Gaussian uncertainties and to combined state-parameter estimation problems. Unifying mathematical principles in these developments are Lagrangian interacting particle representations and optimal coupling arguments.

Sebastian Reich
Universität Potsdam, Germany and University of Reading, United Kingdom

Lunch Break

12:00 PM-1:30 PM

Attendees on their own

Thursday, April 19

IP8

Good and Bad Uncertainty: Consequences in UQ and Design

1:30 PM-2:15 PM

Room:Grand Ballroom ABCD - 1st Floor

Chair: Matthias Heinkenschloss, Rice University, USA

Engineering decisions are invariably made under substantial uncertainty about current and future system cost and response. However, not all variability is equally detrimental. The possibility of exceptionally high performance can be viewed as "good" uncertainty, while the chance of failure is usually perceived as "bad" uncertainty. From this perspective, we examine uncertainty quantification and its use in engineering design. We introduce models for uncertainty quantification and decision making based on superquantile risk (s-risk) that distinguish between good and bad uncertainty, avoid paradoxes, and accrue substantial benefits in risk, reliability, and cost optimization. Leveraging multi-fidelity simulations, we describe methods for predicting s-risk at reduced computational cost for complex systems. Examples from naval architecture, earthquake engineering, and energy management illustrate the framework under both parametric and model uncertainty.

Johannes O. Royset
Naval Postgraduate School, USA

Intermission

2:15 PM-2:30 PM

Thursday, April 19

MT8

Optimization and Control Under Uncertainty

2:30 PM-4:30 PM

Room:Grand Ballroom G - 1st Floor

Many engineering applications require the control or design of a physical system modeled by partial differential equations (PDEs) with uncertain inputs. In this minitutorial, I will discuss theoretical challenges associated with these PDE-constrained optimization problems, including their mathematical formulation and their numerical solution. First, I will formulate these problems as stochastic optimization problems in Banach space and provide assumptions that ensure existence of minimizers and permit the derivation of first-order optimality conditions. In many applications, it is critical to determine optimal solutions that are resilient to uncertainty. To this end, I will review pertinent risk management topics including measures of risk, stochastic dominance and distributionally robust optimization. I will then motivate their use in engineering optimization and demonstrate the importance of quantifying risk through numerical examples. To conclude, I will discuss numerical solution approaches. After discretization, our risk-averse optimization problem becomes an enormous stochastic program. In addition, quantifying risk often results in nonsmooth objective and constraint functions therefore limiting the applicability of many numerical optimization algorithms. To circumvent these complications, I will discuss risk-smoothing techniques. I will also discuss traditional sample-based methods including stochastic and sample-average approximation and progressive hedging.

Organizer and Speaker:

Drew P. Kouri
Sandia National Laboratories, USA

Thursday, April 19

MS35

Model Determination in the Presence of Uncertainty in Dynamical Systems in the Biology and Medicine

2:30 PM-4:30 PM

Room:Salon VIII - 2nd Floor

In a wide range of modeling for biology and medicine, one of the most difficult issues is the separation of uncertainty in mathematical and statistical models. In this session we propose contributions of academic and non-academic investigators involved in modeling of infectious diseases, modeling voluntary immune suppression in transplant patients, and alcohol abuse in humans. Included are discussions on 1) Modeling of uncertainty, and calibration of such models to individual-level data, and highlights of the implications of this uncertainty in the investigation of public health, related questions; 2) Recent theoretical developments with a particular focus on algorithmic considerations for the design of estimators that are both efficient and robust, with a discussion of examples from fields of public health, epidemiology, biology, etc.; 3) Sensor design for estimation of distributions of random parameters in a distributed parameter model with unbounded input and output for the transdermal transport of ethanol in humans; and 4) Uncertainty in clinical data from a kidney transplant recipient infected with BK virus and investigation of mathematical model and statistical model misspecifications.

Organizer: H. T. Banks

North Carolina State University, USA

continued in next column

2:30-2:55 A Review of Algorithmic Tools for Causal Effect Quantification

Clay Thompson, SAS Institute, Inc., USA

3:00-3:25 Mathematical and Statistical Model Misspecifications in Modeling Immune Response in Renal Transplant Recipients

Neha Murad, North Carolina State University, USA

3:30-3:55 Estimating the Distribution of Random Parameters in, and Deconvolving the Input Signal to, a Diffusion Equation Forward Model for a Transdermal Alcohol Biosensor

Melike Sirlanci and I. Gary Rosen, University of Southern California, USA

4:00-4:25 Individual Level Modeling of Uncertainty in Infectious Diseases

Karyn Sutton, Institute for Disease Modeling, USA

Thursday, April 19

MS116

Dynamics with Inherent Noise: Stochastic Modelling and Simulation - Part II of II

2:30 PM-4:30 PM

Room:Grand Ballroom ABCD - 1st Floor

For Part 1 see MS103

Inherent noise is ubiquitous in complex systems such as physics, chemistry, engineering and system biology. Numerical simulations based on stochastic models provide an important tool to understand the influence of noise and the dynamic properties of these systems beyond equilibrium. Synergy of stochastic modelling and numerical solutions techniques often leads to novel ideas and promote applications of stochastic models and solvers. In this minisymposium, we focus on both stochastic modelling and numerical methods with emphasis on the interaction of the-state-of-art computational techniques with applications in modelling dynamic process of complex systems. We invite speakers from both communities and expect them to have fruitful discussion. The speakers will address stochastic modelling problems and numerical techniques to solve stochastic equations arising in various applications. Specific topics includes stochastic dynamics modelled by Markov processes with applications to biology and chemical reaction systems, numerical techniques such as singular perturbation methods, surrogate model methods, long time integration of nonlinear SDE, model reduction methods, etc..

Organizer: Huan Lei

Pacific Northwest National Laboratory, USA

Organizer: Zhongqiang Zhang

Worcester Polytechnic Institute, USA

continued in next column

2:30-2:55 Stochastic Computational Singular Perturbation for Complex Chemical Reaction Systems

Xiaoying Han, Auburn University, USA; Habib N. Najm, Sandia National Laboratories, USA; Yanzhao Cao, Auburn University, USA; Lijin Wang, University of Chinese Academy of Sciences, China

3:00-3:25 Numerical Methods for Stochastic Delay Differential Equations under Non-global Lipschitz Condition

Wanrong Cao, Southeast University, China

3:30-3:55 Chemical Reaction Noise Induced Phenomena: Change in Dynamics and Pattern Formation

Yian Ma, University of Washington, USA

4:00-4:25 Efficient Integration of Fractional Beam Equation with Space-time Noise

Zhongqiang Zhang and Zhaopeng Hao, Worcester Polytechnic Institute, USA

Thursday, April 19

MS117

Design and Analysis for Statistical Uncertainty Quantification - Part III of III

2:30 PM-4:30 PM

Room:Grand Ballroom F - 1st Floor

For Part 2 see MS104

Statistical methods such as Gaussian process and reproducing kernel Hilbert space predictors have become important tools to use after a designed experiment on either a computer model or a physical system. In this session, we will gather junior and senior researchers from various communities to discuss novel contributions on experimental design, sensitivity analysis, variable selection, emulation, calibration, uncertainty propagation and sequential strategies.

Organizer: Xu He

Chinese Academy of Sciences, China

Organizer: Matthew Plumlee

University of Michigan, USA

2:30-2:55 Input-output Uncertainty Comparisons for Optimization via Simulation

Eunhye Song, Pennsylvania State University, USA; Barry Nelson, Northwestern University, USA

3:00-3:25 Universal Convergence of Kriging

Wenjia Wang, Georgia Institute of Technology, USA; *Rui Tuo*, Chinese Academy of Sciences, China; C. F. Jeff Wu, Georgia Institute of Technology, USA

3:30-3:55 Importance Sampling the Union of Rare Events with Bounded Relative Error and an Application to Power Systems Analysis

Art Owen, Stanford University, USA; Yury Maximov and Michael Chertkov, Los Alamos National Laboratory, USA

4:00-4:25 Experimental Designs for Uncertainty Propagation and Robustness Analysis

Roshan Vengazhiyil and Simon Mak, Georgia Institute of Technology, USA

Thursday, April 19

MS118

Machine Learning Aided Uncertainty Quantification Methods for High-dimensional Sampling, Uncertainty Propagation, Design and Inverse Problems - Part II of II

2:30 PM-4:00 PM

Room:Garden 1 - 1st Floor

For Part 1 see MS105

Even though the science of the uncertainty quantification (UQ) evolved remarkably over the recent years, there exist significant computational challenges and mathematical complexities in a few research areas such as sampling, uncertainty propagation, design under uncertainty and inverse problems in high-dimensions. Recent advancements in machine learning (ML) methods such as manifold learning techniques have shown a promising way to address these complexities by learning from the proxy and noisy data. The probability distribution functions delineated on the manifolds built based on the data were shown to be efficient for sampling, robust design and surrogate construction. Also, there is a considerable amount of research focused on discovering governing equations from data using ML and probabilistic inversion. With the advancement of data procurement methods, storage facility and improved computational resources such as multi-core CPUs and GPUs, ML methods can guide to attain efficient UQ methods. This minisymposium brings together experts from the ML and UQ domain to discuss the ML aided UQ methods to solve high-dimensional UQ problems in several real-world applications.

continued in next column

Organizer: Charanraj Thimmisetty
Lawrence Livermore National Laboratory, USA

Organizer: Ramakrishna Tipireddy
Pacific Northwest National Laboratory, USA

2:30-2:55 Efficient Stochastic Inversion Using Adjoint Models and Machine Learning

Charanraj Thimmisetty, Lawrence Livermore National Laboratory, USA; Wenju Zhao, Florida State University, USA; Charles Tong, Joshua A. White, and Chen Xiao, Lawrence Livermore National Laboratory, USA

3:00-3:25 Compressive Sensing with Built-in Basis Adaptation for Reduced Homogeneous Chaos Expansions

Panagiotis Tsilifis and Roger Ghanem, University of Southern California, USA

3:30-3:55 Uncertainty Quantification of Transport in Heterogeneous Porous Media with the Iruq-Cv Method

Weixuan Li, ExxonMobil, USA; David A. Barajas-Solano, *Guzel Tartakovsky*, and Alexander Tartakovsky, Pacific Northwest National Laboratory, USA

Thursday, April 19

MS119

Advances in Reduced Order Modeling for Uncertainty Quantification - Part II of II

2:30 PM-4:30 PM

Room:Garden 2 - 1st Floor

For Part 1 see MS106

Reduced order Modeling (ROM) has emerged in recent years as critical computational tools for accelerating the solution of dynamic and parametric PDEs. By exploiting the intrinsic structure and low dimensionality of the PDE solution manifold, ROM can achieve considerable speedups while retaining certified approximation accuracy. In fact, it has been proven in many cases that ROM leads to optimal approximation in terms of Kolmogorov widths. By reducing PDE solution time from as much as hours on supercomputers to seconds or less on a single CPU core, ROM makes real-time or many-query simulations feasible. In particular, uncertainty quantification (UQ), which is often prohibitive for complex problems, can become tractable with ROM. In this minisymposium, leading experts will present recent research advances in developing and applying ROM for UQ. We focus on the following themes: (1) tackling the curse of dimensionality by ROM for high-dimensional UQ problems; (2) applying ROM to UQ problems governed by more challenging models, including multiphysics, multiscale, and fractional PDE problems; and (3) ROM to facilitate optimal design and control under uncertainty, Bayesian inverse problems, and data assimilation.

Organizer: Peng Chen
University of Texas at Austin, USA

Organizer: Gianluigi Rozza
SISSA, International School for Advanced Studies, Trieste, Italy

Organizer: Omar Ghattas
University of Texas at Austin, USA

2:30-2:55 Random Sketching for Model Order Reduction of High Dimensional Systems

Oleg Balabanov, Ecole Centrale de Nantes, France and Polytechnic University of Catalonia, Spain; Anthony Nouy, Ecole Centrale de Nantes, France

3:00-3:25 Gradient-free Active Subspace Techniques to Construct Surrogate Models Employed for Bayesian Inference

Kayla Coleman and Ralph Smith, North Carolina State University, USA; Brian Williams, Los Alamos National Laboratory, USA; Max D. Morris, Iowa State University, USA

3:30-3:55 Dictionary Measurement Selection for State Estimation with Reduced Models

James A. Nichols, Laboratoire Jacque-Louis Lions and Sorbonne Université, France; Olga Mula, CEREMADE Universite Paris 9 Dauphine, France; Albert Cohen, Université Pierre et Marie Curie, France; Peter Binev, University of South Carolina, USA

4:00-4:25 Certified Reduced Basis Methods for Variational Data Assimilation

Nicole Nellesen, RWTH Aachen University, Germany; Sebastien J. Boyaval, École des Ponts ParisTech, France; Martin Grepl and Karen Veroy, RWTH Aachen University, Germany

Thursday, April 19

MS120

Uncertainty Quantification and Statistical Techniques for Problems in Applied Science

2:30 PM-4:30 PM

Room:Garden 3 - 1st Floor

In applications such computational imaging and material science, data are characterized by estimating a large number of unknowns corrupted by stochastic effects such as measurement error. Moreover, the data are often correlated in a highly structured way so that standard methods of statistical inference are not applicable. Modern techniques for estimation and quantifying uncertainty draw from the literature of numerical analysis and statistics. This minisymposium will focus on applications to real datasets and methods that lie at the intersection of these disciplines with a focus on estimation and quantification of uncertainty.

Organizer: Kevin Joyce

Nevada National Security Site, USA

Organizer: Marylesa Howard

National Security Technologies, LLC, USA

2:30-2:55 Radially Symmetric Modeling for Large Scale Linear Inverse Problems in X-ray Imaging

Kevin Joyce, Nevada National Security Site, USA

3:00-3:25 A Locally Adapting Technique for Quantifying Error in Boundary Locations using Image Segmentation

Margaret C. Hock, University of Alabama, Huntsville, USA

3:30-3:55 Opportunities and Unsolved Problems in Quantifying Seemingly Random Behavior in Images of Shock Waves

Leora Dresselhaus-Cooper, Massachusetts Institute of Technology, USA

4:00-4:25 Fast Experimental Designs for LARGE Linear Processes

Al Parker, Montana State University, USA

Thursday, April 19

MS121

Efficient Sampling Algorithms for High Dimensions

2:30 PM-4:30 PM

Room:Garden 4 - 1st Floor

A major challenge in scientific computing is to efficiently simulate forward and inverse models with large numbers of uncertain parameters. The main focus of such high-dimensional parameter models is to certify uncertainties in simulated quantities of interest (QoI), as well as to reduce the uncertainties by conditioning on observed data. Many such models are typically governed by partial differential equations, which require numerical approximations and can be extremely costly to evaluate even for a single sample of parameters. An efficient treatment of such UQ problems requires sophisticated sampling strategies, the clever use of multilevel model hierarchies, surrogate models that are effective in high dimensions and high performance software implementations that allow to realise the potential of these various methodologies. The minisymposium will focus on all those aspects in the context of real-world applications.

Organizer: Mahadevan Ganesh

Colorado School of Mines, USA

Organizer: Robert Scheichl

University of Bath, United Kingdom

2:30-2:55 Continuous Level Monte Carlo and Sample-adaptive Model Hierarchies

Gianluca Detommaso, University of Bath, United Kingdom; *Tim J. Dodwell,* University of Exeter, United Kingdom; Robert Scheichl, University of Bath, United Kingdom

continued on next page

Thursday, April 19

MS121

Efficient Sampling Algorithms for High Dimensions

2:30 PM-4:30 PM

continued

3:00-3:25 An Efficient Algorithm for a Class of Stochastic Wave Propagation Models

Mahadevan Ganesh, Colorado School of Mines, USA

3:30-3:55 A High-performance Software Framework for Multilevel Uncertainty Quantification

Tim J. Dodwell, University of Exeter, United Kingdom; Ole Klein, Universität Heidelberg, Germany; Robert Scheichl, University of Bath, United Kingdom; *Linus Seelinger*, Universität Heidelberg, Germany

4:00-4:25 Efficient Sampling from High-dimensional Distributions using Low-rank Tensor Surrogates

Sergey Dolgov, University of Bath, United Kingdom; Colin Fox, University of Otago, New Zealand; *Robert Scheichl* and Karim Anaya-Izquierdo, University of Bath, United Kingdom

Thursday, April 19

MS122

Low-rank Approximations for the Forward- and the Inverse Problems - Part III of III

2:30 PM-4:30 PM

Room:Pacific - 2nd Floor

For Part 2 see MS109

Sparse approximations, especially in the form of low-rank methods, have become essential in the solution and representation of high-dimensional stochastic problems. Identification in the form of Bayesian inverse problems - in particular when performed repeatedly or sequentially for dynamical systems - requires the efficient solution and representation of high-dimensional stochastic forward problems. Additionally it seems advantageous if the Bayesian update can take advantage of such sparse representations, and produce the update also in sparse form. An emergent idea is the use of inverse methods to solve the forward problem. The minisymposium will focus on sparse techniques for the representation and solution of high-dimensional problems, and their interplay with Bayesian inverse problems and Bayesian inversion.

Organizer: Alexander Litvinenko

King Abdullah University of Science & Technology (KAUST), Saudi Arabia

Organizer: Martin Eigel

WIAS, Berlin, Germany

Organizer: Hermann Matthies

Technische Universität Braunschweig, Germany

Organizer: Bojana Rosic

Technische Universität Braunschweig, Germany

continued in next column

Organizer: Reinhold Schneider

Technische Universität Berlin, Germany

Organizer: Mike Espig

RWTH Aachen University, Germany

2:30-2:55 Adaptive Tensor Methods for Forward and Inverse Problems

Martin Eigel, WIAS, Berlin, Germany

3:00-3:25 Low-rank Tensors for Stochastic Forward Problems

Mike Espig, RWTH Aachen University, Germany

3:30-3:55 Sparse Spectral Bayesian Estimation of Nonlinear Mechanical Models

Bojana Rosic and Hermann Matthies, Technische Universität Braunschweig, Germany

4:00-4:25 Bayesian Estimation for a Tomography Problem

Leila Taghizadeh, Jose A. Morales Escalante, Benjamin Stadlbauer, and Clemens Heitzinger, Vienna University of Technology, Austria

Thursday, April 19

MS123

Uncertainty Quantification for Multi-scale Physical Systems Models

2:30 PM-4:00 PM

Room:Harbor - 2nd Floor

There are many examples in the physical sciences and engineering of multi-scale systems, where multiple smaller scale models are embedded in a larger physical system model. These multiple levels of computational models and corresponding observations often result in a large number of parameters, and pose challenges in characterizing uncertainty. Inadequate representation or propagation of small-scale (or submodel) uncertainty may result in inaccurate and overconfident predictions for the system. Challenges in analyzing multi-scale systems in the statistical uncertainty quantification context include calibration/emulation in a large parameter space, limited data for the full system, complex model discrepancy, computational challenges in uncertainty propagation, and further implications to extrapolation. Statistical modeling of the multi-scale structure of the system motivates development of new methodology to simplify and tackle these challenges. This session (minisymposium) will feature work addressing some of these challenges with innovative solutions for quantifying uncertainty for these systems, providing better capability as well as insights into the physical system, and leading to broad impact in the physical sciences and engineering.

Organizer: K. Sham Bhat
Los Alamos National Laboratory, USA

2:30-2:55 Calibration and Multi-stage Emulation for Disaggregation and Complex Models
K. Sham Bhat, Kary Myers, and James Gattiker, Los Alamos National Laboratory, USA

3:00-3:25 Dynamic Discrepancy: Intrusive Methods for Getting More Science into Industrial Models
David S. Mebane, West Virginia University, USA

3:30-3:55 Parameter Estimation for System Submodels with Limited or Missing Data using a Data-free Inference Procedure
Tiernan Casey and Habib N. Najm, Sandia National Laboratories, USA

continued in next column

Thursday, April 19

MS124

Characterizing Model Inadequacy in Bayesian Inference - Part III of III

2:30 PM-4:30 PM

Room:Salon I - 2nd Floor

For Part 2 see MS111

Models of complex physical systems are often formulated based on approximations and assumptions that may be in error in some situations. In other cases, the highest fidelity model of the system may be intractable or too computationally expensive for its intended use. In these cases the models are often replaced with less expensive lower fidelity models, which necessarily introduce additional errors. When such inadequate models are used to make predictions, the errors introduce uncertainties in those predictions. Characterization of uncertainties due to model inadequacy introduces formulation and algorithmic challenges. Of particular interest are inadequacy representations that allow characterizing uncertainties in the predictions, thus informing consequential decisions or enabling multi-fidelity approaches. To this aim, it is often helpful to embed inadequacy in the models and to formulate them based on knowledge about the physical system. This introduces additional algorithmic challenges when the model is formulated in terms of ordinary or partial differential equations, since inadequacy representation is often in terms of an infinite dimensional uncertainty. This minisymposium brings together researchers from diverse fields to discuss advances in treatment of model errors, with particular focus on physics-based representation of inadequacy, including the incorporation of stochastic terms in the model equations, and Bayesian calibration of the resulting stochastic models.

continued on next page

Thursday, April 19

MS124

Characterizing Model Inadequacy in Bayesian Inference - Part III of III

2:30 PM-4:30 PM

continued

Organizer: Umberto Villa
University of Texas at Austin, USA

Organizer: Todd A. Oliver
University of Texas at Austin, USA

Organizer: Noemi Petra
University of California, Merced, USA

Organizer: Omar Ghattas
University of Texas at Austin, USA

Organizer: Robert D. Moser
University of Texas at Austin, USA

2:30-2:55 Reducing Model Discrepancies in Turbulent Flow Simulations with Physics-informed Machine Learning

Jinlong Wu and Carlos Michelen, Virginia Tech, USA; Jian-Xun Wang, University of California, Berkeley, USA; Heng Xiao, Virginia Tech, USA

3:00-3:25 Impact of Model Fidelity on Bayesian Experimental Design

Ohiremen Dibua, Wouter N. Edeling, and Gianluca Iaccarino, Stanford University, USA

3:30-3:55 Scalable Parallel Solution and Uncertainty Quantification Techniques for Variational Inference

Vishwas Rao, Argonne National Laboratory, USA; Emil M. Constantinescu, Argonne National Laboratory, USA; Adrian Sandu, Virginia Tech, USA; Vishwas Rao, Argonne National Laboratory, USA

4:00-4:25 Model Error Treatment in Data Assimilation for High-dimensional System - The Environmental Prediction Case

Alberto Carrassi, Nansen Environmental and Remote Sensing Center, Norway

Thursday, April 19

MS125

Inverse Problem and Sequential Design for Hazard Forecasting and Stochastic Simulation Experiments

2:30 PM-4:30 PM

Room:Salon II - 2nd Floor

This minisymposium features recent advances in quantifying uncertainty of computer simulation experiments with a focus on inverse problems and sequential design. Gaussian processes have become a ubiquitous tool for studying uncertainties in simulation experiments regardless of the goal of a particular simulation study. That said, nearly all simulation experiments rely critically on the choice of design and appropriate identification of parameters and initial conditions. These presentations introduce new methodologies for interpretability of calibrated parameters in inverse problems, multi-objective sequential design and stochastic simulation, with applications in hazard forecasting and epidemiology.

Organizer: Mengyang Gu
Johns Hopkins University, USA

Organizer: Elaine Spiller
Marquette University, USA

2:30-2:55 Multi-objective Sequential Design for Hazard Mapping

Elaine Spiller, Marquette University, USA

3:00-3:25 Practical Heteroskedastic Gaussian Process Regression

Robert Gramacy, Virginia Tech, USA; *Mickael Binois*, University of Chicago, USA

3:30-3:55 Bayesian Inversion of Volcano Monitoring Data using Physics-based Eruption Models

Kyle Anderson, U. S. Geological Survey, USA

4:00-4:25 An Improved Approach to Imperfect Computer Model Calibration and Prediction

Mengyang Gu, Johns Hopkins University, USA

Thursday, April 19

MS127

High Dimensional Integration in Light of Physics Applications

2:30 PM-4:30 PM

Room:Salon V - 2nd Floor

High dimensional integrals appear in many applications in physics. In high energy particle physics, gauge theories are at the heart of the models employed to describe elementary particle interactions. These gauge theories are evaluated by very high dimensional integrals over group elements from conjugacy classes. For standard computations using importance sampling Markov Chain Monte Carlo (MCMC) methods it requires state of the art supercomputers running for months or even years on a single problem. In this session we will discuss new high dimensional integration methods for quantum mechanical and gauge systems as well as other physics applications. To this end, we will focus on QMC methods that have the potential to substantially reduce the cost of the very demanding MCMC calculations and even allow for solutions where so far MCMC methods fail. In particular, we will explore quasi-Monte Carlo and related methods which are known to achieve algebraic rates $N^{-\alpha}$ for $\alpha > 1/2$, independently of dimension, at least when the integrands fall in the 'right' theoretical class.

Organizer: Karl Jansen
Deutsches Elektronen-Synchrotron, Germany

Organizer: Frances Y. Kuo
University of New South Wales, Australia

2:30-2:55 Quasi-Monte Carlo Sampling for the Schrödinger Equation

Dirk Nuyens, KU Leuven, Belgium

continued on next page

3:00-3:25 New Efficient High Dimensional Integration Rules for Quantum Field Theoretical Models

Karl Jansen, Deutsches Elektronen-Synchrotron, Germany

3:30-3:55 Recursive Numerical Integration for Lattice Systems with Low-order Couplings

Tobias Hartung, King's College London, United Kingdom

4:00-4:25 Applying Quasi-Monte Carlo to an Elliptic Eigenvalue Problem with Stochastic Coefficients

Alexander D. Gilbert, University of New South Wales, Australia; Ivan G. Graham, University of Bath, United Kingdom; Frances Y. Kuo, University of New South Wales, Australia; Robert Scheichl, University of Bath, United Kingdom; Ian H. Sloan, University of New South Wales, Australia

Thursday, April 19

MS128

Software for UQ - Part IV of IV

2:30 PM-4:30 PM

Room:Salon VI - 2nd Floor

For Part 3 see MS115

With the growing importance of UQ in various disciplines and fields, software solutions and libraries for UQ problems get more and more important. This raises interesting questions for the UQ community such as: What are the current properties of available tools? For which classes of problems have they been developed? What methods or algorithms do they provide? What are challenges for UQ software and which resources are required? What are recent improvements? What are the next steps and the long-term goals of the development? This minisymposium brings together experts for different software in the context of UQ, ranging from tools that ease up individual tasks of UQ up to whole frameworks for solving UQ problems.

Organizer: Tobias Neckel

Technische Universität München, Germany

Organizer: Dirk Pflüger

Technische Universität München, Germany

2:30-2:55 Chaospy: A Pythonic Approach to Polynomial Chaos Expansion

Jonathan Feinberg, Expert Analytics, Norway

3:00-3:25 Prediction and Reduction of Runtime in UQ Simulations on HPC Systems using Chaospy

Florian Künzner, Tobias Neckel, and Hans-Joachim Bungartz, Technische Universität München, Germany

3:30-3:55 UQTk - A Flexible Python/C++ Toolkit for Uncertainty Quantification

Bert J. Debusschere, Khachik Sargsyan, Cosmin Safta, and Kenny Chowdhary, Sandia National Laboratories, USA

4:00-4:25 A Standard for Algorithms of Numerical Experiments: Proposal, Implementation and Feedback

Yann Richet, Institut de Radioprotection et de Surete Nucleaire, France

Organizer and Speaker Index

SIAM Conference on
Uncertainty Quantification

April 16-19, 2018
Hyatt Regency–Orange County
Garden Grove, California, USA

Italicized names indicate session organizers

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Italicized names indicate session organizers

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Italicized names indicate session organizers

Notes

UQ18 Budget

Conference Budget
SIAM Conference on Uncertainty Quantification
April 16 - 19, 2018
Anaheim, CA

Expected Paid Attendance		600	
Revenue			
Registration Income			$217,860
	Total		$217,860
Expenses			
Printing			$4,000
Organizing Committee			$3,800
Invited Speakers			$11,300
Food and Beverage			$30,000
AV Equipment and Telecommunication			$26,000
Advertising			$4,900
Conference Labor (including benefits)			$52,992
Other (supplies, staff travel, freight, misc.)			$10,400
Administrative			$14,398
Accounting/Distribution & Shipping			$9,417
Information Systems			$15,930
Customer Service			$6,144
Marketing			$10,054
Office Space (Building)			$6,532
Other SIAM Services			$8,038
	Total		$213,905
Net Conference Income(Expense)			$3,955
Support Provided by SIAM			$0
			$3,955
Estimated Support for Travel Awards not included above:			
Early Career and Students		38	$30,600

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