SWAM
Prague, Czech Republic
November 17-19, 2022
Conference Booklet
# Schedule


**Thursday, 17th November**  
K1 lecture room, Campus Karlín

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Speaker</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:15–8:50</td>
<td>Registration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:50–9:00</td>
<td>Workshop opening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00–10:30</td>
<td>IT</td>
<td>Rolf Poulsen</td>
<td>Tools for Modern Computational Finance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copenhagen, Denmark</td>
<td></td>
</tr>
<tr>
<td>10:30–11:00</td>
<td>Coffee break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00–11:45</td>
<td>IT</td>
<td>Jens Saak</td>
<td>A Journey to Digital Twins of Machine Tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magdeburg, Germany</td>
<td></td>
</tr>
<tr>
<td>11:45–12:30</td>
<td>IT</td>
<td>Melina Freitag</td>
<td>From Models to Data and Back - An Introduction to Data Assimilation Algorithms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potsdam, Germany</td>
<td></td>
</tr>
<tr>
<td>12:30–13:45</td>
<td>Lunch break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:45–14:05</td>
<td>CT</td>
<td>Jonas Schulze</td>
<td>Diagonally Addressed Matrices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magdeburg, Germany</td>
<td></td>
</tr>
<tr>
<td>14:05–14:25</td>
<td>CT</td>
<td>Petr Vacek</td>
<td>Stopping Criteria for Coarsest-grid Solver in Multigrid V-cycle Method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prague, Czechia</td>
<td></td>
</tr>
<tr>
<td>14:25–14:45</td>
<td>CT</td>
<td>Mohamed Amine Hamadi</td>
<td>A Data-driven Krylov Model Order Reduction for Large-Scale Dynamical Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dunkirk, France</td>
<td></td>
</tr>
<tr>
<td>14:45–15:00</td>
<td>CT</td>
<td>Mariia Vlasiuk</td>
<td>On the Integral Equations Approach for Solving Nonlinear Inverse Elastostatics Problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lviv, Ukraine</td>
<td></td>
</tr>
<tr>
<td>15:00–15:15</td>
<td>SI</td>
<td>Student Introduction</td>
<td>Students will introduce themselves in at most 4 minutes each.</td>
</tr>
<tr>
<td>15:15–15:45</td>
<td>Coffee break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:45–17:15</td>
<td>SI</td>
<td>Student Introduction</td>
<td>Students will introduce themselves in at most 4 minutes each.</td>
</tr>
<tr>
<td>19:00</td>
<td>Conference dinner</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Friday, 18th November
S3 lecture room, Malá Strana Campus

<table>
<thead>
<tr>
<th>Time</th>
<th>Room</th>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00–9:45</td>
<td>IT</td>
<td>Roman Neruda</td>
<td>Adversarial Examples: How Safe are Machine Learning Models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cristóbal Bertoglio</td>
<td>Inverse Problems in Blood Flow Modeling</td>
</tr>
<tr>
<td>10:30–11:00</td>
<td></td>
<td></td>
<td>Coffee break</td>
</tr>
<tr>
<td>11:00–11:45</td>
<td>IT</td>
<td>Jan Papež</td>
<td>Can a Computed Result be Relied on?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Martin Stoll</td>
<td>From PDEs to Data Science: An Adventure with the Graph Laplacian</td>
</tr>
<tr>
<td>12:30–13:45</td>
<td></td>
<td></td>
<td>Lunch break</td>
</tr>
<tr>
<td>13:45–15:15</td>
<td>IT</td>
<td>Jakob Zech</td>
<td>Large Scale Bayesian Inversion: Sparse-Grid and Transport Methods</td>
</tr>
<tr>
<td>15:15–15:45</td>
<td></td>
<td></td>
<td>Coffee break</td>
</tr>
<tr>
<td>15:45–16:30</td>
<td>IT</td>
<td>Petr Minařík</td>
<td>Realtime Interactive Volumetric Water Simulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oldřich Semerák</td>
<td>On the Marmoreally Beautiful and yet Unlovely Sides of Einstein Equations</td>
</tr>
<tr>
<td>17:30</td>
<td></td>
<td></td>
<td>City tour</td>
</tr>
</tbody>
</table>

**Saturday, 19th November**
K1 lecture room, Campus Karlín

<table>
<thead>
<tr>
<th>Time</th>
<th>Room</th>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00–10:30</td>
<td>IT</td>
<td>Friedemann Kemm</td>
<td>How to Prepare a Scientific Presentation</td>
</tr>
<tr>
<td>10:30–11:00</td>
<td></td>
<td></td>
<td>Coffee break</td>
</tr>
<tr>
<td>11:00–11:20</td>
<td>CT</td>
<td>Azza Gaysin</td>
<td>Proof Complexity of CSP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Josephine Westermann</td>
<td>Transport Based Sampling</td>
</tr>
<tr>
<td>11:40–12:00</td>
<td>CT</td>
<td>Liya Gaynutdinova</td>
<td>Micromechanical Parameter Identification Using Bayes Method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muhammad Sami Siddiqui</td>
<td>Euler Elastica Model &amp; Its Treatment</td>
</tr>
<tr>
<td>12:20–12:40</td>
<td>CT</td>
<td>Panasun Manorost</td>
<td>Surface/Subsurface Flow Simulation</td>
</tr>
<tr>
<td>12:40–13:00</td>
<td></td>
<td></td>
<td>Closing remarks</td>
</tr>
</tbody>
</table>
Contents

Schedule ................................................................. 2
  Thursday, 17th November ............................................ 2
  Friday, 18th November ................................................. 3
  Saturday, 19th November ............................................. 3

Presentation ...................................................................... 5
  Organizing Committee .................................................... 5

Abstracts of Invited Talks .................................................. 6
  Rolf Poulsen ................................................................. 6
  Jens Saak ........................................................................ 7
  Melina Freitag .................................................................. 7
  Roman Neruda ............................................................... 7
  Cristóbal Bertoglio ......................................................... 8
  Jan Papež ........................................................................ 8
  Martin Stoll ....................................................................... 9
  Jakob Zech ...................................................................... 9
  Friedemann Kemm .......................................................... 9
  Petr Minařík ................................................................... 10
  Oldřich Semerák ............................................................ 10

Abstracts of Contributed Talks ............................................. 11
  Jonas Schulze ................................................................. 11
  Petr Vacek ......................................................................... 12
  Mohamed Amine Hamadi ............................................... 13
  Mariia Vlasiuk .................................................................. 14
  Azza Gaysin ................................................................. 15
  Josephine Westermann .................................................. 16
  Liya Gaynudinova ........................................................... 17
  Sami Siddiqi ................................................................. 18
  Panasun Manorost ........................................................ 19

Conference venue ................................................................ 20

Participant List ................................................................. 22
The Student Workshop on Applied Mathematics (SWAM) is organized by SIAM Student Chapters Prague and Heidelberg, and the University of Copenhagen Association of Ph.D. Students. The workshop is primarily funded by the 4EU+ Alliance. Support from Charles University, Heidelberg University, and the University of Copenhagen is also acknowledged.

The purpose of this workshop is to bring graduate students studying applied mathematics in natural sciences, engineering, and mathematics together and create an environment to share ideas from different perspectives and to enable easier communication with researchers for possible interdisciplinary international collaboration.

Organizing Committee

Jana Brunátová
Charles University, Czechia

Eda Oktay
Charles University, Czechia

Purushart Saxena
Heidelberg University, Germany

Martin Šýkora
Charles University, Czechia

Tomislav Rožić
University of Copenhagen, Denmark
Abstracts of Invited Talks

Tools for Modern Computational Finance

Rolf Poulsen$^1$

$^1$ University of Copenhagen, Copenhagen, Denmark

Under very general conditions – but for surprisingly subtle reasons – a key part finding a sensible price for any financial contract is the calculation of expected values. After briefly reviewing the arbitrage-free pricing of a call option in the Black-Scholes model, I describe some tools used in modern computational finance. More specifically, but deliberately teasingly, this will involve some of the following concepts and names:

1. Scripting languages and smart contracts
2. Fourier inversion and the return of complex analysis
3. Sobol, Longstaff-Schwartz, Craig-Sneyd
4. Automatic adjoint differentiation
5. Differential machine learning

References

[1] Antoine Savine et al. (2019-23), Modern Computational Finance, volumes 1-3, Wiley
A Journey to Digital Twins of Machine Tools

Jens Saak

Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany

Industry 4.0 requires the design and control of complex models, which generally need to be fitted to measurement data and made suitable for real-time control applications; e.g., digital twins and digital shadows serve as computer-based representations of machines and processes during the entire product cycle. In this talk, we will evaluate strategies for modeling and model order reduction of machine tools, i.e. machines that are used to build (parts of) machines. Thermo-mechanical models for the machine tools feature a couple of challenges for both modeling and order reduction techniques:

1. To limit the effort, usually stationary elasticity is coupled with transient heat equations, rendering the full model a differential algebraic equation.

2. While the heat distribution and elastic deformation can be modeled by linear partial differential equations, some components like bearings and guide shoes feature nonlinearities that are crucial for correct representation of the machine behavior.

3. Modern machine tools feature up to 6 axes along which parts can be moved for optimal placement of the tool relative to the work-piece. On each of these axes, two parts of the machine are moving relative to each other making the entire model time-varying.

Over the recent decade, we have worked out methods to address all these challenges and created an automated workflow for practitioners using both proprietary and open-source tools to create and use the desired digital representation for each task.

From Models to Data and Back - An Introduction to Data Assimilation Algorithms

Melina Freitag

University of Potsdam, Potsdam, Germany

Data assimilation is a method that combines observations (e.g. real world data) of a state of a system with model output for that system in order to improve the estimate of the state of the system. The model is usually represented by discretised time dependent partial differential equations. The data assimilation problem can be formulated as a large scale Bayesian inverse problem. Based on this interpretation we derive the most important variational and sequential data assimilation approaches, in particular three-dimensional and four-dimensional variational data assimilation (3D-Var and 4D-Var), and the Kalman filter. The final part reviews advances and challenges for data assimilation.

Adversarial Examples: How Safe are Machine Learning Models

Roman Neruda

Czech Academy of Sciences, Prague, Czechia

Adversarial examples are special inputs to machine learning models intentionally designed to cause the model to make a mistake. They represent an important issue concerning security and generalisation capabilities of models deployed in practical applications. In the talk we will present several approaches of adversarial attacks for image classifiers, and sketch possible defense strategies.
Inverse Problems in Blood Flow Modeling

Cristóbal Bertoglio

1University of Groningen, Groningen, Netherlands

Mathematical and computational modeling of the cardiovascular system is increasingly providing non-invasive alternatives to traditional invasive clinical procedures. Moreover, it has the potential for generating additional diagnostic markers. In blood flow computations, the personalization of spatially distributed models is a key step which relies on the formulation and numerical solution of inverse problems using clinical data. In the last years, the development and application of inverse methods has rapidly expanded, see [1], most likely due to the increased availability of data in clinical centers and the growing interest of modelers and clinicians in collaborating. In this talk I will present some of the inverse problems in blood flows formulated in our group, in particular from data coming from Magnetic Resonance Imaging and including fluid-structure interaction models.

References


Can a Computed Result Be Relied On?

Jan Papež

1Czech Academy of Sciences, Prague, Czechia

Real-world applications often give rise to complex and challenging problems that can only be solved numerically. In order to reduce the complexity of the problem and allow us to get an approximation within the given time using available computational resources, one has to consider some simplifications, which typically introduce various errors. We should then ask how accurate is the computed approximation and whether it can be used for the original application. This can be answered by so-called a posteriori error estimates that are based on the properties of the problem to be solved and evaluated from the computed approximation. In the talk, we will present some error estimates for numerical solution of partial differential equations.
From PDEs to Data Science: An Adventure with the Graph Laplacian

Martin Stoll

Chemnitz University of Technology, Chemnitz, Germany

In this talk we briefly review some basic PDE models that are used to model phase separation in materials science. They have since become important tools in image processing and over the last years semi-supervised learning strategies could be implemented with these PDEs at the core. The main ingredient is the graph Laplacian that stems from a graph representation of the data. This matrix is large and typically dense. We illustrate some of its crucial features and show how to efficiently work with the graph Laplacian. In particular, we need some of its eigenvectors and for this the Lanczos process needs to be implemented efficiently. Here, we suggest the use of the NFFT method for evaluating the matrix vector products without even fully constructing the matrix. We illustrate the performance on several examples.

Large Scale Bayesian Inversion: Sparse-Grid and Transport Methods

Jakob Zech

Heidelberg University, Heidelberg, Germany

Bayesian inference provides a rigorous framework to learn unknown parameters from noisy data. As such it has become a ubiquitous tool in modern machine learning and applied mathematics. From a practical perspective, it requires the approximation of high-dimensional integrals. Common approaches to do so include (i) sampling methods and (ii) specifically devised deterministic quadrature rules. In this talk I will discuss transport based sampling and sparse-grid quadrature as two instances of such algorithms. Additional to explaining how they can be used to perform parameter inference, I will give some insight into why these methods can deal with high dimensionality for certain PDE driven inverse problems.

How to Prepare a Scientific Presentation

Friedemann Kemm

Brandenburg University of Technology, Cottbus-Senftenberg, Germany

This will be a talk about talks. Giving a presentation in mathematics or science in general shares some issues with presenting science in written form and with giving a public speech in general. Especially the latter is often forgotten when it comes to presenting on a conference in science and mathematics. We will discuss some general strategies how to convey a message in a public talk and some techniques in preparing slides for a presentation that will be helpful in this context.
Real-time Interactive Volumetric Water Simulation

Petr Minařík¹, Ondřej Hroch¹
¹Keen Software House, Prague, Czechia

Water, water everywhere. This talk will focus on illustrating a modern approach to water simulation in video games. This novel solution provides realistic simulation, during real time play, and as a mechanic of play. We will share working examples of our solution, see ¹, including an algorithm that illustrates our core concepts.

Figure 1: Lakes and waterfalls.

On the Marmoreally Beautiful and yet Unlovely Sides of Einstein Equations

Oldřich Semerák¹
¹Charles University, Prague, Czechia

On January 24, 1938, Albert Einstein wrote to Cornelius Lanczos: “I began with a skeptical empiricism more or less like that of Mach. But the problem of gravitation converted me into a believing rationalist, that is, into someone who searches for the only reliable source of Truth in mathematical simplicity.” Mathematics (Riemann-type geometry) played a fundamental role in Einstein’s quest for the new theory of gravitation. We will shortly recall when and how geometry entered the game, why the left-hand (“geometrical”) side of the Einstein equations is so elegant, and why their right-hand (“physical”) side likely has to remain unlovely.
The use of mixed-precision arithmetic showed some sizeable performance improvements for dense linear algebra. Meanwhile, for sparse linear algebra due to memory bandwidth limitations the improvements are much smaller [1]. We suggest a storage scheme for sparse matrices that reduces the memory footprint at no loss of information. This has direct benefits for both classical (one-precision) and mixed-precision algorithms.

Many problems arising in e.g. 2D and 3D FEM simulations only show local coupling between the solution components, i.e. the corresponding matrices have a very low bandwidth \( w \in \mathbb{N} \) (distance from the diagonal) under certain permutations. This suggests to store the indices of the entries in a sparse matrix not absolute but relative to the matrix diagonal, which allows to use a much smaller (integer) data type with a range of \([-w, w]\) instead of \([0, n]\), where \( n \in \mathbb{N} \) denotes the matrix dimensions, \( w \ll n \). Figure 2 shows how to apply this technique to the Compressed Sparse Row (CSR) format, leading to the Diagonally Addressed CSR (DA-CSR) format.

![Figure 2: Storage layout of CSR and DA-CSR. Dots represent values, bars represent the (inner) indices.](image)

We investigate the benefits of this new storage scheme by means of the matrix vector product (SpMV), which is a basic building block of many iterative algorithms. Based on the positive definite subset of the Suite Sparse Matrix Collection [2], we observe a (up to) more than 15% performance uplift of DA-CSR having 16 bit inner indices compared to CSR having all 32 bit indices using IEEE double precision values. Current work focuses on measuring the uplift of DA-CSR for SpMV going from double to single precision values.

References


Stopping Criteria for Coarsest-grid Solver in Multigrid V-cycle Method

Petr Vacek*1, Erin C. Carson1, Kirk M. Soodhalter2

1Charles University, Prague, Czechia
2Trinity College, Dublin, Ireland

Multigrid methods are frequently used when solving systems of linear equations, applied either as standalone solvers or as preconditioners for iterative methods. Within each cycle, the approximation is computed using smoothing on fine levels and solving on the coarsest level.

With growth of the size of the problems that are being solved, the size of the problems on the coarsest grid is also growing and their solution can become a computational bottleneck. In practice the problems on the coarsest-grid are often solved approximately, for example by Krylov subspace methods or direct methods based on low rank approximation; see, e.g., [1; 2]. The accuracy of the coarsest-grid solver is typically determined experimentally in order to balance the cost of the solves and the total number of multigrid cycles required for convergence.

In this talk, we present an approach to analyzing the effect of approximate coarsest-grid solves in the multigrid V-cycle method for symmetric positive definite problems. We discuss several stopping criteria derived based on the analysis and suggest a strategy for utilizing them in practice. The results are illustrated through numerical experiments.

References


A Data-driven Krylov Model Order Reduction for Large-Scale Dynamical Systems

Mohamed A. Hamadi*,1,2, Khalide Jbilou1,2, Ahmed Ratnani2

1Université du Littoral Côte d’Opale, Calais, France
2Université Mohammed VI polytechnique, Ben Guerir, Morocco

Some of the challenges encountered in learning dynamical systems, is the non-linearity of dynamics or in some cases, the lack of the governing physics or system’s equations of motions. However, some numerically or experimentally measured data can be found. Based on this data, and using a data-driven method such as the Loewner framework, it is possible to manage this data to derive a high fidelity reduced dynamical system that mimics the behavior of the original data. In this paper, we tackle the issue of large amount of data presented by samples of transfer functions in a frequency-domain. The main step in this framework consists on computing singular value decomposition (SVD) of the Loewner matrix which provides accurate reduced systems. However, the large amount of data prevents this decomposition from being computed properly. We exploit the fact that the Loewner and shifted Loewner matrices, the key tools of Loewner framework, satisfy certain large scale Sylvester matrix equations. Using an extended block Krylov subspace method, a good approximation in a factored form of the Loewner and shifted Loewner matrices can be obtained, also, a minimal computation cost of the SVD is ensured. This method facilitates the process of a large amount of data and guarantee a good quality of the inferred model at the end of the process. Accuracy and efficiency of our method are assessed in the final section.

References


Elastostatics describes the processes of linear elasticity. We assume that $D$ is a doubly connected bounded domain in $\mathbb{R}^2$ with the boundary $\partial D$ consisting of two disjoint closed $C^2$ curves $\Gamma_1$ and $\Gamma_2$ such that $\Gamma_1$ is contained in the interior of $\Gamma_2$. The direct elastostatics problem is: Given a vector function $f$ on $\Gamma_2$ consider the Dirichlet problem for a vector function $u \in C^2(D) \cap C(D)$ satisfying the Navier equation and the boundary conditions

$$ \mu \Delta u + (\lambda + \mu) \text{grad} \text{div} u = 0 \quad \text{in } D, $$

$$ u = 0 \quad \text{on } \Gamma_1, \quad u = f \quad \text{on } \Gamma_2, $$

where $\mu$ and $\lambda$ ($\mu > 0$, $\lambda > -\mu$) are given Lamé coefficients.

The inverse problem is: Given the Dirichlet data $f$ on $\Gamma_2$ with $f \neq 0$ and the Neumann data

$$ Tu = g \quad \text{on } \Gamma_2, $$

determine the shape of the interior boundary $\Gamma_1$. Here $Tu = \lambda \text{div} u \nu + 2\mu (\nu \cdot \text{grad})u + \mu \text{div}(Qu)Q\nu$, where $\nu$ is an outward unit normal vector to the boundary, and $Q$ is a rotational matrix. As opposed to the direct boundary value problem, the inverse problem is nonlinear and ill-posed. It can be shown, that the problem has at most one solution. In order to reduce problem to the system of nonlinear integral equations, we define functional $G(U) = \int_{\Gamma_2} (Tu f - Ug) \, ds$, where $f$ and $g$ are given data from (2) and (3) respectively, $U \in H^1(D)$ is a vector function that satisfies the Navier equation (1).

It can be shown that inverse boundary value problem is equivalent to the system of nonlinear integral equations. A similar approach of reducing the problem to a system of nonlinear equations is also highlighted in [1], [2]. In order to linearize system, it is essential to calculate the Fréchet derivatives of the nonlinear operators and the elastic potential with respect to the some radial function $r$. For solving linear system, iteration scheme is applied. Note that the system is linear, however it still remains incorrect due to the incorrectness of the initial problem. To obtain a stable numerical solution, the Tikhonov regularization can be applied at each iteration.

We apply quadrature method to partially discretize system of integral equations. For full discretization, we collocate the obtained relations in nodes of quadrature formulas. As a result, we get an overdetermined system of linear equations. To handle this, least squares approach can be used. For the case of a discrete problem, the method of least squares gives us a regularized system of linear equations.

The method is effective for both accurate and noisy input data. The main advantage of the proposed approach is that it is enough to measure certain data on the outside, in order to accurately reproduce the internal state of the environment.

References


Proof Complexity of CSP

Azza Gaysin

1Charles University, Prague, Czechia

A wide range of well-known combinatorial problems, such as SAT, 3-coloring, graph homomorphism, and many others can be formulated in terms of Constraint Satisfaction Problem (CSP): a problem of finding an assignment of values to a set of variables, such that this assignment satisfies some specified feasibility conditions. If such an assignment exists, we call the instance satisfiable and unsatisfiable otherwise. Equivalently, CSP can be defined as a homomorphism problem between relational structures over the same vocabulary. CSP dichotomy theorem says that this class contains either NP-complete or P-time problems [1; 2].

For unsatisfiable instances of CSP, the statement that there is no homomorphism from an input structure to a target one can be expressed as a propositional tautology. Tautology is the central concept of propositional proof complexity, an area in mathematics connecting computational complexity theory and mathematical logic. The main question of proof complexity is whether NP (corresponding to SAT) is equal to coNP (corresponding to TAUT). If there is no polynomially bounded propositional proof system, then the answer is negative. The negative answer would imply that P is not equal to NP. Besides this primary goal, proof complexity embraces many other applied problems (such as SAT solvers, optimization algorithms, etc.).

We investigate the proof complexity of polynomial time CSPs. We try to prove the soundness of Zhuk’s algorithm [1] solving polynomial time CSP in the theory of bounded arithmetic (with induction axiom scheme restricted to the class of bounded formulas), namely in theory $V^1$. If we succeed, it will imply that a class of natural tautologies is not hard for Extended Resolution proof system.

References


Transport Based Sampling Using Polynomial Density Surrogates

Josephine Westermann\textsuperscript{1}, Jakob Zech\textsuperscript{1}

\textsuperscript{1}University of Heidelberg, Heidelberg, Germany

Generating samples from arbitrary probability distributions is an integral task in various areas of modern applied mathematics such as parameter inference and uncertainty quantification. In this talk, we describe a sampling algorithm based on the Knothe-Rosenblatt transport, that can be used to approximately sample from target distributions on the $d$-dimensional unit cube $[0, 1]^d$ under mild assumptions on the target density. The method is based on the use of polynomial density surrogates, which allows to explicitly and analytically construct the corresponding transport. We discuss efficient implementation schemes and derive error convergence rates for target densities belonging to different smoothness classes.
Micromechanical parameters are required for constitutive laws that help to predict complex physical processes in materials, such as strain localisation, plasticity, delamination, and cracks. The considered problem is identification of micromechanical parameters in a fibre-reinforced plane strain composite, where the Digital Image Correlation (DIC) method is used as a full-field measurement technique [3; 4]. The existing deterministic approach to parameter identification in the form of Integrated DIC (IDIC) was shown to be overly sensitive to boundary data errors[2]. In this work, the stochastic approach is proposed, which employs a Markov Chain Monte Carlo sampling method, i.e. the Metropolis-Hastings algorithm (MHA). The identified parameters fall into two distinct groups: material and boundary condition parameters. First, the MHA that only identifies the material parameters with fixed boundary conditions is considered, and its sensitivity with respect to random and systematic errors in the boundary conditions is quantified and compared to the IDIC. MHA's parameter field is then expanded with two different ways of approximating the boundary conditions, and the method is compared to the Boundary Enriched IDIC [1]. All methods are tested with a virtual experiment that employs a Neo-Hookean hyperelastic micromechanical model, discretised with the finite element method. The benefits and pitfalls of all studied algorithms are discussed.

References


Euler Elastic Model & Its Treatment

Sami Siddiqui

Institute of Business Administration, Karachi, Pakistan

Elastic body deformation at different loading conditions has various applications in engineering, soft structures, and soft robotics. It also serves medical purposes, such as comprehending the forms of vesicles and cell membranes and their deformation behavior.

In this talk, we will consider the Euler elastica ring model subjected to uniform external force \( p \) under various loading conditions [1].

![Elastic ring deforms under two sided symmetric uniform external force \( p \)](image)

We will see the solution of the curvature-based nonlinear differential equation (Euler elastic equation) through different approximation methods [2] and compare the results with the Elliptic solution [3]. Furthermore, we will also discuss the stability diagram of the elastic ring using harmonic balance formulation.

References


In this work, we propose the circumcenter based finite volume method for the surface/subsurface flow model describing the dynamics of groundwater flow and overland flow model together with their interactions. The brief explanation of the model will be presented. We can prove that the scheme always provides a non-negative solution. Moreover, the numerical algorithm can be applied to the unstructured mesh. For the numerical result, we will show the simulation on a non-uniform unstructured grid with adaptive mesh refinement. Eventually, we will indicate the future work. The numerical implementation is powered by Distributed and Unified Numerics Environment (DUNE), the software framework for high-performance PDE solver.
LECTURES ON THURSDAY AND SATURDAY WILL BE HELD AT CAMPUS KARLIN (ROOM K1, SECOND FLOOR), ON FRIDAY, AT MALA STRANA CAMPUS (ROOM S3, THIRD FLOOR)

Malá Strana Campus: Malostranské nám. 2/25, 118 00 Praha 1.

Campus Karlín: Sokolovská 49/83, 186 00 Praha 8-Karlín.

Student Meet-up on Wednesday at 7 p.m.: Campus Karlín MFF UK, Faculty of Mathematics and Physics, Room K1 (second floor), Sokolovská 49/83, 186 00 Praha 8-Karlín.

Registration: Campus Karlín MFF UK, Faculty of Mathematics and Physics, Room K1 (second floor), Sokolovská 49/83, 186 00 Praha 8-Karlín.

Conference Dinner on Thursday at 7 p.m.: Tankovna Karlín, Sokolovská 100, 186 00 Praha 8-Karlín. (Right down the street from the conference venue.)

Figure 4: Route from Campus Karlin to Tankovna Karlin.
Figure 5: Route from Florenc to Malostranské náměstí by bus no. 194.
Participant List

YOUSSFI AHMED
University Sidi Mohamed Ben Abdellah-Fez

SHARANYAACHUT
University of Göttingen

CRISTÓBAL BERTOGLIO
University of Groningen

JANA BRUNÁTOVÁ
Charles University

JAKUB CACH
Charles University

KAUSTAV DAS
Luxembourg Institute of Science and Technology ¦ CTU Prague

MELINA FREITAG
University of Potsdam

GUILLERMO GAMBOA
Charles University

LIYA GAYNUTDINNOVA
Czech Technical University

AZZA GAYSIN
Charles University

ISABEL GERNAND
University of Heidelberg

MUHAMMAD BILAL HAFEEZ
Gdansk University of Technology

MOHAMED AMINE HAMADI
University of Littoral Côte d’Opale

MARTIN HOSTAČNÝ
Charles University

ONDŘEJ HROCH
Keen Software House

QIAOWEN HU
University of Heidelberg

YAN CHENG
University of Copenhagen

MAX KAHL
University of Heidelberg

FRIEDEMANN KEMM
BTU Cottbus-Senftenberg

NOAMAN KHAN
Charles University

GAURAV KUCHERIYA
Charles University

MARTIN LADECKÝ
Czech Technical University

FAISAL MAHMOOD
Charles University

PANASUN MANOROST
University of Heidelberg

MAREN RAUS
University of Heidelberg

PETR MINARÍK
Keen Software House

STANISLAV MOSNÝ
Charles University

ROMAN NERUDA
Czech Academy of Sciences

EDA OKTAY
Charles University

JAN PAPEZ
Czech Academy of Sciences

PENG GAO
University of Heidelberg

ROMAN PIROGOV
Czech Technical University

ROLF POUlsen
University of Copenhagen

TOMISLAV ROŽIĆ
University of Copenhagen

JUDITA RUNCZIKOVÁ
Czech Technical University

DANIELA RUNCZIKOVÁ
Czech Technical University

JENS SAAK
Max Planck Institute

MUHAMMAD SAQIB
Gdansk University of Technology

PURUSHARTH SAXENA
University of Heidelberg

OLDŘICH SEMERÁK
Charles University

ALLAHKARAM SHAFIEI
Czech Technical University

HYUNGEUN SHIN
Charles University

JONAS SCHULZE
MPI DCTS
MUHAMMAD SAMI SIDDQUI
Institute of Business Administration, Karachi

MATVEI SLAVENKO
Charles University

MARTIN STOLL
Chemnitz University of Technology

MARTIN SÝKORA
Charles University

PETR VACEK
Charles University

MARTIN VEJVODA
Charles University

MARIIA VLASIUK
Ivan Franko National University of Lviv

JOSEPHINE WESTERMANN
University of Heidelberg

CONGCONG XU
University of Heidelberg

SHAZMA ZAHID
Charles University

JAKOB ZECH
University of Heidelberg

ZIXIANG ZHOU
University of Heidelberg