“智能计算与应用”同济大学数学中心

Mathematical Center of Intelligent Computing and Application

# 数学及其交叉科学研讨会

# 会议手册

同济大学数学科学学院

“智能计算与应用”同济大学数学中心

2020年11月14-15日

| | |
|---|---|
| 会议地点 | 上海市杨浦区四平路 1239 号<br>同济大学数学科学学院致远楼 108 报告厅 |
| 会议时间 | 2020 年 11 月 13-15 日 |
| 组织委员会 | 许学军 xuxj@tongji.edu.cn<br>姜立建 ljjiang@tongji.edu.cn<br>殷俊锋 yinjf@tongji.edu.cn<br>吴 昊 hwu@tongji.edu.cn<br>崔宰珪 jaycjk@tongji.edu.cn<br>关晓飞 guanxfat@tongji.edu.cn |
| 联系人 | 吴 昊 13641792109<br>马钰超 18717816786 |

# 会议日程

| 11 月 14 日<br>星期六 | 数学科学学院致远楼 108 室 |
|---|---|
| **08:30－09:00** | **开幕式 嘉宾致辞 合影** |
| | 主持人：**吴昊** |
| **09:00－09:30** | 主讲人：**王增琦** 上海交通大学<br>报告题目：Restrictively Preconditioned Conjugate Gradient Method for a Series of Constantly Augmented Least Squares Problems |
| **09:30－10:00** | 主讲人：**李博峰** 同济大学<br>报告题目：数学大地测量的若干热点问题 |
| **10:00－10:30** | 主讲人：**邱越** 上海科技大学<br>报告题目：Preconditioning Navier-Stokes Control Using Multilevel Sequentially Semiseparable Matrix Computations |
| 茶　　歇 | 致远楼 103 室 |
| | **主持人：殷俊锋** |
| **10:50－11:20** | 主讲人：**秦环龙** 同济大学附属第十人民医院<br>报告题目：待定 |
| **11:20－11:50** | 主讲人：**王雪松** 同济大学<br>报告题目：道路交通安全统计分析与建模国际对比研究 |
| **11:50－12:20** | 主讲人：**刘琦** 同济大学<br>报告题目：AI-Based Biomedical Omics Data Analysis |
| 午　　餐 | 三好坞餐厅 |

| 11 月 14 日<br>星期六 | 数学科学学院致远楼 108 室 |
|---|---|
| | **主持人：关晓飞** |
| **13:30－14:00** | 主讲人：**白正简** 厦门大学<br>报告题目：Riemannian Newton-CG Methods for Constructing a Positive Doubly Stochastic Matrix from Spectral Data |
| **14:00－14:30** | 主讲人：**何志坚** 华南理工大学<br>报告题目：Sensitivity Estimation of Conditional Value at Risk Using Randomized Quasi-Monte Carlo |
| **14:30－15:00** | 主讲人：**任晓丹** 同济大学<br>报告题目：**非线性结构系统求解的两尺度一致割线算法** |
| **15:00－15:30** | 主讲人：**李义宝** 西安交通大学<br>报告题目：An Efficient Multiscale Topology Optimization Method for Lattice Materials |
| **茶　　歇** | 致远楼 103 室 |
| | **主持人：李博峰** |
| **15:50－16:20** | 主讲人：**李铁香** 东南大学<br>报告题目：Fast Algorithms for Maxwell's Equations for Three-Dimensional Photonic Crystals |
| **16:20－16:50** | 主讲人：**竺立哲** 香港中文大学（深圳）<br>报告题目：Enhancing Molecular Dynamics Simulations of Bio-macromolecules: towards a Fully Automated Algorithmic Framework |
| **16:50－17:20** | 主讲人：**赵程辰** 同济大学<br>报告题目：A DNA Methylation State Transition Model Reveals the Programmed Epigenetic Heterogeneity in Human Pre-implantation Embryos |
| **晚　　餐** | 同济君禧大酒店 |

| 11 月 15 日<br>星期日 | 数学科学学院致远楼 108 室 |
| --- | --- |
| | 主持人：**许学军** |
| **08:30－09:00** | 主讲人：**陈建兵** 同济大学<br>报告题目：随机动力系统的整体灵敏度 |
| **09:00－09:30** | 主讲人：**闫亮** 东南大学<br>报告题目：Stein Variational Gradient Descent with Local Approximations |
| **09:30－10:00** | 主讲人：**黄朝琴** 中国石油大学（华东）<br>报告题目：深层油气藏多场耦合数值模拟和机器学习应用 |
| **10:00－10:30** | 主讲人：**高华东** 华中科技大学<br>报告题目：超导模型中金兹堡-朗道方程的高效数值算法 |
| **茶　　歇** | 致远楼 103 室 |
| | 主持人：**陈建兵** |
| **10:50－11:20** | 主讲人：**许志钦** 上海交通大学<br>报告题目：Implicit Bias of Deep Learning and MscaleDNN for Solving PDEs |
| **11:20－11:50** | 主讲人：**林聪萍** 华中科技大学<br>报告题目：Structure and Dynamics of Endoplasmic Reticulum Networks in a Plant Cell |
| **11:50－12:20** | 主讲人：**张一威** 华中科技大学<br>报告题目：Understanding Physical Mixing Processes via Transfer Operator Approach |
| **午　　餐** | 三好坞餐厅 |

| 11 月 15 日<br>星期日 | 数学科学学院致远楼 108 室 |
|---|---|
| | 主持人：**王胤** |
| **13:30－14:00** | 主讲人：**郑龙坡** 同济大学附属第十人民医院<br>报告题目：待定 |
| **14:00－14:30** | 主讲人：**郭玲** 上海师范大学<br>报告题目：Deep Learning for Uncertainty Quantification: Solving Forward and Inverse Stochastic Problems via Physics-Informed Neural Networks |
| **14:30－15:00** | 主讲人：**王涵** 北京应用物理和计算数学研究所<br>报告题目：DeePKS: A Comprehensive Data-Driven Approach towards Chemically Accurate Density Functional Theory |
| **15:00－15:30** | 主讲人：**魏泽勇** 同济大学<br>报告题目：电大尺寸电磁场计算与应用 |
| **茶　　歇** | 致远楼 103 室 |
| | 主持人：**崔宰珪** |
| **15:50－16:20** | 主讲人：**周涛** 中国科学院数学与系统科学研究院<br>报告题目：Adaptive Multi-Fidelity Surrogate Modeling for Bayesian Inference in Inverse Problems |
| **16:20－16:50** | 主讲人：**王胤** 同济大学<br>报告题目：基于深度学习的计算机视觉---从理论到实践 |
| **16:50－17:20** | 主讲人：**李昭祥** 上海师范大学<br>报告题目：A New Augmented Singular Transform and Its Partial Newton-Correction Method for Finding More Solutions to Nonvariational Quasilinear Elliptic PDEs |

登录网址可查看最新会议日程及其它信息:

https://math.tongji.edu.cn/b8/43/c14975a178243/page.htm

# 报告摘要

## Restrictively Preconditioned Conjugate Gradient Method for a Series of Constantly Augmented Least Squares Problems

**王增琦**

上海交通大学

摘要：In this study, we analyze the real-time solution of a series of augmented least squares problems, which are generated by adding information to an original least squares model repetitively. Instead of solving the least squares problems directly, we transform them into a batch of saddle point linear systems and subsequently solve the linear systems using restrictively preconditioned conjugate gradient (RPCG) methods. Approximation of the new Schur complement is generated effectively based on a previously approximated Schur complement. Owing to the variations of the preconditioned conjugate gradient method, the proposed methods generate convergence results similar to the conjugate gradient method and achieve a very fast convergent iterative sequence when the coefficient matrix is well preconditioned. Numerical tests show that the new methods are more effective than some standard Krylov subspace methods. Updated RPCG methods meet the requirement of real-time computing successfully for multifactor models.

# 数学大地测量的若干热点问题

**李博峰**

同济大学

**摘要**：当代大地测量的观测手段发生了空前的变革，主要特征包括从地面到空间、从单传感器到多源传感器融合、从事后到实时应用，相应地对测量数据处理理论和方法也带来了巨大挑战。报告从卫星定位基本原理和应用场景出发，阐述当前高精度定位的应用前景和市场空间；然后从定位应用热点需求凝练核心数学模型，包括混合整数模型和多传感器融合等，通过报告当前测绘学科处理这些数学模型方法的同时，详细阐述待解决的关键数学理论问题及其难点。

# Preconditioning Navier-Stokes Control Using Multilevel Sequentially Semiseparable Matrix Computations

**邱越**

上海科技大学

摘要：In this talk, we study preconditioning techniques for the control of the Navier-Stokes equation, where the control only acts on a few parts of the domain. Optimization, discretization, and linearization of the control problem results in a generalized linear saddle-point system. The Schur complement for the generalized saddle-point system is very difficult or even impossible to approximate, which prohibits satisfactory performance of the standard block preconditioners. We apply the multilevel sequentially semiseparable (MSSS) preconditioner to the underlying system. Compared with standard block preconditioning techniques, the MSSS preconditioner computes an approximate factorization of the global generalized saddle-point matrix up to a prescribed accuracy in linear computational complexity. This in turn gives parameter independent convergence for MSSS preconditioned Krylov solvers. We use a simplified wind farm control example to illustrate the performance of the MSSS preconditioner. We also compare the performance of the MSSS preconditioner with the performance of the state-of-the-art preconditioning techniques. Our results show the superiority of the MSSS preconditioning techniques to standard block preconditioning techniques for the control of the Navier-Stokes equation.

# 道路交通安全统计分析与建模国际对比研究

**王雪松**

同济大学

**摘要**：道路交通安全是全球共同关注的重点；现阶段我国安全水平与欧美存较大差距、道路交通事故频发。国务院发布的“交通强国”战略均对改善我国交通安全提出明确要求。欧美国家聚焦事故基础数据、分析理论、工程应用，安全改善取得了极大的成效。我国近年来在安全领域发展迅速，但存在数据不全面、理论不深入、应用不系统等问题。开展道路交通安全统计分析与建模国际对比研究，旨在建立国际数据平台和长期合作机制，融合先进经验与研究资源，揭示我国道路交通安全的典型问题，加速构建中国特色的道路交通安全统计分析与建模技术。从基础数据、安全分析理论与改善技术、国际对比等维度开展城市的道路交通安全统计分析与建模技术研究。通过国际对比分析，揭示我国城市交通安全存在的典型问题；借鉴欧、美经验，形成系统的交通安全分析建模方法，支撑我国城市的道路设施隐患判别与安全改善。

# AI-Based Biomedical Omics Data Analysis

**刘琦**

同济大学

**摘要:** 高通量测序技术产生了多源、异质的生物医学组学数据，对这些组学数据进行有效挖掘是精准医学的重要研究方向。本报告结合课题组前期若干研究案例，展示如何发展和应用人工智能方法，面向特定的应用场景进行生物医学组学数据的有效挖掘。

# Riemannian Newton-CG Methods for Constructing a Positive Doubly Stochastic Matrix from Spectral Data

**白正简**
厦门大学

摘要：In this talk, we consider the inverse eigenvalue problem for the positive doubly stochastic matrices, which aims to construct a positive doubly stochastic matrix from the prescribed realizable spectral data. By using the real Schur decomposition, the inverse problem is written as a nonlinear matrix equation on a matrix product manifold. We propose monotone and nonmonotone Riemannian inexact Newton-CG methods for solving the nonlinear matrix equation. The global and quadratic convergence of the proposed methods is established under some assumptions. We also provide invariant subspaces of the constructed solution to the inverse problem based on the computed real Schur decomposition. Finally, we report some numerical tests, including an application in digraph, to illustrate the effectiveness of the proposed methods.

# Sensitivity Estimation of Conditional Value at Risk Using Randomized Quasi-Monte Carlo

**何志坚**

华南理工大学

**摘要：** Conditional value at risk (CVaR) is a popular measure for quantifying portfolio risk. Sensitivity analysis of CVaR is very useful in risk management and gradient-based optimization algorithms. In this paper, we study the infinitesimal perturbation analysis estimator for CVaR sensitivity using randomized quasi-Monte Carlo (RQMC) simulation. We first prove that the RQMC-based estimator is strongly consistent under very mild conditions. Under some technical conditions, RQMC that uses d-dimensional points in CVaR sensitivity estimation yields a mean error rate of O(n^(-1/2-1/(4d-2)+ϵ)) for arbitrarily small ϵ>0. The numerical results show that the RQMC method performs better than the Monte Carlo method for all cases.

# 非线性结构系统求解的两尺度一致割线算法

**任晓丹**

同济大学

**摘要**：结构非线性行为的分析和模拟问题，是土木工程领域的核心科学问题之一，至今未得到很好地解决。从数学角度分析，该问题属于非线性系统的求解问题，是一个经典问题。虽然数学领域已经提出了很多的方法，但是这些方法大都适用于结构较为简单的问题，对于实际工程结构形成的非线性系统，其求解的收敛性和稳定性尚不能满足要求。为了克服传统求解方法面临的困难，报告人及其合作者合理考虑结构受力之后的开裂和损伤对系统的影响，提出了从材料和结构两个尺度建立割线刚度（雅克比矩阵）的两尺度一致算法。算例结果表明对于结构非线性行为的模拟问题，该算法的效率和稳定性优于传统切线算法和割线算法。

# An Efficient Multiscale Topology Optimization Method for Lattice Materials

**李义宝**
西安交通大学

摘要：In this talk, we will introduce an efficient multiscale topology optimization method for lattice materials. In macro-scale, we present a second-order unconditionally energy stable schemes for the topology optimization problem. Using porous media approach, our objective functional composes of five terms including mechanical property, Ginzburg-Landau energy, two penalized terms for solid and the volume constraint. A Crank-Nicolson method is proposed to discrete the coupling system. We prove that our proposed scheme is unconditionally energy stable. In macro-scale, we propose a simple volume merging method for triply periodic minimal structure. A modified Allen–Cahn type equation with a correction term is proposed. The mean curvature on the surface will be constant everywhere at the equilibrium state. Computational experiments are presented to demonstrate the efficiency of the proposed method.

# Fast Algorithms for Maxwell's Equations for Three-Dimensional Photonic Crystals

**李铁香**

东南大学

摘要：In this work, we propose the Fast Algorithms for Maxwell's Equations (FAME) package for solving Maxwell's equations for modeling three-dimensional photonic crystals. FAME combines the null-space free method with fast Fourier transform (FFT)-based matrix-vector multiplications to solve the generalized eigenvalue problems (GEPs) arising from Yee's discretization. The GEPs are transformed into a null-space free standard eigenvalue problem with a Hermitian positive-definite coefficient matrix. The computation times for FFT-based matrix-vector multiplications with matrices of dimension 7 million are only 0.33 and 3.6 x 10^{-3} seconds using MATLAB with an Intel Xeon CPU and CUDA C++ programming with a single NVIDIA Tesla P100 GPU, respectively. We successfully use FAME on a single P100 GPU to solve a set of GEPs with matrices of dimension more than 19 million, in 127 to 191 seconds per problem. These results demonstrate the potential of our proposed package to enable large-scale numerical simulations for novel physical discoveries and engineering applications of photonic crystals.

# Enhancing Molecular Dynamics Simulations of Bio-macromolecules: towards a Fully Automated Algorithmic Framework

**竺立哲**

香港中文大学（深圳）

**摘要：** Molecular Dynamics simulation is an indispensable tool for revealing the functional dynamics of biomolecules. In spite of the fascinating atomic-level dynamics it provides about the biomolecules, its efficiency has been the bottleneck limiting its overall popularity in large-scale applications, especially for huge biomolecular systems. In this talk, I will review various techniques that aimed to address this efficiency problem, with a focus on the popular techniques used for constructing Markov State Models, a popular protocol developed in the past two decades. I will also share my recent thoughts about further automation of the enhanced sampling protocol, particularly on the incorporation of the latest machine-learning techniques.

# A DNA Methylation State Transition Model Reveals the Programmed Epigenetic Heterogeneity in Human Pre-implantation Embryos

**赵程辰**
同济大学

**摘要:**
Background: During mammalian early embryogenesis, expression and epigenetic heterogeneity emerge before the first cell fate determination, but the programs causing such determinate heterogeneity are largely unexplored.

Results: Here, we present MethylTransition, a novel DNA methylation state transition model, for characterizing methylation changes during one or a few cell cycles at single-cell resolution. MethylTransition involves the creation of a transition matrix comprised by three parameters that represent the probabilities of DNA methylation-modifying activities in order to link the methylation states before and after a cell cycle. We apply MethylTransition to single-cell DNA methylome data from human pre-implantation embryogenesis and elucidate that the DNA methylation heterogeneity that emerges at promoters during this process is largely an intrinsic output of a program with unique probabilities of DNA methylation-modifying activities. Moreover, we experimentally validate the effect of initial DNA methylation on expression heterogeneity in pre-implantation mouse embryos.

Conclusions: Our study reveals the programmed DNA methylation heterogeneity during human pre-implantation embryogenesis through a novel mathematical model and provides valuable clues for identifying driving factors of the first cell fate determination during this process.

# 随机动力系统的整体灵敏度

**陈建兵**

同济大学

**摘要**：地震、强风、巨浪等灾害性作用下的复杂工程结构是一个典型的非线性随机动力系统。随机动力系统的整体灵敏度具有重要的意义。非线性动力系统随机参数的整体灵敏度应具有三个特点：（1）作为重要性测度，提供参数对系统性能影响大小的排序（仅考虑大小）；（2）作为一种“探测”手段，有助于理解和把握非线性随机动力系统的全局性质与整体行为规律（具有分布性质）；（3）作为“路标”，对结构设计、优化和理性决策提供定量依据（同时具有大小和方向）。本报告将首先依据上述三个原则，对已有的主要整体灵敏度指标进行评述。在此基础上，在随机力学的泛函分析观点框架下，提出基于 Fréchet 导数的整体灵敏度指标，讨论其基本性质与特征，并介绍基于概率密度演化理论-测度变换的高效计算方法。报告还将讨论若干具体应用以及需要进一步研究的问题。

# Stein Variational Gradient Descent with Local Approximations

**闫亮**

东南大学

**摘要：** Bayesian computation plays an important role in modern machine learning and statistics to reason about uncertainty. A key computational challenge in Bayesian inference is to develop efficient techniques to approximate, or draw samples from posterior distributions. Stein variational gradient decent (SVGD) has been shown to be a powerful approximate inference algorithm for this issue. However, the vanilla SVGD requires calculating the gradient of the target density and cannot be applied when the gradient is unavailable or too expensive to evaluate. In this talk we explore one way to address this challenge by the construction of a local surrogate for the target distribution which the gradient can be obtained in a much more computationally feasible manner. The key idea is to approximate the forward model using a deep neural network (DNN) which is trained on a carefully chosen training set, which also determines the quality of the surrogate. To this end we propose a general adaptation procedure to refine the local approximation online without destroying the convergence of the resulting SVGD. This significantly reduces the computational cost of SVGD and leads to a suite of algorithms that are straightforward to implement. The new algorithm is illustrated on a set of challenging Bayesian inverse problems, and numerical experiments demonstrate a clear improvement in performance and applicability of standard SVGD.

# 深层油气藏多场耦合数值模拟和机器学习应用

**黄朝琴**

中国石油大学（华东）

**摘要**：随着我国油气勘探开发逐渐向深部以及非常规油气资源的转移，开发中的多物理场耦合效应日益凸显。而实际油藏通常是强烈非均质的，各种参数在空间上有显著的多尺度特征，其开发过程为一典型的多尺度、多物理场、多相流动问题。本报告内容包括：1、深层缝洞型碳酸盐岩油藏中的渗流-自由流耦合流动模拟；2、深层页岩油气油藏热流固耦合数值模拟；3、机器学习在油气渗流中的应用，包括组分模型闪蒸计算代理模型、考虑物理过程的深度学习网络模型和基于图神经网络的井间响应关系研究。

# 超导模型中金兹堡-朗道方程的高效数值算法

**高华东**

华中科技大学

摘要：We propose and analyze an efficient numerical method for the time-dependent Ginzburg-Landau (TDGL) equations. The proposed method uses the well-known gauge-invariant finite difference approximations with staggered variables in a rectangular mesh, and a stabilized semi-implicit Euler discretization for time integration. The resulted fully discrete system leads to two decoupled linear systems at each time step, thus can be efficiently solved. We prove that the proposed method unconditionally preserves the point-wise boundedness of the solution and is also energy-stable. Moreover, the proposed method under the zero-electric potential gauge is shown to be equivalent to a mass-lumped version of the lowest order rectangular Nedelec edge element approximation and the Lorentz gauge scheme to a mass-lumped mixed finite element method. These indicate the method is also effective in solving the TDGL problems in non-convex domains although the solutions are often of low-regularity in such situation. Various numerical experiments are also presented to demonstrate effectiveness and robustness of the proposed method.

# Implicit Bias of Deep Learning and MscaleDNN for Solving PDEs

**许志钦**
上海交通大学

**摘要**: We demonstrate an implicit bias of deep learning in Fourier domain, that is, a very universal frequency principle that deep neural networks learn low frequency faster. We utilize the frequency principle to understanding why we need a deep rather than shallow network in complex tasks. We also design a multi-scale DNN (MscaleDNN) for solving PDEs, which overcomes the slow convergence of high frequency.

# Structure and Dynamics of Endoplasmic Reticulum Networks in a Plant Cell

**林聪萍**
华中科技大学

摘要：The endoplasmic reticulum (ER) in plant cells forms a highly dynamic network of complex geometry. ER network morphology and dynamics are influenced by a number of biophysical processes, including filament/tubule tension, viscous forces, Brownian diffusion, and interactions with many other organelles and cytoskeletal elements. Our studies indicated that ER networks can be thought of as constrained minimal-length networks acted on by a variety of forces that perturb and/or remodel the network. We also studied two specific biophysical processes involved in remodeling. One is the dynamic relaxation process involving a combination of tubule tension and viscous forces. The other is the rapid creation of cross-connection tubules by direct or indirect interactions with cytoskeletal elements. These processes are able to remodel the ER network: the first reduces network length and complexity whereas the second increases both. Using live cell imaging of ER network dynamics in tobacco leaf epidermal cells, we examine these processes on ER network dynamics. Away from regions of cytoplasmic streaming, we suggest that the dynamic network structure is a balance between the two processes, and we build an integrative model of the two processes for network remodeling. This model produces quantitatively similar ER networks to those observed in experiments. We use the model to explore the effect of parameter variation on statistical properties of the ER network.

# Understanding Physical Mixing Processes via Transfer Operator Approach

**张一威**

华中科技大学

摘要：Industrial and chemical mixing processes of various kinds occur throughout nature and are vital in many technological applications. In the context of discrete dynamical systems, the transfer operator approach has been shown as a powerful tool from both theoretic and numerical view point. In this talk, I will use a toy model (i.e., the one dimensional stretch and fold map) as an example to provide a brief introduction on the relationships between the spectral properties of the associated transfer operator and the estimations of the optimal mixing rate of the mixing process. Moreover, I will address how the optimal mixing rate varies according to the stretch and fold map has "cutting and shuffling" behavior (i.e., composing with a permutation). If time permits, I will also talk about how to interpret this problem to the eigenvalue estimations for the Random bi-stochastic matrices (free probability theory) and the locations of poles of the dynamical zeta function.

# Deep Learning for Uncertainty Quantification: Solving Forward and Inverse Stochastic Problems via Physics-Informed Neural Networks

**郭玲**

上海师范大学

**摘要：** Physics-informed neural networks (PINNs) have recently emerged as an effective way of numerically solving partial differential equations. In this talk, we will review some recent developments on using PINNs to quantify uncertainty propagation in a unified framework forward, inverse and mixed stochastic problems based on scattered measurements. We will demonstrate the capability of the stochastic version of PINNs with the applications for the long-time integration of Burgers equation and stochastic Kovasznay flow.

# DeePKS: A Comprehensive Data-Driven Approach towards Chemically Accurate Density Functional Theory

**王涵**

北京应用物理和计算数学研究所

摘要：In this talk, we present the Deep Kohn-Sham (DeePKS) scheme, which is a data-driven approach of modeling the energy functional under the generalized Kohn-Sham density functional framework. The DeePKS scheme has two key components, a deep learning-based representation of the energy functional and a self-consistent training scheme that targets not only energy labels but also on the force and density labels. The DeePKS model is by construction extensible and preserving all symmetries. When trained with high-accuracy data, the DeePKS model is demonstrated to reach chemical accuracy and be generalizable to a large class of molecules. We believe it is a good starting point towards developing a universally accurate functional for molecules and condensed matter systems.

# 电大尺寸电磁场计算与应用

**魏泽勇**

同济大学

**摘要**：随着航空航天、汽车电子、5G 技术的发展，计算电磁学发挥着越来越重要的作用。电磁场仿真计算从器件级别的仿真朝着系统级别发展，计算尺寸越来越大，计算精度要求越来越高。有限元、矩量法和时域有限差分方法是电磁场全波仿真主要方法，频域算法算法复杂度与自由度 Nlog(N)相关，而时域有限差分方法所耗费的资源与自由度成线性相关，在计算电大尺寸电磁场问题时，具有较大优势，但基于 Yee 网格时域有限差分方法难以实现共型计算，在此背景下，我们实现了基于非正交网格的时域有限差分方法，并开发了计算软件，使得 100 倍波长的电大尺寸电磁场仿真在单节点工作站上得以实现。

# Adaptive Multi-Fidelity Surrogate Modeling for Bayesian Inference in Inverse Problems

**周涛**

中国科学院数学与系统科学研究院

**摘要：** The generalized polynomial chaos (gPC) are widely used as surrogate models in Bayesian inference to speed up the Markov chain Monte Carlo simulations. However, the use of gPC-surrogates introduces model errors that may severely distort the estimate of the posterior distribution. In this talk, we present an adaptive procedure to construct an adaptive gPC-surrogate. The key idea is to refine the surrogate over a sequence of samples adaptively so that the surrogate is much more accurate in the posterior region. We then introduce an adaptive surrogate modeling approach based on deep neural networks to handle problems with high dimensional parameters.

# 基于深度学习的计算机视觉---从理论到实践

**王胤**

同济大学

**摘要**：基于深度学习的计算机视觉技术经过近十年的发展，发生了翻天覆地的变化。尤其在学术界，从最开始的图像分类到目标检测、语义分割，到目前的场景理解、3D 图像、视频理解等问题，几乎每年都会有新问题和划时代的技术出现。但是在应用领域，即便是最为基础的分类等问题，也有很多悬而未决的疑难，限制了深度学习的推广。本报告通过遥感影像处理、手写识别、行人重识别、医疗图像等常见图像处理问题领域，介绍深度学习实践中碰到的一些难题，希望发掘新的研究方向和解决办法。

# A New Augmented Singular Transform and Its Partial Newton-Correction Method for Finding More Solutions to Nonvariational Quasilinear Elliptic PDEs

**李昭祥**

上海师范大学

摘要：In this talk, in order to find more solutions to a nonvariational quasilinear PDE, a new augmented singular transform (AST) is developed to form a barrier surrounding previously found solutions so that an algorithm search from outside cannot pass the barrier and penetrate into the inside to reach a previously found solution. Thus a solution found by the algorithm must be new. Mathematical justifications of AST formulation are established. A partial Newton-correction method is designed accordingly to solve the augmented problem and to satisfy a constraint in AST. The new method is applied to numerically investigate bifurcation, symmetry-breaking phenomena to a non-variational quasilinear elliptic equation through finding multiple solutions. Such phenomena are numerically captured and visualized for the first time, and still open for theoretical verification. Since the formulation is general and simple, it opens a door to solve other multiple solution problems.