



深圳北理莫斯科大学

УНИВЕРСИТЕТ МГУ-ППИ В ШЭНЬЧЖЭНЕ
SHENZHEN MSU-BIT UNIVERSITY

2024

**第一届深北莫-北理-莫大
计算数学与控制博士生研讨会**

主办单位：深圳北理莫斯科大学
莫大-北理-深北莫应用数学联合研究中心

2024年1月14-16日 深圳

三、会议日程(Program Schedule)

第一天(Day 1): Jan 14, 2024	
14:00- 17:30	Registration
17:30- 19:30	Dinner&discussion
08:30-09:00	
Opening Ceremony & Group Photo Welcome Remarks by Ye Zhang & Boris Budak	
Chair: 王迎奥	
09:00-09:30	申晴 Stable Numerical Solution Algorithms for the Inverse Problem of Population Dynamics with Nonlinearities of Integral Type
09:30- 10:00	蒋演 On Blowup of Classical Solutions to the Compressible Navier- Stokes Equations
10:00- 10:20	Tea break
Chair: 申晴	
10:20- 10:50	朱巧 Dual-activation neural network for solving parabolic equations with time delay
10:50- 11:20	汤天翔 Parameterized synchronous transducers and the complexity of their decision problems
11:20- 11:50	栾致漫 Rayleigh-Marangoni convection of Jeffreys fluids in a fluid-porous system
Lunch 12:00-14:00	
Chair: 孙优	
14:00- 14:30	周庆 Vessel detection in fundus images
14:30- 15:00	王迎奥 On a class of linear regression methods
15:00-15:30	穆景源 广义括号表达式及其在形式语言理论中的应用
15:30- 15:50	Tea break
Chair: 周庆	

15:50-16:20	孙优 A concentration preserving discontinuous Galerkin method for nonlinear multi-component chromatography models
16:20-16:50	李加勉 将形式语言和L-图相互转换的算法
16:50-17:20	王岚 Lavrent'ev regularized collocation method for auto-convolution equation
17:20-17:50	穆权 Monte Carlo simulation of halos in the crystal clouds
18:00- 19:40	Banquet: 3-rd floor Canteen 1

第三天(Day 3): Jan 16, 2024	
9:00- 12:00	博士生和导师讨论会
15:00- 16:00	Irina V. Mursenkova Pulsed discharges in gas flows: a review of modern

五、报告摘要(Abstracts)

On Blowup of Classical Solutions to the Compressible Navier-Stokes Equations

Yan Jiang
Jilin University

Abstract: In this talk, we'll present the finite time blow up of smooth solutions to the Compressible Navier-Stokes system when the initial data contain vacuums. We prove that any classical solutions of viscous compressible fluids without heat conduction will blow up in finite time, as long as the initial data has an isolated mass group.

将形式语言和L-图相互转换的算法

李加勉
莫斯科国立大学

摘要: L-图是一种用于分析和整合形式语言的方便的工具。本项工作的核心内容是在Chomsky的各种类型的语法和L-图之间找到等价转换的算法。这使得能够通过图上应用算法以优化语法，从而在识别、语法分析和翻译等过程中起到重要的实际应用意义。在本次报告中，主要讨论在计算机理论领域应用较广泛的上下文无关语法和上下文无关L-图之间等效转换的算法。并以此为基础引出对于上下文相关、递归和递归可枚举语言的类似算法。

Rayleigh-Marangoni convection of Jeffreys fluids in a fluid-porous system

Zhiman Luan
Beijing Institute of Technology

Abstract: Based on the modified Darcy Brinkman Jeffreys model to characterize the flow state in sparse porous media, this paper investigates the Rayleigh Marangoni convective instability problem of Jeffreys fluid in a fluid porous media bilayer system under isothermal heating conditions. This article uses linear stability analysis and spectral methods for numerical simulation to obtain neutral curves such as wavenumber Rayleigh number and wavenumber Marangoni number, and further obtains the critical Rayleigh number and Marangoni number. It was found that isothermal heating, compared to isothermal heating, will exacerbate the instability of two types of convection in the long wave branch, but the instability performance results are the same in the short wave branch. The increase of Darcy number in porous media helps to enhance the stability of Rayleigh convection, but reduces the stability of Marangoni convection. As the wave number increases, the difference in critical Rayleigh number at different Darcy numbers becomes larger, and the characteristic of the difference in critical Marangoni number is to first increase and then decrease. The stability of two types of convection increases with the increase of Biot number, while

Marangoni convection gradually shifts from being dominated by the porous layer to being controlled by the fluid layer as the thermal conductivity of the free surface improves. When the Biot number reaches a critical value, the wavenumber Marangoni number curve changes to a single mode, and instability is dominated by the fluid layer. In addition, this article also analyzed the trend of Rayleigh convection stability changes at different Marangoni values, and found that Marangoni convection enhances the Rayleigh convection stability in the coupled mode, and there are two characteristics: single mode and bimodal at different thickness ratios. The research results of this article can provide theoretical basis and numerical results for related fields such as flow stability problems.

广义括号表达式及其在形式语言理论中的应用

穆景源

莫斯科国立大学

摘要：本文介绍了在形式语言理论中，从正则表达式推广到上下文无关语言的广义括号表达式，并讨论了上下文无关表达式与L-图转换的相关算法。该算法通过构建等价的上下文无关L-图，实现了满足广义括号表达式的字符串的有效搜索。描述了进一步推广广义括号表达式的可能性，扩展至上下文依赖、递归和递归可枚举语言的子类，并设计相应的搜索算法。这将涉及使用多个独立的括号系统，使得算法更加灵活和适用于更广泛的语言类别。此外，研究了构建将广义括号表达式转换为L-图的算法，以作为在文本中搜索满足给定括号表达式的字符串的计算基础。

研究的重要特征是对广义括号表达式的拓展，其中包括一种特殊形式的括号系统。这为形式语言理论领域提供了新的理论和算法基础。此外，创建了一套用于处理由括号表达式定义的形式语言的软件工具，以促进该领域的进一步发展。

Stable Numerical Solution Algorithms for the Inverse Problem of Population Dynamics with Nonlinearities of Integral Type

Qing SHEN

Lomonosov Moscow State University

Abstract: This research investigates direct and inverse problems formulated based on a model describing the dynamics of populations. The study explores algorithms for numerically solving both forward and inverse problems, with a focus on nonlinear population dynamics. The proposed algorithms have been implemented and tested through simulations on model examples. For the forward problem, the study analyzes solutions to the direct model, providing insights into the population dynamics over time. The direct problem involves determining the population distribution using given initial conditions and model parameters. In addressing the inverse problem, the research formulates algorithms for the numerical reconstruction of model parameters

and initial conditions from observed data. The study emphasizes the uniqueness and stability of solutions to the inverse problem, demonstrating that there is typically a unique set of parameters and initial conditions that satisfy the observed data. The proposed algorithms have been implemented and tested through simulations on model examples. The results showcase the efficiency and accuracy of the numerical methods in reconstructing population dynamics.

A concentration preserving discontinuous Galerkin method for nonlinear multi-component chromatography models

You Sun
Beijing Institute of Technology

Abstract: The mass balance equations for liquid chromatography consist of nonlinear convection dominated partial differential equations. This talk includes designing, analyzing and numerically validating a concentrations preserving discontinuous Galerkin method for solving various multi-component chromatographic models. The semi-discrete formulation is shown to preserve the concentrations of all components in both mobile and stationary phase. The numerical experiments demonstrate optimal rates of convergence. In this talk, it also shows that the shape of the solution, after long time simulation, is well preserved due to the invariant preserving property.

Parameterized synchronous transducers and the complexity of their decision problems

Tianxiang TANG
Lomonosov Moscow State University, Moscow

Abstract: The aim of the research is to develop new techniques and algorithms for analyzing and synthesizing certain types of finite state machines (FSMs) with control components (such as state transitions, variables, and output sequences). These computational models are parameterized, allowing parameters to be modified, evaluated, and fine-tuned. The study focuses on Finite State Transducers (FSTs) as examples, which generalize automaton models with input-output functions and possess greater expressive power. The themes include the complexity of decision-making for parameterized synchronous transducers, examining a range of decision problems such as weak equivalence, strong equivalence, and minimization issues. The research methodology primarily encompasses formal models and techniques from discrete mathematics, complexity theory, automata theory, mathematical logic for developing effective algorithms to address decidability and complexity issues in automata, and model checking problems based on automata-based program models.

Lavrent'ev regularized collocation method for auto-convolution equation

Lan Wang
Beijing Institute of Technology

Abstract: Auto-convolution equation as a type of nonlinear ill-posed inverse problem has important application value in the fields of spectroscopy and statistics. In this talk, we propose a Lavrent'ev regularized collocation method for Auto-convolution Volterra integral equations of the first kind(AVIEs). This talk contains detailed description of the collocation method and the discretized collocation form of Lavrent'ev regularized auto-convolution equation. We illustrate the wellposedness of Lavrent'ev regularized collocation solution and provide an error analysis. Also we shows the performance of Lavrent'ev regularized collocation solution by some numerical examples.

On a class of linear regression methods

Yingao Wang
Beijing Institute of Technology

Abstract: In this talk, a unified study is presented for the design and analysis of a broad class of linear regression methods. The proposed general framework includes the conventional linear regression methods (such as the least squares regression and the Ridge regression) and some new regression methods (e.g. the Landweber regression and Showalter regression), which have recently been introduced in the fields of optimization and inverse problems. The strong consistency, the reduced mean squared error, the asymptotic Gaussian property, and the best worst case error of this class of linear regression methods are investigated. Various numerical experiments are performed to demonstrate the consistency and efficiency of the proposed class of methods for linear regression.

Dual-activation neural network for solving parabolic equations with time delay

Qiao Zhu
Beijing Institute of Technology

Abstract: In this talk, we present the dual-activation neural network (DANN), a novel network architecture designed for solving parabolic equations with time delay. In DANN, each neuron is equipped with two activation functions to augment the network's nonlinear expressive capacity. Additionally, a new parameter is introduced for the construction of the quadratic terms, which further enhances the network's ability to capture complex nonlinear relationships. Numerical results are presented to demonstrate the superior accuracy and faster convergence of DANN compared to the physics-informed neural network (PINN).

Vessel detection in fundus images

Qing ZHOU
Lomonosov Moscow State University

Abstract: In this paper, I propose a method for segmenting blood vessels in fundus images, which includes image preprocessing, detection of blood vessels, segmenting blood vessels, connecting blood vessels, and comparing the final results. The preprocessing of fundus vessel images includes graying, image denoising by median filtering and bilateral filtering, and contrast enhancement by limiting contrast adaptive histogram equalization. Gaussian matched filtering and Gabor filtering were applied to detected vessels. The segmented fundus vessel image is segmented by double thresholding to eliminate the background noise in the image, highlight the contours and complete the vessel extraction. Finally, the vessel skeleton was obtained by morphological processing, and the vessel skeleton was used to connect the vessel breakpoints, thus enabling the extraction of the fundus image vessels. The detected images of blood vessels were compared with the manually segmented images in the international publicly available DRIVE fundus image database. The experiments confirmed that the images obtained by this method are more accurate and have some applicability and reference value.

Monte Carlo simulation of halos in the crystal clouds

Quan Mu
ShenZhen MSU-BIT university

Abstract: In this talk, we try to answer the question: how the multiple scattering, the sun elevation, shape and orientation of ice crystals in the cirrus clouds affect a halo pattern. To study the radiation transfer in optically anisotropic clouds, we have developed the software based on Monte Carlo method and ray tracing. In addition to halos, this software enables one to simulate “anti-halos”, which above the cloud layer can be seen by observers. We present the visualization of halos and anti-halos generated by the cirrus clouds for different shapes and orientations of ice crystals.