DEPARTMENT OF MATHEMATICS
THE CHINESE UNIVERSITY OF HONG KONG

2024 CUHK SIAM Student Annual Workshop

Date: Saturday, 23 March 2024 (Online and Offline)

Time: 9:00 a.m. - 5:00 p.m.

Venue: Lady Shaw Building LT6 (LSB LT6),
The Chinese University of Hong Kong

CUHK SIAM Student Chapter

Information

2024 CUHK SIAM Student Annual Workshop

Sponsors

The following organizations generously support the workshop:

Department of Mathematics, The Chinese University of Hong Kong

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Introduction

This workshop aims to provide a forum for the past graduates, who have excelled in their academic or professional journeys, to deliver engaging talks and share their expertise. We hope to provide a good channel for communication between current PhD students and alumni of the department of mathematics in CUHK. PhD students from other universities are also welcome to join.

Invited Speakers

Gary CHOI	The Chinese University of Hong Kong
Yuwei FAN	Huawei Theory Lab, Hong Kong
Fuqun HAN	University of California, Los Angeles
Wing Tat LEUNG	City University of Hong Kong
Simon PUN	Qube Research & Technologies
Yating WANG	Xi'an Jiaotong University
Hok Shing WONG	University of Bath

Schedule

Time: March 23, 2024 (HK Time)
Venue: LT6, Lady Shaw Building, CUHK

TIMELINE	CONTENT
9.00-9.30	Yating Wang (Online)
9.35-10:05	Fuqun Han
10.10-10.40	Simon Pun
10.45-11.15	**Open Discussion**
11.20-11.50	**Open Discussion**
12.00-14.00	**Lunch**
14.00-14.30	Yuwei Fan
14.35-15.05	Gary Choi
15.05-15.25	**Group Photo & Coffee Break**
15.25-15.55	Wing Tat Leung
16.00-16.30	Hok Shing Wong (Online)
16.30-17.00	**Open Discussion**

Abstract

Yating Wang

Xi'an Jiaotong University

Efficient temporal splitting scheme for multiscale flow problems

In this talk, we present some recent work on multiscale flow problems with partially explicit splitting temporal discretisation. For parabolic equation with multiscale coefficients, explicit temporal discretization is computational expensive due to the high-contrast property of the coefficient. Partially explicit splitting scheme has shown to be efficient if the construction of multiscale spaces can ensure that the time-step size is independent of the contrast. Here, we consider a linear diffusion problem in high-contrast media, and introduce an adaptive framework for the splitting scheme. We derive both temporal and spatial error estimators to identify local regions where enrichments are needed for two components of the solutions. An adaptive algorithm is then proposed to achieve higher computational efficiency with the desired accuracy. We will also discuss an efficient approach to solve nonlinear problem with the help of explicit-implicit-null (EIN) method and splitting scheme.

Fuqun Han

University of California, Los Angeles

Tensor train based sampling algorithms for approximating regularized Wasserstein proximal operators

In this presentation, we will introduce an algorithm based on tensor train approximations for sampling from a target distribution. We will start by reviewing the backgrounds of sampling using Langevin dynamics and tensor train approximation for high-dimensional functions. Then we will employ tensor train approximation to capture the evolution of high-dimensional probability density in Langevin dynamics.

This process leverages the regularized Wasserstein proximal operator, which has a simple kernel integration formulation. The integration, typically performed in high-dimensional space, presents a practical challenge, and our algorithm becomes implementable through the assistance of tensor train approximation.

A rigorous analysis of the algorithm on Gaussian distributions will be presented. To show the effectiveness of our methods, we will provide numerical examples including sampling from various distributions and solving Bayesian inverse problems.

Simon Pun

Qube Research & Technologies

Navigating the seas of opportunity: planning your post PhD career

Embarking on a career journey after completing a PhD in Mathematics presents a unique set of challenges and opportunities. In this talk, we will explore the vast landscape of career paths available to mathematics PhD graduates, from academia and research to industry and beyond. We will discuss strategies for identifying and seizing opportunities that align with personal ambitions and the skills that are in high demand across various sectors. Through a blend of personal anecdotes, insights from successful professionals, and practical advice, this presentation aims to demystify the process of career planning.

Yuwei Fan

Huawei Theory Lab, Hong Kong

To Be Announced

Gary Choi

Chinese University of Hong Kong

Density-equalizing map with applications

We present surface and volumetric mapping methods based on a natural principle of density diffusion. Specifically, we start with a prescribed density distribution in a surface or volumetric domain, and then create shape deformations with different regions enlarged or shrunk based on the density gradient. By changing the density distribution, we can achieve different mappings including area-preserving parameterizations. Applications of the methods to medical shape analysis, data visualization, remeshing and shape morphing will be presented.

Wing Tat Leung

City University of Hong Kong

Multicontinuum homogenization in multiscale media

In this talk, we will explore the recent advancements in multiscale simulations for high contrast problems with no scale separation. We will specifically focus on the nonlocal multicontinua (NLMC) method, which introduces multiple macroscopic variables in each computational grid. We present a general derivation of multicontinuum equations and discuss cell problems. We present constraint cell problem formulations in a representative volume element and oversampling techniques that allow reducing boundary effects. We discuss different choices of constraints for cell problems. I will also share some of my personal experiences in my Ph.D. study.

Hok Shing Wong

University of Bath

Learning and inferencing convex neural network:
A bilevel optimization framework for learned convex regularizers

In inverse problems, a classical reconstruction framework is based on the idea of variational regularization. This approach encodes prior information about potential reconstructions through a variational regularizer. Traditional methods often employ hand-crafted regularizers, such as total variation (TV) and total generalized variation (TGV). With the success of deep learning image reconstruction, there has been increasing interest in data-driven regularizers, potentially replacing manually designed regularizers with neural networks. In this talk, we explore learned convex regularizers within the variational setting, specifically when the convex regularizer is parameterized by an Input Convex Neural Network (ICNN). While various attempts have been made to learn regularizers, the adversarial training approach utilizes a loss that aims to separate ground-truth images from those with artifacts. However, the adversarial regularizer is not explicitly trained for the reconstruction task. To address this, we present a bilevel optimization framework to incorporate reconstruction quality in the learning process. We will also present a novel approach of solving the variational problem within a primal-dual framework. By introducing auxiliary variables corresponding to the activations of intermediate layers, we eliminate the nested nature of a neural network. This reformulates the variational problem as a constrained convex problem.