HKBU-SJTU Joint Workshop on Scientific Computing

April 20-22, 2018

Hong Kong Baptist University

Organization

Organizing Committee:

Jianguo Huang	Shanghai Jiao Tong University
Hongyu Liu	Hong Kong Baptist University
Michael Kwok-Po Ng	Hong Kong Baptist University

Sponsors:

Department of Mathematics, HKBU

Hong Kong Research Grants Council

Contact:

Xinlin Cao	16482670@life.hkbu.edu.hk	+852 5267 7970
Hongjie Li	hongjie_li@yeah.net	+852 9589 1856
Shiqi Ma	mashiqi@life.hkbu.edu.hk	+852 9514 1026
Xianchao Wang	xcwang90@gmail.com	+852 6483 3395
Jingni Xiao	xiaojn@live.com	+852 6765 5014

Quick Information

Conference Venue:

Room: FSC1217

Building: Fong Shu Chuen Library 方樹泉圖書館

Ho Sin Hang Campus 善衡校園

Hong Kong Baptist University

Registration:

13:30-14:00, April 20 (Friday), at FSC1217

Accommodation:

Dr. Ng Tor Tai International House (NTTIH) 吳多泰博士國際中心

Address: 32 Renfrew Road, Kowloon Tong, Kowloon, Hong Kong

香港 九龍 九龍塘聯福道32號

http://sass.hkbu.edu.hk/sass/ntt/guests/chi/index.php

Banquet:

18:00-22:00 April 21 (Saturday)

Venue: 八月花 Festival Walk, Kowloon Tong

Lunch and Dinner

12:00-13:30	April 20 (Friday)	Lunch
18:00-20:00	April 20 (Friday)	Dinner
12:30-14:00	April 21 (Saturday)	Lunch

All at Renfrew Restaurant (聯福樓).

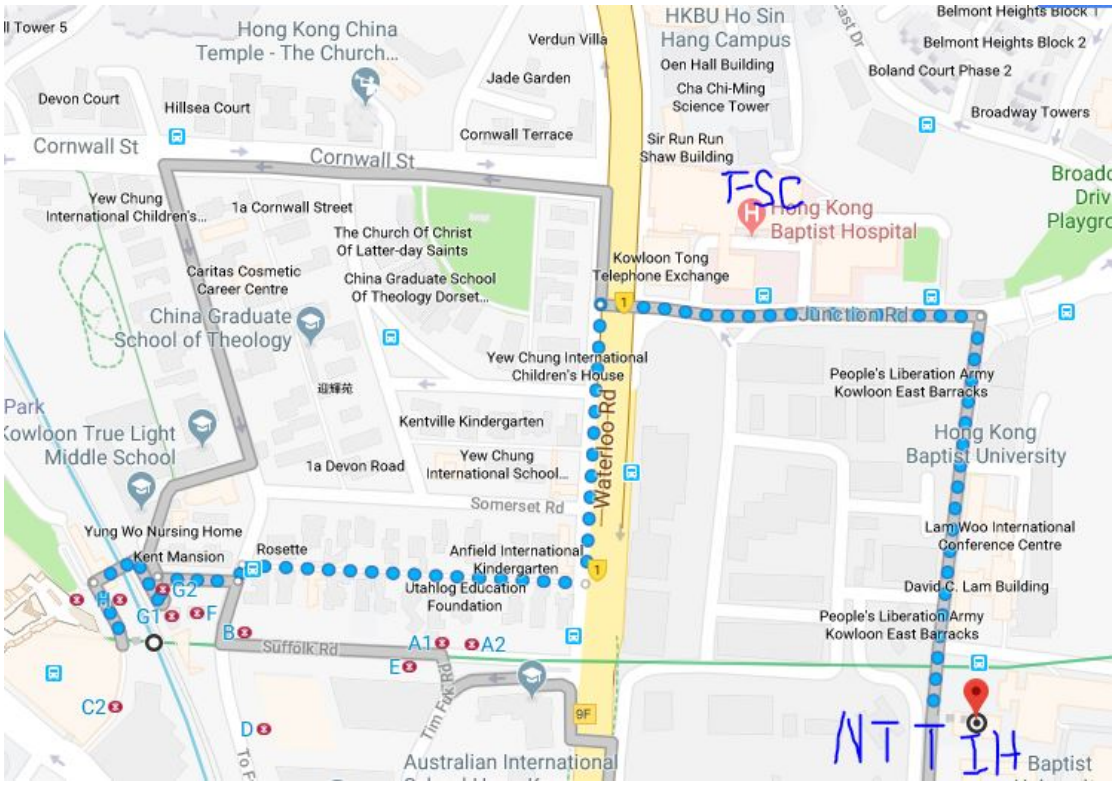
Internet Access

Transportation

1. **Airport (HK) → NTTIH:**
    - **Taxi:** 30-45 min, 250-300 Hong Kong Dollar
    - **Bus:** E22 from the airport. Exit at 香港浸會大學聯合道站 provided by the hotel. Please see the attachment for more details.
    - **Metro:** MTR **Kowloon Tong** Station (**九龍塘**), Exit A/E/G

      Route: *Airport Express* to **Tsing Yi** Station (青衣), *Tung Chung Line* to **Nam Cheong** Station (南昌), *West Rail Line* to **Hung Hom** Station (紅磡)
2. **ShenZhen → NTTIH:** To across the port first. Then,
    - **Metro:** MTR **Kowloon Tong** Station (**九龍塘**), Exit A/E/G

      Route: *East Rail Line*
3. **Kowloon Tong MTR Station → NTTIH:**
    - **Minibus:** Exit E/G
      Take minibus 25M/25M(S), and **let the driver know** that you are going to "HKBU Baptist University Rd Campus 浸會大學道" station.
    - **Walk:** Exit **A2**, around 15min



Schedule

Day 1: Friday, April 20, 2018	
12:00-13:30	**Lunch at Renfrew Restaurant**
13:30-14:00	**Registration**
14:00-14:10	**Opening Remark**
Afternoon Session	
14:10-14:55	Ling Leevan (HKBU) Recent on kernel based approximation methods
14:55-15:40	Jinyan Fan (SJTU) Monotonically positive matrices
15:40-16:10	**Tea break**
16:10-16:55	Lizhi Liao (HKBU) Computational Issues in the Interior Point Approach
16:55-17:40	Weiyang Ding (HKBU) Computing the p-Spectral Radii of Uniform Hypergraphs with Applications
18:00-20:00	**Dinner at Renfrew Restaurant**

Day 2: Saturday, April 21, 2018	
Morning Session	
09:00-09:45	Jianguo Huang (SJTU) A robust finite element method for elastic vibration problems
09:45-10:30	Zhenli Xu (SJTU) Analysis and computation for modified Poisson-Nernst-Planck equations
10:30-11:00	**Tea break**
11:00-11:45	Wenjun Ying (SJTU) Solution of the Biharmonic Equation with the Kernel-free Boundary Integral Method
11:45-12:30	Yuliang Wang (HKBU) Vanishing and localizing of transmission eigenfunctions near corners/edges
12:30-14:00	**Lunch at Renfrew Restaurant**
Afternoon Session	
14:00-14:45	Lei Zhang (SJTU) A priori and a posteriori error estimates on multiscale coupling methods for materials defects
14:45-15:30	Jun Fan (HKBU) Spectral algorithms for functional linear regression
15:30-16:00	**Tea break**
16:00-16:45	Felix Kwok (HKBU) Waveform relaxation methods: analysis and implementation
16:45-17:30	Hongyu Liu (HKBU) Simultaneously recovering sources and mediums and its applications
18:00-21:00	**Banquet**

Day 3: Sunday, April 22, 2018	
09:00-11:00	**Free Discussion**

Abstracts

Recent on Kernel Based Approximation Methods

Leevan Ling

Department of Mathematics
Hong Kong Baptist University

Abstract: this talk begins with an introduction of kernel methods and will cover some popular numerical methods for solving PDEs including asymmetric collocation and meshfree finite difference methods.

Monotonically Positive Matrices

Jinyan Fan

School of Mathematical Sciences
Shanghai Jiao Tong University

Abstract: A matrix A is monotonically positive (MP) if there exists a matrix U such that A =UU^T and each column of U is monotonically nonincreasing or nondecreasing. We propose a semidefinite algorithm for checking whether or not a matrix is MP. If it is not MP, a certificate for it can be obtained; if it is MP, an MP-decomposition can be obtained. Some computational experiments are presented to show how to do this.

Computational Issues in the Interior Point Approach

Lizhi Liao

Department of Mathematics
Hong Kong Baptist University

Abstract: In this talk, we will discuss and address the computational issues in many interior point algorithms. We will start by addressing some convergent interior point methods and continuous trajectories. Then some numerical difficulties and challenges resulting from these methods and trajectories will be raised and discussed. Some preliminary numerical results on certain numerical algorithms will be also reported.

Computing the p-Spectral Radii of Uniform Hypergraphs with Applications

Weiyang Ding

Department of Mathematics
Hong Kong Baptist University

Abstract: The p-spectral radius of a uniform hypergraph covers many important concepts, such as Lagrangian and spectral radius of the hypergraph, and is crucial for solving spectral extremal problems of hypergraphs. In this talk, we establish a spherically constrained maximization model and propose a first-order conjugate gradient algorithm to compute the p-spectral radius of a uniform hypergraph (CSRH). By the semialgebraic nature of the adjacency tensor of a uniform hypergraph, CSRH is globally convergent and obtains the global maximizer with a high probability. When computing the spectral radius of the adjacency tensor of a uniform hypergraph, CSRH outperforms existing approaches. Furthermore, CSRH is competent to calculate the p-spectral radius of a hypergraph with millions of vertices and to approximate the Lagrangian of a hypergraph. Finally, we show that the CSRH method is capable of ranking real-world data set based on solutions generated by the p-spectral radius model.

A Robust Finite Element Method for Elastic Vibration Problems

Jianguo Huang

School of Mathematical Sciences
Shanghai Jiao Tong University

Abstract: A robust finite element method is introduced for solving elastic vibration problems in two dimensions. The discretization in time is based on the P_1-continuous discontinuous Galerkin (CDG) method, while the spatial discretization on the Crouziex-Raviart (CR) element. It is proved that the error of the displacement (resp. velocity) in the energy norm (resp. L^2 norm) is bounded by $O(h+k)$ (resp. $O(h^2+k)$), where h and k denote the mesh sizes of the subdivisions in space and time, respectively. Under some regularity assumptions on the exact solution, the error bound is independent of the Lam\'{e} coefficients of the elastic material under discussion. Several numerical results are reported to illustrate numerical performance of the proposed method.

Analysis and Computation for Modified Poisson-Nernst-Planck Equations

Zhenli Xu

School of Mathematical Sciences
Shanghai Jiao Tong University

Abstract: We develop a modified Poisson-Nernst-Planck model to include Coulomb many-body properties in electrolytes, which also takes the ion-size effect into account and is expected to provide more accurate prediction for ion dynamics with microscopic confinement. Asymptotic expansions are performed to remove the multiscale properties of the equations and also used to understand dielectric properties near interfaces. Furthermore, we discuss numerical strategies to solve the resulted PDEs and show numerical results to demonstrate the performance of our numerical methods.

Solution of the Biharmonic Equation with the Kernel-free Boundary Integral Method

Wenjun Ying

Institute of Natural Sciences and School of Mathematical Sciences
Shanghai Jiao Tong University

Abstract: In this talk, I will present two versions (one has second-order accuracy and another one has fourth-order accuracy) of the kernel-free boundary integral method for the biharmonic equation on complex domains. This method is a generalization of the traditional boundary integral method. It does not need to know analytical expressions of the kernel or associated Green's function of the differential operator and evaluate boundary and volume integrals by solving equivalent simple interface problems on Cartesian grids with FFT-based fast solvers. The method has several advantages over the traditional finite element based biharmonic solvers that work with a saddle-point formulation and unstructured grids. Numerical examples will be included to demonstrate accuracy and efficiency of the method.

Vanishing and Localizing of Transmission Eigenfunctions near Corners/Edges

Yuliang Wang

Department of Mathematics
Hong Kong Baptist University

Abstract: In this talk I will present our recent finding on the intrinsic geometric structure of interior transmission eigenfunctions arising in wave scattering theory. We numerically show that the aforementioned geometric structure can be very delicate and intriguing. The major findings can be roughly summarized as follows. If there is a cusp, i.e. a discontinuity of the surface tangent on the support of the underlying potential function, then the interior transmission eigenfunction vanishes near the cusp if its interior angle is less than Pi, whereas the interior transmission eigenfunction localizes near the cusp if its interior angle is bigger than Pi. Furthermore, we show that the vanishing and blowup orders are inversely proportional to the interior angle of the cusp: the sharper the corner, the higher the convergence order.

A Priori and a Posteriori Error Estimates on Multiscale Coupling Methods for Materials Defects

Lei Zhang

Institute of Natural Sciences and School of Mathematical Sciences
Shanghai Jiao Tong University

Abstract: I will talk about some recent progress on multiscale coupling methods for materials defects. Based on an unified analytical framework, we have studied a priori and a posteriori error estimate for atomisitc/continuum (a/c) coupling, higher order continuum model, and furthermore, extensions to electronic models and soft materials such as nematic liquid crystal.

Spectral Algorithms for Functional Linear Regression

Jun Fan

Department of Mathematics
Hong Kong Baptist University

Abstract: Functional data analysis is concerned with inherently infinite dimensional data such as curves or images. It attracts more and more attentions because of its successful applications in many areas such as neuroscience and econometrics. We consider a class of regularization methods called spectral algorithms for functional linear regression within the framework of reproducing kernel Hilbert space. The proposed estimators can achieve the minimax optimal rates of convergence. Despite of the infinite dimensional nature of functional data, we show that the algorithms are easily implementable.

Waveform relaxation methods: analysis and implementation

Felix Kwok

Department of Mathematics
Hong Kong Baptist University

Abstract: In this talk, we consider a class of domain decomposition methods, known as waveform relaxation (WR) methods, for solving time-dependent PDEs numerically on many different processors in parallel. WR methods are distinctive in that a typical subdomain problem is posed in both space and time; each iteration requires the parallel solution of these space-time subproblems, followed by an exchange of interface data defined over the whole time window. An often cited advantage of WR methods is that they allow each subdomain to use a different spatial and temporal grid that is adapted to the dynamics of the local subproblem.

In this talk, I will first present some new results on the convergence of WR methods of the Neumann-Neumann type. Next, I will discuss two ways of introducing parallelism in time to the basic WR method. The first approach uses a fixed time-window size and yields an algorithm that is mathematically equivalent to the original WR method. The second one, on the other hand, chooses time-window size dynamically based on how many free processors are available; this leads to a method with improved convergence behaviour. We demonstrate the effectiveness of both approaches by comparing their running times against those obtained from classical time-stepping methods, where the same number of processors is used to parallelize in space only.

Simultaneously recovering sources and mediums and its applications

Hongyu Liu

Department of Mathematics
Hong Kong Baptist University

Abstract: In this talk, we shall consider a class of inverse problems of simultaneously recovering an embedded source and it surrounding mediums. This type of inverse problems arises from a variety of applications including thermoacoustic and photoacoustic tomography, brain imaging and geomagnetic detection technology. I shall talk about the recent progress of our study on those inverse problems.

Participants

Xinlin Cao	Hong Kong Baptist University
Weiyang Ding	Hong Kong Baptist University
Huaian Diao	Northeast Normal University
Jinyan Fan	Shanghai Jiao Tong University
Jun Fan	Hong Kong Baptist University
Jianguo Huang	Shanghai Jiao Tong University
Felix Kwok	Hong Kong Baptist University
Ling Leevan	Hong Kong Baptist University
Hongjie Li	Hong Kong Baptist University
Lizhi Liao	Hong Kong Baptist University
Hongyu Liu	Hong Kong Baptist University
Shiqi Ma	Hong Kong Baptist University
Michael Ng	Hong Kong Baptist University
Yuliang Wang	Hong Kong Baptist University
Xianchao Wang	Hong Kong Baptist University
Jingni Xiao	Hong Kong Baptist University
Zhenli Xu	Shanghai Jiao Tong University
Wenjun Ying	Shanghai Jiao Tong University
Lei Zhang	Shanghai Jiao Tong University