DEPARTMENT OF MATHEMATICS
THE CHINESE UNIVERSITY OF HONG KONG

CUHK RESEARCH SUMMIT SERIES

Workshop on

Optimization in Scientific Computing

21-23 June 2017 • HONG KONG

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Introduction

Optimization is an important technique in scientific computing. In imaging applications, one needs the recovery of enhanced images from noisy signals and the reconstruction of some unknown information from external measurements. In radar applications, one needs the determination of the position of certain targets from the knowledge of reflected wavefields. In these scientific applications, optimization is an essential component in the numerical algorithms for solving these problems. Due to the complexity of realistic applications, traditional optimization techniques are not sufficient to meet the need, and there is much on-going research in the past decade in order to tackle the challenges. While there are many successful approaches in literature addressing some of the difficulties in developing optimization methods for scientific computing, there are still many challenges and open problems.

This international workshop aims to provide a platform for researchers working on optimization and scientific computing to gather and enhance the interaction among them. In particular, the workshop gives a forum for researchers to present their latest achievements and explore new research directions. The workshop is also an opportunity for graduate students and postdoc to learn basic knowledge and overall development in the field.

Organizing Committee

Raymond CHAN	The Chinese University of Hong Kong
Eric CHUNG	The Chinese University of Hong Kong
Ronald LUI	The Chinese University of Hong Kong
Jun ZOU	The Chinese University of Hong Kong

Sponsors

The workshop is generously supported by the following organizations:

Department of Mathematics,
The Chinese University of Hong Kong

Research Summit Series,
The Chinese University of Hong Kong

Faculty of Science,
The Chinese University of Hong Kong

Hong Kong Mathematical Society

Invited Speakers

Zhengjian BAI	Xiamen University, China
Jianfeng CAI	The Hong Kong University of Science and Technology, Hong Kong
Xiaojun CHEN	The Hong Kong Polytechnic University, Hong Kong
Eric CHUNG	The Chinese University of Hong Kong, Hong Kong
Patrick CIARLET	ENSTA ParisTech, France
Jan HESTHAVEN	Ecole Polytechnique Federale de Lausanne, Switzerland
Kazufumi ITO	North Carolina State University, USA
Hui JI	National University of Singapore, Singapore
Bangti JIN	University College London, UK
Simon LABRUNIE	University of Lorraine, France
Rongjie LAI	Rensselaer Polytechnic Institute, France
Shingyu LEUNG	The Hong Kong University of Science and Technology, Hong Kong
Peijun LI	Purdue University, USA
Jie LIU	National University of Singapore, Singapore
Xiliang LU	Wuhan University, China
Jun MA	Macquarie University, Australia
Shiqian MA	The Chinese University of Hong Kong, Hong Kong
Benedetta MORINI	University of Florence, Italy
Ivan OSELEDETS	Skoltech, Moscow, Russia
Xuecheng TAI	Hong Kong Baptist University, Hong Kong
Haijun WU	Nanjing University, China
Wotao YIN	University of Califonia, Los Angeles, USA
Xiaoming YUAN	Hong Kong Baptist University
Tieyong ZENG	Hong Kong Baptist University

Schedule Overview

June 21, 2017 (Wednesday)

Venue: LT1, Lady Shaw Building

8:45-9:20	Registration
9:20-9:30	Opening
9:30-10:10	Jan Hesthaven
10:10-10:50	Simon Labrunie
10:50-11:10	Coffee Break
11:10-11:50	Xiaoming Yuan
11:50-12:30	Rongjie Lai
12:30-2:00	Lunch
2:00-2:40	Kazufumi Ito
2:40-3:20	Peijun Li
3:20-3:40	Coffee Break
3:40-4:20	Jianfeng Cai
4:20-5:00	Hui Ji

June 22, 2017 (Thursday)

Venue: LT1, Lady Shaw Building

9:00-9:30	Registration
9:30-10:10	Patrick Ciarlet
10:10-10:50	Benedetta Morini
10:50-11:10	Coffee Break
11:10-11:50	Bangti Jin
11:50-12:30	Xiliang Lu
12:30-2:00	Lunch
2:00-2:40	Xiaojun Chen
2:40-3:20	Ivan Oseledets
3:20-3:40	Coffee Break
3:40-4:20	Zhengjian Bai
4:20-5:00	Tieyong Zeng
6:00-8:00	Banquet

June 23, 2017 (Friday)

Venue: LT1, Lady Shaw Building

9:00-9:30	Registration
9:30-10:10	Wotao Yin
10:10-10:50	Shingyu Leung
10:50-11:10	Coffee Break
11:10-11:50	Haijun Wu
11:50-12:30	Jun Ma
12:30-2:00	Lunch
2:00-2:40	Xuecheng Tai
2:40-3:20	Jie Liu
3:20-3:40	Coffee Break
3:40-4:20	Shiqian Ma
4:20-5:00	Eric Chung

Schedule with Titles of Talks

June 21, 2017 (Wednesday)

Venue: LT1, Lady Shaw Building

8:45-9:20	Registration
9:20-9:30	Opening
9:30-10:10	Jan Hesthaven Advances in reduced order modeling
10:10-10:50	Simon Labrunie Modelling and simulation of Boltzmann-Poisson plasma equilibria
10:50-11:10	Coffee Break
11:10-11:50	Xiaoming Yuan How to implement ADMM to large-scale datasets
11:50-12:30	Rongjie Lai Nonrigid Point Clouds Registration Using Laplace-Beltrami Eigenmaps
12:30-2:00	Lunch
2:00-2:40	Kazufumi Ito Constrained optimization method and randomized algorithm for ill-posed problems
2:40-3:20	Peijun Li Inverse Source Problems for Wave Propagation
3:20-3:40	Coffee Break
3:40-4:20	Jianfeng Cai Non-Convex Methods for Low-Rank Matrix Reconstruction
4:20-5:00	Hui Ji Computational methods for multi-linear problems in computer vision

June 22, 2017 (Thursday)

Venue: LT1, Lady Shaw Building

9:00-9:30	Registration
9:30-10:10	Patrick Ciarlet Designing Meshes for Problems with Sign-Changing Coefficients
10:10-10:50	Benedetta Morini Regularizing trust-region methods for ill-posed nonlinear systems
10:50-11:10	Coffee Break
11:10-11:50	Bangti Jin Time stepping schemes for fractional diffusion
11:50-12:30	Xiliang Lu Randomized Kaczmarz Method for Linear Inverse Problems
12:30-2:00	Lunch
2:00-2:40	Xiaojun Chen Penalty methods for a class of non-Lipschitz optimization problems
2:40-3:20	Ivan Oseledets Optimization over low-rank matrix and tensor manifolds
3:20-3:40	Coffee Break
3:40-4:20	Zhengjian Bai A Riemannian Inexact Newton-CG Method for Nonnegative Inverse Eigenvalue Problems: Nonsymmetric Case
4:20-5:00	Tieyong Zeng Image Recovery: the Never Ending Story
6:00-8:00	Banquet

June 23, 2017 (Friday)

Venue: LT1, Lady Shaw Building

9:00-9:30	Registration
9:30-10:10	Wotao Yin Asynchronous Parallel Algorithms for Large Scale Fixed-Point Problems and Optimization
10:10-10:50	Shingyu Leung A Level Set Based Variational Principal Flow Method for Nonparametric Dimension Reduction on Riemannian Manifolds
10:50-11:10	Coffee Break
11:10-11:50	Haijun Wu Polynomial preserving recovery of linear FEM for Helmholtz equation with high wave number
11:50-12:30	Jun Ma From statistical image processing to survival analysis modelling – applications of constrained optimization
12:30-2:00	Lunch
2:00-2:40	Xuecheng Tai New region force for variational models in image segmentation and high dimensional data clustering
2:40-3:20	Jie Liu A second-order changing-connectivity ALE scheme and its application to fluid structure interaction with large convection of fluids and near contact of structures
3:20-3:40	Coffee Break
3:40-4:20	Shiqian Ma Geometric descent method for convex composite minimization
4:20-5:00	Eric Chung Local multiscale model reduction via constraint energy minimization

Titles and Abstracts

A Riemannian Inexact Newton-CG Method for Nonnegative Inverse Eigenvalue Problems: Nonsymmetric Case

Zhengjian Bai
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Abstract

In this talk, we consider the nonnegative inverse eigenvalue problem of finding a nonnegative matrix such that its spectrum is the prescribed self-conjugate set of complex numbers. We reformulate the nonnegative inverse eigenvalue problem as an underdetermined constrained nonlinear matrix equation over several matrix manifolds. Then we propose a Riemannian inexact Newton-CG method for solving the nonlinear matrix equation. The global and quadratic convergence of the proposed method is established. Finally, we report some numerical experiments to illustrate the efficiency of the proposed method.

Non-Convex Methods for Low-Rank Matrix Reconstruction

Jianfeng Cai
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Abstract

We present a framework of non-convex methods for reconstructing a low rank matrix from its limited information, which arises from numerous practical applications in machine learning, imaging, signal processing, computer vision, etc. Our methods will be applied to several concrete example problems such as matrix completion, phase retrieval, and spectral compressed sensing with super resolution. We will also provide theoretical guarantee of our methods for the convergence to the correct low-rank matrix.

Penalty methods for a class of non-Lipschitz optimization problems

Xiaojun Chen
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Abstract

We consider a class of constrained optimization problems with a possibly nonconvex non-Lipschitz objective and a convex feasible set being the intersection of a polyhedron and a possibly degenerate ellipsoid. Such problems have a wide range of applications in data science, where the objective is used for inducing sparsity in the solutions while the constraint set models the noise tolerance and incorporates other prior information for data fitting. To solve this class of constrained optimization problems, a common approach is the penalty method. However, there is little theory on exact penalization for problems with nonconvex and non-Lipschitz objective functions. In this paper, we study the existence of exact penalty parameters regarding local minimizers, stationary points and ε-minimizers under suitable assumptions. Moreover, we discuss a penalty method whose subproblems are solved via a nonmonotone proximal gradient method with a suitable update scheme for the penalty parameters, and prove the convergence of the algorithm to a KKT point of the constrained problem. Preliminary numerical results demonstrate the efficiency of the penalty method for finding sparse solutions of underdetermined linear systems.

Local multiscale model reduction via constraint energy minimization

Eric Chung
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The Chinese University of Hong Kong, Hong Kong
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Abstract

Many practical applications involve solutions of PDE with highly oscillatory and high contrast coefficients. Solving them by traditional approaches require large amount of computer time and memory, and some type of model reductions are therefore necessary. In the design of localized reduced models, one challenge is to construct local modes that can capture longer range effects, which are due to, for example, high contrast channels in the domain. We have developed a new methodology to construct such local modes, and the idea is based on a constrained energy minimization principle. We show that, our approach gives a convergence rate depending only on the mesh size, but independent of the heterogeneous coefficient.

Designing Meshes for Problems with Sign-Changing Coefficients

Patrick Ciarlet

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Abstract

This talk summarizes joint works by the speaker and Anne-Sophie Bonnet-Ben Dhia, Lucas Chesnel, Camille Carvalho and Juan-Pablo Borthagaray.

Transmission problems with sign-changing coefficients occur in electromagnetic theory in the presence of negative materials surrounded by classical materials. For general geometries, establishing Fredholmness of these transmission problems is well-understood thanks to the T-coercivity approach.

Let σ be a parameter that is strictly positive in some part of the computational domain, and strictly negative elsewhere. We focus on the scalar source problem: find u such that $\mathrm{div}\,\sigma\,\nabla u = f$ plus boundary condition, where f is some data. And on the related scalar eigenvalue problem: find (u, λ) such that $\mathrm{div}\,\sigma\,\nabla u = \lambda u$ plus boundary condition.

The shape of the interface separating the two materials must be taken into account to solve the problems numerically. For a plane interface, there exist meshing rules that guarantee an optimal convergence rate for the finite element approximation. We propose a new treatment at the corners of the interface which allows to design meshing rules for an arbitrary polygonal interface and then recover standard error estimates. This treatment relies on the use of simple geometrical transforms to define the meshes. Numerical results illustrate the importance of this new design.

In a last part (time permitting), we discuss the extension of those results to nonlocal problems with sign-changing coefficients.

Advances in reduced order modeling

B. F. Afkram, J. S. Hesthaven, N. Ripamonti and S. Ubbiali
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Abstract

The development of reduced order models for complex applications, offering the promise for rapid and accurate evaluation of the output of complex models under parameterized variation, remains a very active research area. Applications are found in problems which require many evaluations, sampled over a potentially large parameter space, such as in optimization, control, uncertainty quantification and applications where near real-time response is needed.
However, many challenges remain to secure the flexibility, robustness, and efficiency needed for general large scale applications, in particular for nonlinear and/or time-dependent problems.
After giving a brief general introduction to reduced order models, we discuss developments in two different directions. In the first part, we discuss recent developments of reduced methods that conserve chosen invariants for nonlinear time-dependent problems. We pay particular attention to the development of reduced models for Hamiltonian problems and propose a greedy approach to build the basis. As we shall demonstrate, attention to the construction of the basis must be paid not only to ensure accuracy but also to ensure stability of the reduced model. We shall also briefly discuss how to extend the approach to include more general dissipative problems through the notion of port-Hamiltonians, resulting in reduced models that remain stable even in the limit of vanishing viscosity.
The second part of the talk discusses the combination of reduced order modeling for nonlinear problems with the use of neural networks to overcome known problems of on-line efficiency for general nonlinear problems. We discuss the general idea in which training of the neural network becomes part of the offline part and demonstrate its potential through a number of examples, including for the nonlinear Poisson equation and the incompressible Navier-Stokes equations with geometric variations.

Constrained optimization method and randomized algorithm for ill-posed problems

Kazufumi Ito
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Abstract

We develop the constrained optimization method for ill-posed problems. We formulate the least squares problem for the ill-posed problems with non-negative constraint and the side constraints for derivatives. We demonstrate the feasibility of our approach for remedying the ill-posed numerical method for Burgers equation and applying it to ill-posed inverse problems. Also, we develop and analyze a randomized Kaczmarz method for nonlinear ill-posed problems.

Computational methods for multi-linear problems in computer vision

Hui Ji
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Abstract

Many low-level vision problems or often seen techniques in vision can be formulated as bi-linear problems, e.g., blind image deblurring, vision in bad weather condition, dictionary learning, and many others. These problems are challenging ill-posed non-linear inverse problems yet see a wide range of applications in machine vision. In this talk, I will represent several models and techniques that provide feasible solutions to these challenging bi-linear problems, which is built upon several mathematical tools, including wavelet tight frames, sparse approximation, L1-norm relating regularization, and optimization methods for non-convex problems.

Time stepping schemes for fractional diffusion

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Abstract

Over the last decade, a large number of time stepping schemes have been developed for time-fractional diffusion problems. These schemes can be generally divided into: finite difference type, convolution quadrature type and discontinuous Galerkin methods. Many of these methods are developed by assuming that the solution is sufficiently smooth, which however is generally not true. In this talk, I will describe our recent works in analyzing and developing robust numerical schemes that do not assume solution regularity directly, but only data regularity.

Modelling and simulation of Boltzmann-Poisson plasma equilibria

O. Goubet, F. Karami, S. Labrunie and B. Pincon
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Abstract

Electrostatic equilibria of plasmas can be modelled by a non-linear Poisson equation, where the right-hand side (the charge density) is proportional to the negative exponential of the potential, while its integral is fixed.
This equation can be equivalently solved by several convex optimisation problems. Well-posedness is easy to prove, but numerical implementation can be tricky when certain parameters tend to infinity. Another interesting issue is the interplay between the non-linearity and the singularities caused by the shape of the domain. This talk presents several theoretical and numerical results on these issues.

Nonrigid Point Clouds Registration Using Laplace-Beltrami Eigenmaps

Rongjie Lai
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Abstract

Electrostatic equilibria of plasmas can be modelled by a non-linear Poisson equation, where the right-hand side (the charge density) is proportional to the negative exponential of the potential, while its integral is fixed.
This equation can be equivalently solved by several convex optimisation problems. Well-posedness is easy to prove, but numerical implementation can be tricky when certain parameters tend to infinity. Another interesting issue is the interplay between the non-linearity and the singularities caused by the shape of the domain. This talk presents several theoretical and numerical results on these issues.

A Level Set Based Variational Principal Flow Method for Nonparametric Dimension Reduction on Riemannian Manifolds

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We present a variational formulation for dimension reduction on Riemannian manifolds. The algorithm is developed based on the level set method together with a recently developed principal flow algorithm. The original principal flow algorithm is a Lagrangian technique which extends the principal component analysis (PCA) to dimension reduction on Riemannian manifolds. We propose to incorporate the level set method to obtain a fully implicit formulation so that the overall algorithm can naturally handle various topological changes in the curve evolution. The variational energy consists of two terms which try to balance the contributions from both the dataset itself and the principal direction by the PCA. We will demonstrate that the method is insensitive to the initial guess and is robust enough for noisy data. This is a joint work with H. Liu, Z. Yao and T.F. Chan.

Inverse Source Problems for Wave Propagation

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Abstract

The inverse source problems, as an important research subject in inverse scattering theory, have significant applications in diverse scientific and industrial areas such as antenna design and synthesis, medical imaging, optical tomography, and fluorescence microscopy. Although they have been extensively studied by many researchers, some of the fundamental questions, such as uniqueness, stability, and uncertainty quantification, still remain to be answered.

In this talk, our recent progress will be discussed on the inverse source problems for acoustic, elastic, and electromagnetic waves. I will present a new approach to solve the stochastic inverse source problem. The source is assumed to be a random function driven by the additive white noise. The inverse problem is to determine the statistical properties of the random source. The stability will be addressed for the deterministic counterparts of the inverse source problems. We show that the increasing stability can be achieved by using the Dirichlet boundary data at multiple frequencies. I will also highlight ongoing projects in random medium and time-domain inverse problems.

A second-order changing-connectivity ALE scheme and its application to fluid structure interaction with large convection of fluids and near contact of structures

Jie Liu
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Abstract

Fluid structure interaction (FSI) studies the motion of a rigid or elastic structure interacting with surrounding or enclosed fluids. We propose a second-order characteristic-inclined changing-connectivity arbitrary Lagrangian Eulerian (ALE) FSI solver. It does not explicitly calculate the characteristics but allows characteristic-inclined discretization. Large mesh distortions are prevented by mesh smoothing and edge/face swapping techniques. The resulting scheme can therefore handle problems with large deformation of the structure and strong convection of the fluid. The scheme is very efficient as we only need to solve a linear equation in each time step. We use the standard P_m/P_{m-1} finite elements and prove that the scheme has optimal convergence rate for the incompressible Navier-Stokes equations on a time varying domain. When the deformation of the fluid domain is part of the unknown, the scheme is shown to be stable. I will also mention the limitation of the current PDE model.

Randomized Kaczmarz Method for Linear Inverse Problems

Prof. Xiliang Lu
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Abstract

In this talk we will discuss a randomized Kaczmarz method for linear inverse problems. We will explain why randomized Kaczmarz is suitable for linear inverse problem by providing pre-asymptotic analysis and studying the structure of some specific problems. Numerical examples validated our analysis.

From statistical image processing to survival analysis modelling – applications of constrained optimization

Jun Ma
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Abstract

Constrained optimization technique becomes an important component in many modern statistical methods, such as density estimation, semi-parametric hazard regression, statistical image processing etc. In particular, situations arises frequently that the number of constraints can be extremely large, often even larger than the number of observations. Therefore, efficient constrained optimization methods which can handle large number of constraints become crucial in successful applications of these statistical methods. In this talk, we will provide some statistical estimation examples where the number of constraints encountered can be very large. Specially designed algorithms will be applied to solve these constrained optimization problems.

Geometric descent method for convex composite minimization

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Abstract

We extend the geometric descent method recently proposed by Bubeck, Lee and Singh to tackle nonsmooth and strongly convex composite problems. We prove that our proposed algorithm, dubbed geometric proximal gradient method (GeoPG), converges with a linear rate $(1-1/\sqrt{\kappa})$, and thus achieves the optimal rate among first-order methods, where κ is the condition number of the problem. Numerical results on linear regression and logistic regression with elastic net regularization show that GeoPG compares favorably with Nesterov's accelerated proximal gradient method, especially when the problem is ill-conditioned.

Regularizing trust-region methods for ill-posed nonlinear systems

Benedetta Morini
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Abstract

Nonlinear systems modeling inverse problems are typically ill-posed, in the sense that their solutions do not depend continuously on the data and their data are affected by noise. We develop a regularizing optimization method in the trust-region framework. Our new trust-region procedure approaches a solution of the unperturbed problem by forming approximations of increasing accuracy until the discrepancy principle is met. We discuss the convergence properties of the new method and show its numerical behavior making comparisons with existing approaches from the literature.

Optimization over low-rank matrix and tensor manifolds

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Abstract

Optimization with low-rank matrix/tensor constraint plays an important role in many applications. The standard parametrization of low-rank sets leads to a non-convex formulation, but even simple alternating (block coordinate) algorithms show good convergence properties. More advanced optimization algorithms are based on the so-called Riemannian framework.
In this talk, I will discuss different theoretical and algorithmic issues, including:
1) Dealing with singular points on low-rank manifolds using desingularization approach from algebraic geometry
2) Local convergence properties of ALS and Riemannian optimization algorithms
3) Generalization of Jacobi-Davidson method to Riemannian optimization

New region force for variational models in image segmentation and high dimensional data clustering

Xuecheng Tai
Department of Mathematics
Hong Kong Baptist University, Hong Kong
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Abstract

In this work, we propose an effective framework for multi-phase image segmentation and semi-supervised data clustering by introducing a novel region force term into the Potts model. Assume the probability that a pixel or a data point belongs to each class is known a priori. We show that the corresponding indicator function obeys the Bernoulli distribution and the new region force function can be computed as the negative log-likelihood function under the Bernoulli distribution. We solve the Potts model by the primal-dual hybrid gradient method and the augmented Lagrangian method, which are based on two different dual problems of the same primal problem. Empirical evaluations of the Potts model with the new region force function on benchmark problems show that it is competitive with existing variational methods in both image segmentation and semi-supervised data clustering.
This is based on a joint work with Tony Chan, Ke Wei and Ke Yin.

Polynomial preserving recovery of linear FEM for Helmholtz equation with high wave number

Haijun Wu
Department of Mathematics
Nanjing University, China
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Abstract

Superconvergence properties of the linear finite element method with the polynomial preserving recovery for the two dimensional Helmholtz equation with high wave number are considered. Estimates with explicit dependence on the wave number are derived. Numerical examples are provided to illustrate the theoretical findings.

Asynchronous Parallel Algorithms for Large Scale Fixed-Point Problems and Optimization

Wotao Yin
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Abstract

Since 2005, the single-threaded CPU speed has stopped improving significantly; it is the numbers of cores in each machine that continue to arise. On the other hand, most of our algorithms are still single-threaded, and because so, their running time will stay about the same in the future. To develop faster algorithms, especially for those large-scale problems, it is inevitable to consider parallel computing.

In parallel computing, multiple agents (e.g. CPU cores) collaboratively solve a problem by concurrently solving their simpler subproblems. For most, the subproblems depend on each other, so the agents must regularly exchange information. In asynchronous computing, each agent can compute with the information it has, even if the latest information from other agents has not arrived. Asynchronism is extremely important to the efficiency and resilience of parallel computing. Without asynchronism, all cores have to wait for the arrival of latest information, so the speed of parallel computing is dictated by the slowest core, the most difficult subproblem, and the longest communication delay. Without asynchronism, the entire parallel computing must stop when an agent (or a network link) fails and awaits a fix, and such failures will happen more often as the system gets larger. Today, most algorithms are still singled-threaded, and most of the already-parallelized algorithms are synchronous. In spite of both mathematical and coding challenges, we report recently established convergence and numerical results for a set of fixed point problems and optimization problems that arise in machine learning, image processing, portfolio optimization, second-order cone programming, and beyond.

How to implement ADMM to large-scale datasets

Xiaoming Yuan
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Abstract

The alternating direction method of multipliers (ADMM) is being popularly used for a wide range of applications including many in data science and engineering. To tackle very large-scale datasets of some representative statistical learning problems such as the LASSO and distributed LASSO, it is neither possible nor necessary to solve the ADMM subproblems exactly or up to a high precision --- inexact solutions in low-accuracy are cheaper while indeed better towards the convergence. We try to study this implementation issue mathematically. We are particularly interested in the case where the subproblems are very large-scale systems of linear equations and they are solved iteratively by benchmark numerical linear algebra solvers such as CG or SOR. We show how to rigorously ensure the convergence for this case. More specifically, we estimate precisely how many iterations of these numerical linear algebra solvers are needed to ensure the convergence. We thus make the implementation of ADMM embedded with benchmark numerical linear algebra solvers for large-scale cases of some statistical learning and engineering problems fully automatic, with proved convergence.

Image Recovery: The Never Ending Story

Tieyong Zeng
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Abstract

Image recovery is fundamental in the domain of image processing. We present some recent progress in this area.

Directions

A. Between Airport and Accommodation

1) Royal Park Hotel （帝都酒店）

Address: 8 Pak Hok Ting Street, Sha Tin, New Territories, Hong Kong香港新界沙田白鶴汀街八號

Telephone: +852 2601 2111

Website: http://www.royalpark.com.hk/hongkong/eng/index.html

By Public Airport Bus

(Not recommended for guests who have bulky luggage)

Public Airport Bus No. A41 goes from the airport to Royal Park Hotel bus stop (帝都酒店巴士站), for HK$22.3 per person. It runs from 06:00 to 24:00 and departs every 20 min at Airport Bus Terminus. The journey takes approx. 65 min.

Details of Airport Bus No. A41:
http://search.kmb.hk/KMBWebSite/index.aspx?lang=en

By Taxi

A direct taxi ride from the airport to the hotel would cost about HK$300 per car (max 5 persons each), and would take around 40 minutes depending on the traffic.

*For your easy communication with taxi driver, you may show the following Chinese note card:

請送我到 (Please drive me to):

新界沙田白鶴汀街八號帝都酒店

Royal Park Hotel,
8 Pak Hok Ting Street, Sha Tin, N.T.

2) Yali Guest House （香港中文大學雅禮賓館）

Address: Yali Guest House, University Guest House System, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong
香港新界沙田香港中文大學 大學賓館系統 雅禮賓館

Telephone: +852 2603 6411

Website: http://www.cuhk.edu.hk/ugh/

By Public Airport Bus

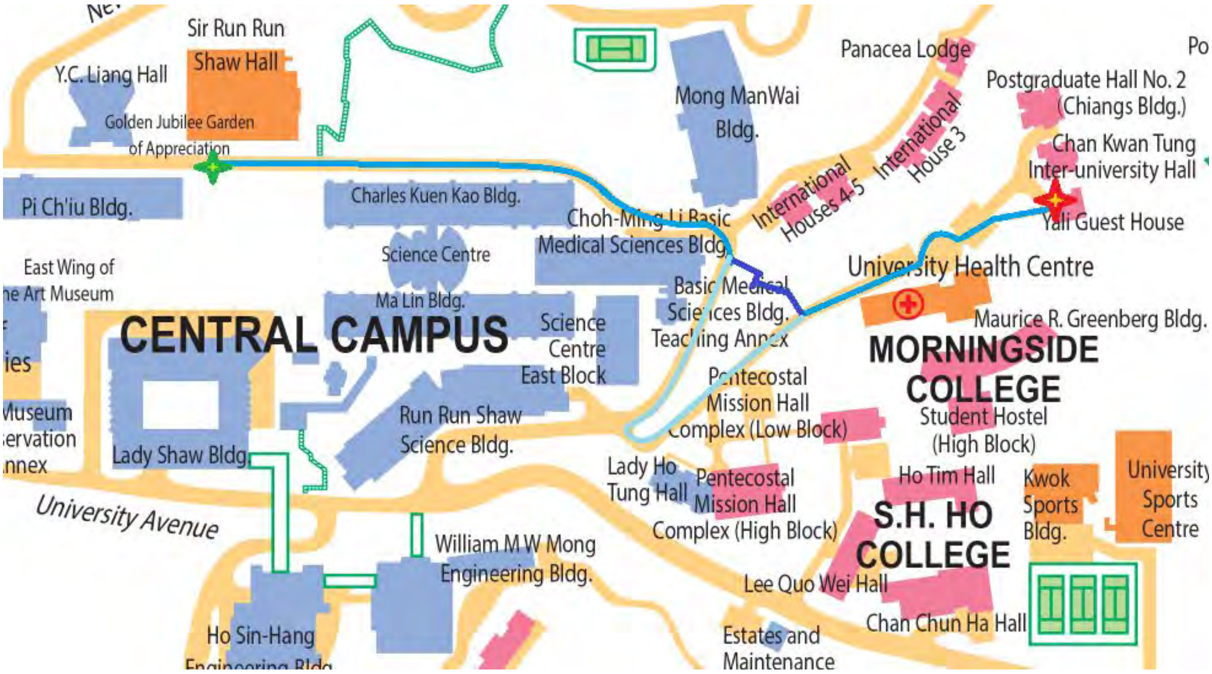
(Not recommended for guests who have bulky luggage)

Take the airport bus to the Shatin MTR station, then connect to either taxi or MTR train. At the Airport Bus Terminus, take Airport Bus A41. Get off at Shatin Central Bus Terminus, above which is a mall known as New Town Plaza (新城市廣場). Please note that the stop should appear after passing a long tunnel, and it is not the terminal stop for Bus A41. Ask the driver where to get off or pay attention to the announcement to get off correctly. The bus departs every 20 minutes, and the journey takes around 40 minutes depending on traffic conditions.

At Shatin MTR Station, you can connect by:

- **Taxi**
  You can take a taxi to the guest house. The fare is about HK$70. It will take about 15 minutes. For easy communication with the taxi driver, you may show the Chinese note card on the next page.
- **MTR Train**
  Take the escalator from the Bus Terminus to New Town Plaza, and board the MTR from Sha Tin to University. It is a 9-minute ride. At University MTR Station, take Exit A.
  You may then either take the campus shuttle bus or the guest house shuttle service. For campus shuttle bus, you can take Route 1A / 1B / H near MTR Exit A - C or Route 3 near MTR Exit D. Get off at the Sir Run Run Shaw Hall stop. On disembarking, get on the sidewalk where Sir Run Run Shaw Hall is. Look towards where the bus came from and you should see a building that includes a yellow cylindrical tower. Keep walking towards that building (Mong Man Wai Building) until the driveway makes a right turn, where three student halls stand. There are two choices depending on physical ability:
    - Easy walking: Descend along the bend and turn left at the next intersection, where the path on the left makes an acute angle of around 40 degrees with the original slope, and where the parking entrance of the colorful Run Run Shaw Science Building lies on the other side of the road. Then walk to the end of the pavement.
    - Shortcut: Descend the staircase to the right of the student halls. At the foot of the staircase, turn left and walk to the very end of the path.

  In either case, the guest house is partially hidden behind trees. The following map shows the two paths:



On the other hand, the Yali Guest House provides free shuttle bus service to and from Exit A of the University MTR Station. You may find the service timetable at http://www.cuhk.edu.hk/ugh/Guest-house/BusSchedule(UGH)2015.pdf. If you require shuttle bus service at night, please send your request to aggie@math.cuhk.edu.hk before your arrival.

By Taxi

A direct taxi ride from the airport to the hotel would cost about HK$300 per car (max 5 persons each), depending on the traffic.

*For your easy communication with taxi driver, you may show the following Chinese note card:

請送我到 (Please drive me to):

香港中文大學 雅禮賓館 (保健處旁)

(司機請於大學門口向保安組人員查詢詳細位置)

Yali Guest House,
The Chinese University of Hong Kong,
Sha Tin, N.T.

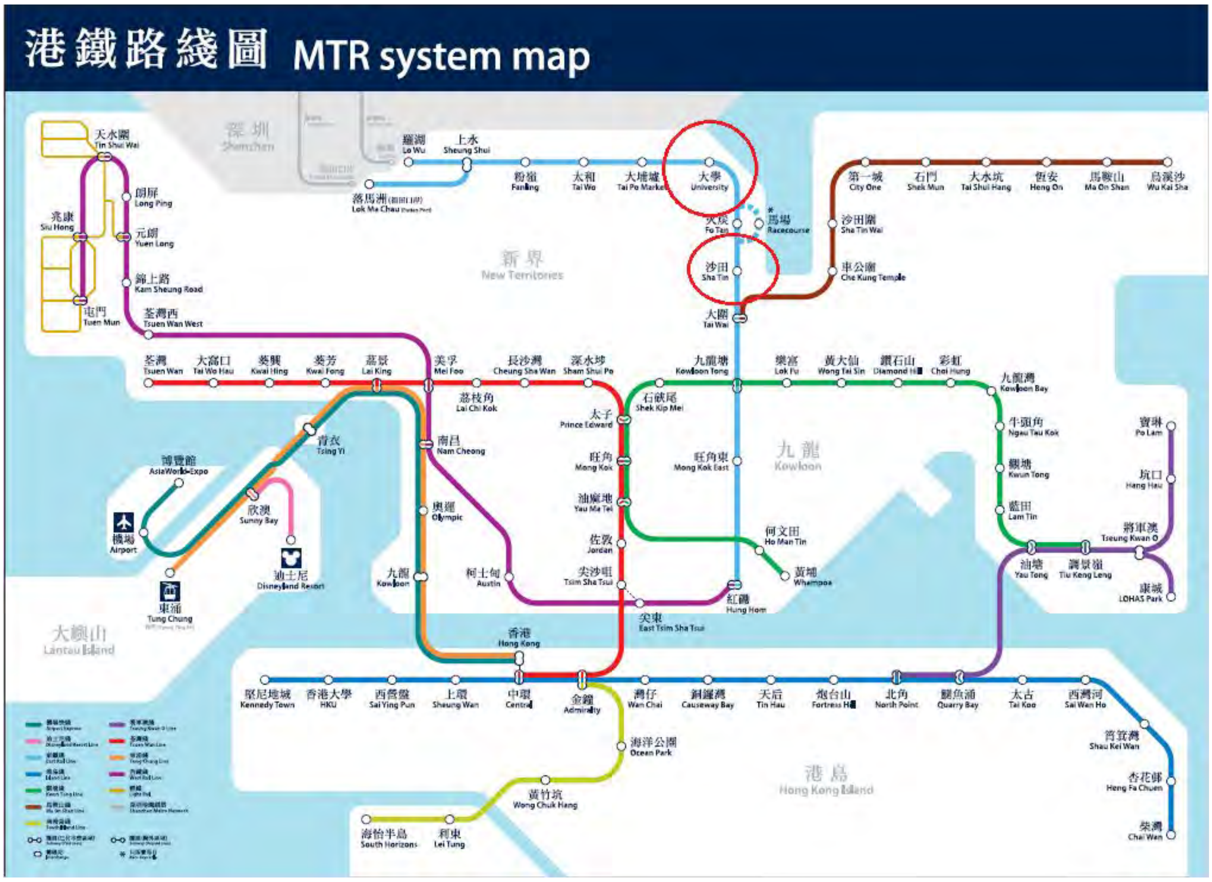
B. Between Accommodation & Conference Venue

The workshop will take place at LT1, Lady Shaw Building (LSB), The Chinese University of Hong Kong.

For guests staying at the Royal Park Hotel

Step 1: From your hotel to Shatin MTR station
From Royal Park Hotel (帝都酒店), you can walk to Shatin MTR station through the New Town Plaza (新城市廣場). It takes about 10 minutes.

Step 2: From Shatin MTR station to University MTR Station
Take the train to University MTR station, which is two stops away from Shatin MTR station.



Step 3: From University MTR Station to LSB

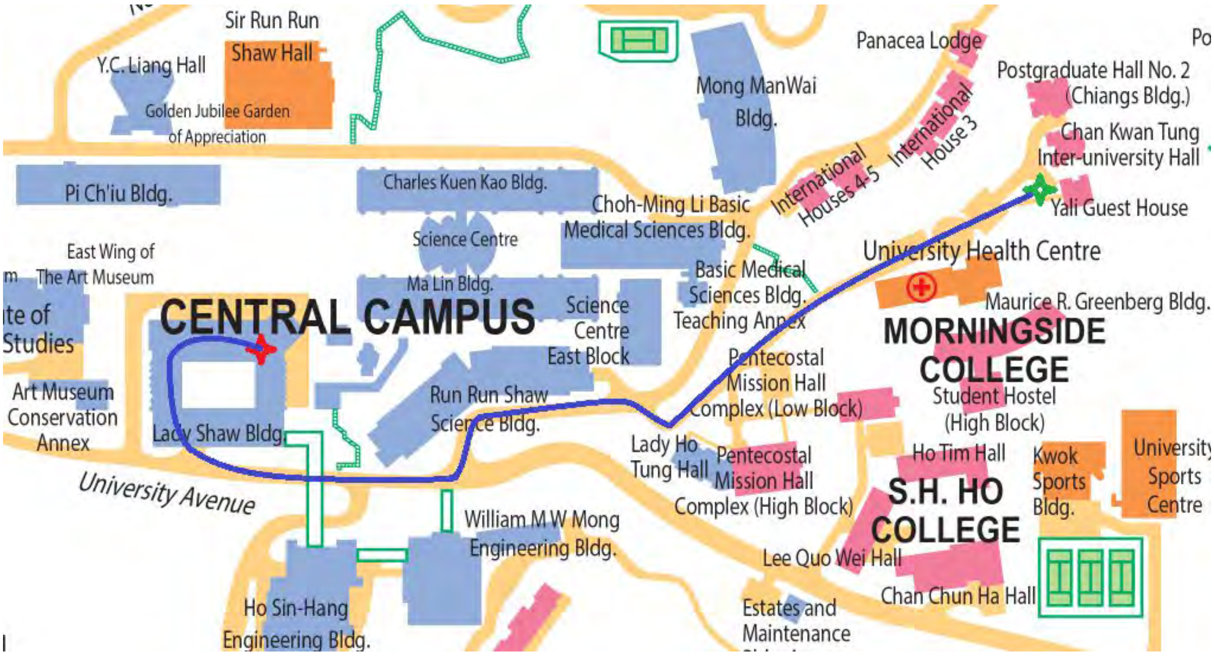
The LSB building is located at the main campus of CUHK. Take Shuttle Bus 1A / 1B / H near MTR Exit A - C or Shuttle Bus 3 near MTR Exit D. Get off at the Sir Run Run Shaw Hall stop.

The rooftop garden opposite Sir Run Run Shaw Hall is part of Lady Shaw Building. Go there and go downstairs the reach the Lady Shaw Building. Go to 1/F and turn left to go to LT1.

For guests staying at Yali Guest House

Follow the route indicated by the map below. Be careful when crossing the road, as cars and shuttle buses often travel along the roads in this path.

Climb uphill along University Avenue until you reach a three-way intersection. Enter the glass doors on your right. Enter the lift at LG2/F of Lady Shaw Building. The lecture theatre LT1 is on 1/F. Turn left when you get off the elevator.



Meals

We will provide tea breaks, lunches and a banquet during the workshop.

Banquet

Venue: Jasmine Room II, Level 2, Royal Park Hotel

Date: 22 June 2017

Time: Starts at 6:00pm

Wi-Fi Account

Wi-Fi SSID:	**CUguest**
User ID:	**osc2017@conference.cuhk.edu.hk**
Password:	**Cuhkmath**

Useful Information

1. Travel Card

Octopus Card, an electronic fare card that is accepted by almost all forms of public transport, and at many fast food chains and stores. It's convenient and eliminates the need for small change.

Add money to it whenever you need to, and any unspent value in On-Loan Octopus is refundable along with the HKD50 deposit at any MTR Station. *minus HKD9 handling fee for cards returned within three months.

For more details, please refer to:

http://www.octopus.com.hk/home/en/index.html

2. Emergency Numbers

For any kind of emergency, please contact the Security Unit.
Telephone: 3943 7999
Email: security_unit@cuhk.edu.hk

CUHK Campus Map

MTR System Map

List of Participants

Bakhyt ALIPOVA	International Information Technology University
Ivan AU YEUNG	The Chinese University of Hong Kong
Zhengjian BAI	Xiamen University
Jianfeng CAI	The Hong Kong University of Science and Technology
Raymond CHAN	The Chinese University of Hong Kong
Hei Long CHEN	The Chinese University of Hong Kong
Shixiang CHEN	The Chinese University of Hong Kong
Xiaojun CHEN	The Hong Kong Polytechnic University
Xinshi CHEN	The Chinese University of Hong Kong
Wanyou CHENG	Dongguan University of Technology
Zaiheng CHENG	Jiangxi Normal University
Eric CHUNG	The Chinese University of Hong Kong
Patrick CIARLET	ENSTA ParisTech
Stefano CIPOLLA	University of Rome "Tor Vergata"
Chengzhi DENG	Nanchang Institute of Technology
Zengde DENG	The Chinese University of Hong Kong
Thuat DO VAN	The Hong Kong University of Science and Technology
Jie DU	The Chinese University of Hong Kong
Mingmeng GENG	Southern University of Science and Technology
Xuyang GUO	The Chinese University of Hong Kong
Jan S. HESTHAVEN	Ecole Polytechnique Federale de Lausanne
Kazufumi ITO	North Carolina State University
Hui JI	National University of Singapore
Bangti JIN	University College London
Guoliang JU	Southern University of Science and Technology
Simon LABRUNIE	University of Lorraine
Owen LAI	The Chinese University of Hong Kong

Rongjie LAI	Rensselaer Polytechnic Institute
Chi Yeung LAM	The Chinese University of Hong Kong
Ming Fai LAM	The Chinese University of Hong Kong
Chun Pong LAU	The Chinese University of Hong Kong
Haitao LENG	South China Normal University
Shingyu LEUNG	The Chinese University of Hong Kong
Yusan LEUNG LIU	The Chinese University of Hong Kong
Chor Hung LI	The Chinese University of Hong Kong
Jiao LI	Changsha University of Science and Technology
Lan LI	Chinese Academy of Sciences
Peijun LI	Purdue University
Zhenzhen LI	The Hong Kong University of Science and Technology
Ying LIANG	The Chinese University of Hong Kong
Haixia LIU	The Hong Kong University of Science and Technology
Zhifang LIU	Nankai University
Jie LIU	National University of Singapore
Yi-Su LO	The Hong Kong University of Science and Technology
Xiliang LU	Wuhan University
Ronald LUI	The Chinese University of Hong Kong
Jun MA	Macquarie University
Mingxi MA	Nanchang Institute of Technology
Shiqian MA	The Chinese University of Hong Kong
Lizhang MIAO	The Hong Kong University of Science and Technology
Benedetta MORINI	University of Florence
Ivan OSELEDETS	Skoltech, Moscow
Sai Mang PUN	The Chinese University of Hong Kong
Yingchun QI	Southern University of Science and Technology
Di QIU	The Chinese University of Hong Kong
Yi RONG	The Hong Kong University of Science and Technology
Feng SHI	Harbin Institute of Technology

Xin SU	The Chinese University of Hong Kong
Xuecheng TAI	Hong Kong Baptist University
Abdel Hamid TALAAT	Menoufiya University
Conghui TAN	The Chinese University of Hong Kong
Samad WALI	Nankai University
Keyan WANG	South China Normal University
Peng WANG	The Chinese University of Hong Kong
Tianming WANG	The Hong Kong University of Science and Technology
Bokai WU	Jiangxi Normal University
Haijun WU	Nanjing University
Lilei WU	National University of Defense Technology
Guiyun XIAO	Xiamen University
Yue XUAN	South China Normal University
Qile YAN	The Chinese University of Hong Kong
Zhengzheng YAN	Chinese Academy of Sciences
Wotao YIN	University of California, Los Angeles
Jinyong YING	Central South University
Xiaoming YUAN	Hong Kong Baptist University
Taishan ZENG	South China Normal University
Tieyong ZENG	Hong Kong Baptist University
Jun ZHANG	Nanchang Institute of Technology
Yufei ZHANG	The Chinese University of Hong Kong
Yulong ZHOU	Hong Kong Baptist University
Jun ZOU	The Chinese University of Hong Kong