International Workshop on Numerical Linear Algebra with Applications

in honor of the 75th birthday of
Prof. Robert Plemmons

November 17-18, 2013
Hong Kong

香 港 中 文 大 學
The Chinese University of Hong Kong

香港浸會大學
HONG KONG BAPTIST UNIVERSITY

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Introduction

The workshop aims to provide a forum for leading experts and active young researchers in the field of Numerical Analysis and Image Processing to exchange ideas and present their latest research achievements, as well as to explore exciting new directions in the areas. It is also an occasion to celebrate the 75^{th} birthday for Prof. Robert Plemmons.

Numerical Linear Algebra is one of the many active research areas to which Prof. Robert Plemmons has made fundamental contributions in the past, such as in nonnegative matrices and M-matrices, etc. He has worked on applications of numerical linear algebra and optimization to image processing for the past 20 years. His work includes a wide range of disciplines, such as geospatial imaging and randomized algorithms for remote sensing. Prof. Plemmons's research has been continuously funded by research grants form a variety of government sources since 1968.

Professor Robert Plemmons

Robert Plemmons was born on 18 December 1938 in Old Fort, North Carolina. He received his bachelor's degree in mathematics from Wake Forest University in 1961 and his doctorate in applied mathematics from Auburn University in 1965, under the supervisor of Prof. Richard Ball. He has held research positions at Martin-Marietta Company and the National Security Agency. He has also testified before two U.S. Congressional Committees as a consultant on DoD basic research priorities. In addition, he has held academic positions at the University of Tennessee and North Carolina State University, and found the University of North Carolina System's Center for Research in Scientific Computation at North Carolina State University.

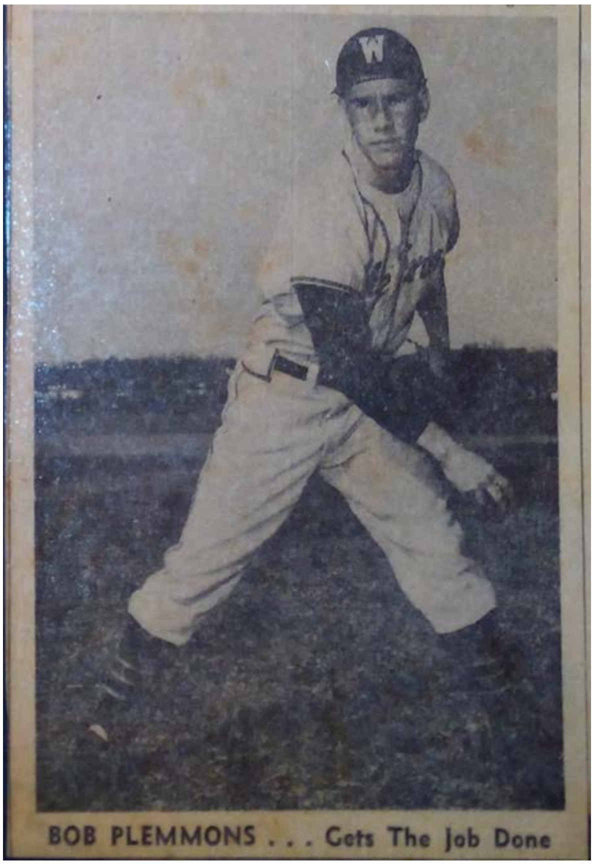
In 1990, as the Emeritus Z. Smith Reynolds Professor of Mathematics and Computer Science, Prof. Plemmons returned back and joined the Wake Forest University faculty. Although retired from teaching in 2013, he never cease to conduct research.

His research interest includes computational mathematics applied to problems arising in image and signal processing, optics, and photonics. His work is supported by the Air Force Office of Scientific Research (AFOSR) on the topic of "space situational awareness", in collaboration with Sudhakar Prasad at the University of New Mexico, David Brady at Duke University, and Peter Zhang at Wake Forest University. In U.S. Defense Department research for over 40 years, Prof. Plemmons' recent efforts have focused on using applied mathematics (algorithms) in remote sensing methods such as hyperspectral, LiDAR and polarimetric imaging.

This precious picture is taken in the First International Invited Conference at Oxford University, 1968. Prof. Plemmons is the second right in the first row.

Prof. Plemmons is a member of APS, IEEE, OSA and SPIE, and a SIAM Fellow. He served on the editoral boards of six journals. During his career, he has published more than 250 articles and books on computational mathematics, has presented over

350 invited research lectures, including lectures in 30 foreign countries, and has received research grants from the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), the Department of Energy (DOE), the National Science Foundation (NSF), and the North Atlantic Treaty Organization (NATO).



He played professional baseball in the Baltimore Orioles farm System for four years in the 1960's after graduating from Wake Forest on a baseball scholarship. He is an eager ocean fisherman and gardener; he has often gone fishing trips to Gulf Stream with his friends and colleagues. He even used to pilot his own airplane.

Prof. Plemmons speaks often, and most proudly, about his family. However, probably his best well-known nonmathematical attribute is his kindness and generosity. He likes to travel to different parts of the world. He first visited Hong Kong in 1991 after a trip in Japan.

The left picture is from the newspaper *THE CHARLOTTE OBSERVER* on April 17, 1960, which reported that "Plemmons Fast Balls Deacs Toward Title" and "Plemmons Hurls 9-2 Victory For Deacons".

His excellent Ph. D. students are listed as follows: James Dombeck (1970), Donald Ramsey (1970), James Wall (1971), James Nichols (1973), Linda Lawson (1975), William Harrod (1982), Daniel Pierce (1986), Ching Pan (1987), AF Major Douglas James (1989), William Ferng (1991), Ho-Jong Jang (1991), James Nagy (1991), Tim Persons (co-supervised, 2001).

Top: a family picture taken at Bob's retirement dinner, in the back row: Bob and his son Greg; in the middle row from left: Bob's son-in-law Pau'l Pauca, Bob's daughter-in-law Yuki, Bob's wife Mary Jo, Bob's daughter Theresa, and Bob's eldest granddaughter Sofia; in the front row from left: Bob's grandchildren Victor, Sakura Anne and Francesca; the left top one is Bob with his smallest grandson Akira Everett. Bottom left: Bob in Machu Picchu, Peru. Bottom right: Bob and Mary Jo in a trip to Japan in 1991---before they came to Hong Kong for the first time.

A Grandfather

By Sofia Pauca

A Grandfather is like no other,
The one who nurtures you is your mother,
The one who tumbles playfully around with you is your sister or brother,
Your father protects you, but doesn't smother,
You can spend a wintery evening baking cookies with your grandmother,
But nobody else has the wisdom of a grandfather.

He takes you out to movies with coke and popcorn,
And out to the mall to buy clothes that you haven't already worn,
Together you play baseball outside with your jeans that are torn,
But that doesn't matter because you have nothing in the world to mourn.

Yet, what really matters is the wisdom he teaches you,
The lessons of life are what count too,
You go from a toddler who belongs in a zoo,
To a thoughtful teen who knows exactly what to do.

That's what makes a grandfather the wise and loving man that he is,
Especially my own grandfather,
Nay-Nay.

A poem written by Bob's granddaughter Sofia

Organizing Committee

- Raymond Chan (Chair), The Chinese University of Hong Kong
- Ronald Lui, The Chinese University of Hong Kong
- Michael Ng, Hong Kong Baptist University

Sponsors

- Hong Kong Mathematical Society
- Department of Mathematics, The Chinese University of Hong Kong
- Centre for Mathematical Imaging and Vision, Hong Kong Baptist University

Special Issue for Prof. Robert Plemmons's 75th Birthday Workshop

We are happy to announce that there will be a special issue for the workshop. It will be published by Numerical Linear Algebra with Applications (NLAA), and edited by James Nagy and Michael Ng.

All invited speakers in the workshop are invited to submit an original paper to the special issue. The deadline for submission is May 31, 2014, and the reviewing process follows the NLAA regulations. In particular, the chief editor of NLAA reserves the right not to publish papers outside the scope of NLAA.

Invited Speakers

George Barbastathis	University of Michigan – Shanghai Jiao Tong University Joint Institute
Abraham Berman	Technion - Israel Institute of Technology
Michael Berry	The University of Tennessee
Dave Brady	Duke University
Raymond Chan	The Chinese University of Hong Kong
Tony Chan	The Hong Kong University of Science & Technology
Donghui Chen	Southwestern University of Finance and Economics
Wai-ki Ching	The University of Hong Kong
Moody Chu	North Carolina State University
Nicolas Gillis	Université de Mons
Stuart Jefferies	University of Hawaii (cancelled)
Misha Kilmer	Tufts University (cancelled)
James G. Nagy	Emory University
Michael Ng	Hong Kong Baptist University
Robert Plemmons	Wake Forest University
Sudhakar Prasad	University of New Mexico
Liqun Qi	The Hong Kong Polytechnic University
Haiwei Sun	University of Macau
Jinyun Yuan	Universidade Federal do Paraná
Peter Zhang	Wake Forest University

Schedule

November 17, Sunday

Venue:	LT3, Lady Shaw Building, CUHK (see map on p.22)
Session Chair	**Michael Ng**
09:10-09:30	Opening Ceremony and Group Photo
09:30-10:10	Abraham Berman *Completely Positive Matrices and Optimization* (p.11)
10:10-10:50	James Nagy *Iterative Krylov Subspace Methods for Sparse Reconstruction* (p.16)
10:50-11:10	Coffee Break
11:10-11:50	David Brady *Compressive Tomography* (p. 12)
11:50-12:30	Peter Zhang *Compressive Hyperspectral Imaging of Space Objects* (p. 20)
12:30-14:30	Lunch (Benjamin Franklin Centre Staff Canteen)
Session Chair	**James G. Nagy**
14:30-15:10	Moody Chu *DNA-like Structure of Surfaces* (p.14)
15:10-15:50	Michael Berry *Using Large-scale Matrix Factorizations to Identify Users of Social Networks* (p.11)
15:50-16:10	Coffee Break
16:10-16:50	Wai-Ki Ching *On Construction of Probabilistic Boolean Networks* (p.14)
16:50-17:30	George Barbastathis *Compressive phase retrieval* (please refer to the supplementary page)

November 18, Monday

Venue:	LT1, Cheng Yu Tung Building, CUHK (see map on p.25)
Session Chair	**Raymond Chan**
09:30-10:10	Sudhakar Prasad *3D Computational Imaging via Rotating PSFs* (p.17)
10:10-10:50	Michael Ng *What I learned from Professor Robert Plemmons* (p.17)
10:50-11:10	Coffee Break
11:10-11:50	Nicolas Gillis *Some Recent Advances in Nonnegative Matrix Factorization and their Applications to Hyperspectral Unmixing* (p.15)
11:50-12:30	Donghui Chen *Multiplicative Updates for Nonnegative Least Squares* (p. 13)
12:30-14:30	Lunch (Café 12, 3/F Cheng Yu Tung Building)
Session Chair	**Moody Chu**
14:30-15:10	Liqun Qi *Hankel Tensors: Associated Hankel Matrices and Vandermonde Decomposition* (p.18)
15:10-15:50	Haiwei Sun *Fast Approximate Inversion of Block Triangular Toeplitz Matrix with Applications to Fractional Sub-Diffusion Equations* (p. 19)
15:50-16:10	Coffee Break
16:10-16:50	Jinyuan Yuan *The Ostrowski-Reich Theorem for Splitting Iterative Methods* (p.19)
16:50-17:30	Raymond Chan *A Two-stage Image Segmentation Method using a Convex Variant of the Mumford-Shah Model and Thresholding* (p.12)
17:30-18:10	Tony Chan *Image Denoising using Mean Curvature of Image Surface* (p.13)
18:30-	Banquet (Sha Tin 18 Restaurant, 4/F, Hyatt Regency Hotel) (see map on p.26)

Titles and Abstracts

Completely Positive Matrices and Optimization

Abraham Berman
Department of Mathematics
Technion-Israel Institute of Technology

Abstract

A matrix A is completely positive if it has a nonnegative factorization $A = BB^T$ where B is element wise nonnegative. The smallest number of columns in such a matrix B is called the cp-rank of A. The $n \times n$ completely positive matrices form a closed convex cone and its dual is the cone of co-positive matrices. A completely positive matrix is doubly nonnegative – it is positive semi definite and it is element wise nonnegative. The $n \times n$ doubly nonnegative matrices also form a closed convex cone which, for $n > 4$, strictly contains the cone of completely positive matrices. Every optimization problem with quadratic objective function, linear constrains and binary variables can be equivalently written as a linear problem over the completely positive cone. However, the problem of checking whether a given matrix is completely positive is NP-hard. A bound for the optimal value can be obtained by replacing the completely positive cone by the doubly nonnegative cone.

In the talk I will show how one can generate co-positive cuts for this relaxation. I will also describe some recent results on the cp-rank.

Using Large-scale Matrix Factorizations to Identify Users of Social Networks

Michael W. Berry
Department of Electrical Engineering and Computer Science
The University of Tennessee

Abstract

Users of social media interact with the network and its users. Each interaction creates network specific data between the engaged users and the chosen social avenue. Over time, these engagements accumulate to describe the user's social fingerprint, an identity which encapsulates the user's persona on the network. The agglomeration of this information showcases the user's activity on the social network and establishes a traceable social fingerprint. These fingerprints can be tracked and stored as large matrices representing the quantity and occurrence of observed user behavior. We seek to apply large-scale matrix factorization techniques to establish the signature component vector of a social network user's identity. The preliminary results presented will demonstrate that a user's social finger-print is both quantifiable and identifiable on a social network through out time.

This is a joint work with Denise R. Koessler.

Compressive Tomography

David J. Brady
Center for Nonlinear and Complex Systems
Duke University

Abstract

Since coming to Duke in 2001 I have had many interactions with Bob Plemmons and other members of the North Carolina numerical processing community. Beginning with work on reference structure tomography in 2004 with Xiaobai Sun and Nikos Pitisianis and continuing through recent work with Bob and Qiang Zhang on classification of compressed spectral images, this work has revolved around the theme of snapshot tomographic imaging. This talk reviews this history and considers practical applications in x-ray tomography, radar, holography and photography.

A Two-stage Image Segmentation Method using a Convex Variant of the Mumford-Shah Model and Thresholding

Raymond Chan
Department of Mathematics
The Chinese University of Hong Kong

Abstract

The Mumford-Shah model is one of the most important image segmentation models, and has been studied extensively in the last twenty years. In this talk, we propose a two-stage segmentation method based on the Mumford-Shah model. The first stage of our method is to find a smooth solution g to a convex variant of the Mumford-Shah model. Once g is obtained, then in the second stage, the segmentation is done by thresholding g into different phases. The thresholds can be given by the users or can be obtained automatically using any clustering methods. Because of the convexity of the model, g can be solved efficiently by techniques like the split-Bregman algorithm or the Chambolle-Pock method. We prove that our method is convergent and the solution g is always unique. In our method, there is no need to specify the number of segments K ($K \geq 2$) before finding g. We can obtain any K-phase segmentations by choosing K - 1 thresholds after g is found in the first stage; and in the second stage there is no need to recompute g if the thresholds are changed to reveal different segmentation features in the image. Experimental results show that our two-stage method performs better than many standard two-phase or multi-phase segmentation methods for very general images, including anti-mass, tubular, MRI, noisy, and blurry images; and for very general noise models such as Gaussian, Poisson and multiplicative Gamma noise.

Image Denoising using Mean Curvature of Image Surface

Tony Chan
Department of Computer Science & Engineering
The Hong Kong University of Science & Technology

Abstract

We propose a new variational model for image denoising, which employs the L^1-norm of the mean curvature of the image surface $(x, f(x))$ of a given image $f\colon \Omega \to \mathbb{R}$. Besides eliminating noise and preserving edges of objects efficiently, our model can keep corners of objects and greyscale intensity contrasts of images and also remove the staircase effect. We analytically study the proposed model and justify why our model can preserve object corners and image contrasts. We apply the proposed model to the denoising of curves and plane images, and also compare the results with those obtained by using the classical Rudin—Osher—Fatemi model. Finally, we will also discuss a fast computational method for our model using augmented Lagrangian method, which can convert the original higher order and non-differentiable minimization problem to several lower order and easier-to-handle ones.

This is a joint work with Wei Zhu, Department of Mathematics, University of Alabama, and Xue-Cheng Tai, Department of Mathematics, University of Bergen.

Multiplicative Updates for Nonnegative Least Squares

Donghui Chen
School of Securities and Futures
Southwestern University of Finance and Economics

Abstract

Many problems in image processing involve solving least squares problems with nonnegativity constraints. In this talk, we derive multiplicative updates that converge monotonically to the global minimum. The updates have a simple closed form and are amenable to fine-grained data parallelism. We provide complete proofs of convergence for these updates and describe their application to problems in image processing.

On Construction of Probabilistic Boolean Networks

Wai-ki Ching
Advanced Modeling and Applied Computing Laboratory
Department of Mathematics
The University of Hong Kong

Abstract

Modeling genetic regulatory networks is an important problem in genomic research. Boolean Networks (BNs) and their extensions Probabilistic Boolean Networks (PBNs) have been proposed for modeling genetic regulatory interactions. We are interested in system synthesis which requires the construction of such a network. It is a challenging inverse problem, because there may be many networks or no network having the given properties, and the size of the problem is huge. The construction of PBNs from a given transition-probability matrix and a given set of BNs is an inverse problem of huge size. In this talk, we shall propose some construction methods. In particular, we propose a maximum entropy approach for the captured problem. Newton's method in conjunction with the Conjugate Gradient (CG) method is then applied to solving the inverse problem. We investigate the convergence rate of the proposed method. Numerical examples are also given to demonstrate the effectiveness of our proposed method.

DNA-like Structure of Surfaces

Moody Chu
Department of Mathematics
North Carolina State University

Abstract

The importance of DNA to living organisms and its general structure of a double helix joined by base pairings whose sequences encode the genetic information are well known facts. Proposed in this work is a new computational and data analysis technique that exploits a remarkably similar structure underneath all smooth surfaces. Such a structure exists even in higher dimensional spaces, but the development of fundamental theory and novel algorithms for surfaces alone should be of great significance already. The crux at the center of this approach is our recent discovery that, analogous to the double helix structure with two (AT and CG) base parings in DNA, two strands of curves and eight base pairings would encode properties of an arbitrary surface. The idea is based on generalizing the common notion of gradient adaption from a scalar field to vector fields – singular vectors of the Jacobian of any given function form a natural moving frame pointing in directions that capture the most critical infinitesimal deformation of the underlying map. Trajectories of these singular vectors, referred to as singular curves, unveil some interesting, perplexing, intriguing patterns per the given function. At points where two or more singular values coalesce, curious and complex behavior occurs, manifesting specific landmarks for the underlying function. Such an innate dynamical structure thus raises the curiosity of whether the double strands with base pairings would be the universal

structure encoding all 3-dimensional entities, life or lifeless. We anticipate that the notion of a DNA genetics for surfaces might provide a unifying paradigm to such an extent that almost all surfaces can be genome sequenced and classified accordingly.

Some Recent Advances in Nonnegative Matrix Factorization and their Applications to Hyperspectral Unmixing

Nicolas Gillis
Department of Mathematics and Operational Research
Université de Mons

Abstract
Nonnegative matrix factorization (NMF) is a powerful dimensionality reduction technique as it automatically extracts sparse and meaningful features from a set of nonnegative data vectors. NMF has many applications; for example in text mining and hyperspectral imaging. Unfortunately, NMF is NP-hard in general, and highly ill-posed. In this talk, we present two new directions to tackle NMF problems, and illustrate the results on hyperspectral images: (1) It is possible to solve NMF recursively using underapproximations constraints which allows the extraction of features in a recursive way, such as PCA, but preserving nonnegativity, such as NMF. (This is joint work with R. Plemmons.) (2) NMF has been shown recently to be tractable under the separability assumption, equivalent to the pure-pixel assumption. We present some recent advances for solving near-separable NMF problems in a robust way, including an approach using successive orthogonal projections and semidefinite programming. (This is a joint work with S. Vavasis.)

Compact Multi-frame Blind Deconvolution

Stuart M. Jefferies
Institute for Astronomy
University of Hawaii

Abstract
We describe a compact multi-frame blind deconvolution (CMFBD) algorithm that uses spectral ratios (the ratio of the Fourier spectra of two data frames) as a way to model the inherent temporal signatures encoded by the observed images and significantly reduce the number of unknowns to be determined. By applying Givens rotations to the multi-frame data we generate a smaller set of pseudo data that capture the relevant information from the full data set and can be modeled with a relatively small number of variables. We show that CMFBD yields high-quality restorations in a much shorter time than are achieved with traditional MFBD algorithms: it may also provide higher fidelity solutions.

This is a joint work with H. Schomburg and J. Nagy.

A t-SVD-based Nuclear Norm with Imaging Applications

Misha Kilmer
Department of Mathematics
Tufts University

Abstract

A tensor is a multi-way array. In recent years, research in tensor analysis and decomposition has gained much popularity. The momentum has been fueled in part by the ever-growing challenges of data analysis and the need for compression, as well as a new appreciation for the potential modeling accuracy that can be provided by leaving the data in its natural, multidimensional form. For example, a collection of 2D gray scale images can naturally represented as a third order tensor while a color video sequence can be represented as a fourth order tensor.

We begin this talk by defining a new tensor nuclear norm (Hao, 2013) that is based on the recently introduced t-SVD of Kilmer and Martin (LAA 2011). We then consider two applications: the use of the tensor nuclear norm as a regularizer for inverse problems such as multi-energy X-Ray CT and the use of the tensor nuclear norm in the context of video completion.

This is joint work with several colleagues and it has been supported by NSF-DMS 0914957 and NSF:CIF:SMALL 1319653.

Iterative Krylov Subspace Methods for Sparse Reconstruction

James G. Nagy
Department of Mathematics and Computer Science
Emory University

Abstract

In this talk we consider iterative Krylov subspace algorithms to solve ill-posed inverse problems with l-p regularization. The main idea is to consider suitable, adaptively-defined preconditioners that allow using the usual 2-norm. The preconditioners can be updated at each step and/or after some iterations have been performed, leading to two different approaches: one is based on the idea of iteratively reweighted least squares, and can be obtained considering flexible preconditioned Krylov subspaces; the second approach is based on restarting the Arnoldi algorithm. Numerical examples are given in order to show the effectiveness of these new methods and comparison with some other existing algorithms are made.

What I learned from Professor Robert Plemmons

Michael Ng
Department of Mathematics
Hong Kong Baptist University

Abstract

In this talk, I present my research work in image processing: image restoration and hyperspectral imaging, and show what I learned from Professor Robert Plemmons.

3D Computational Imaging via Rotating PSFs

Sudhakar Prasad
Department of Physics and Astronomy
University of New Mexico

Abstract

Conventional diffraction-limited imaging is severely constrained by its relatively short depth of focus, particularly at large imaging-aperture diameters needed both for high spatial resolution and for collecting light under faint source illumination. To acquire image data with such an imager from a 3D scene with high focal depth, one must then scan in focus, slice by slice, at the cost of highly reduced efficiency. For rapidly evolving objects, e.g., those under rapid translation or rotation, this is evidently not a practical option.

A computational-imaging approach can overcome this limitation, as we show here by engineering the pupil phase in an appropriate, object-independent manner to fashion a PSF that, although not as tight as the Airy spot of the conventional in-focus PSF, maintains its shape and size while rotating uniformly with changing defocus over many waves of defocus phase at the pupil edge. The partitioning of a circular pupil aperture into M Fresnel zones, with the m^{th} zone having an outer radius proportional to $\sqrt{m}$ and impressing a spiral phase profile of form $m\varphi$ on the light wave, where φ is the azimuthal angle coordinate measured from a fixed x axis (the "dislocation" line), yields a PSF[1] that rotates with defocus while keeping its shape and size. Physically speaking, a nonzero defocus of a point source means a quadratic optical phase in the pupil that, because of the square-root dependence of the zone radius on the zone number, increases on average by the same amount from one zone to the next. This uniformly incrementing phase yields, in effect, a rotation of the dislocation line, and thus a rotated PSF. Since the zone-to-zone phase increment depends linearly on defocus to first order, the PSF rotates uniformly with changing defocus. For an M-zone pupil, a complete rotation of the PSF occurs when the defocus-induced phase at the pupil edge changes by M waves.

[1] S. Prasad, "Rotating Point Spread Function by Pupil Phase Engineering," Opt. Lett., vol. 38, pp. 585-587 (2013)

I shall present extensive simulations of 3D image reconstruction from rotating-PSF-based image data. For point sources, we obtained excellent recovery of their field locations, field depths, and brightness values even at moderately large SNR. For extended sources with nontrivial 3D depth profile, we need a minimum of two independent image frames, which we can acquire by employing two different spiral phase plates placed in the pupil (or in its Gaussian conjugate plane) through which we image the object sequentially. The two frames enable us to recover both the intensity and depth profiles of the object scene across the image pixel array, and thus reconstruct the full 3D image scene. Regularized reconstructions from simulated data, using an alternating minimization algorithm, yield, as I shall show, fairly robust results for the estimated intensity and depth distributions across the image plane.

This is a joint work with Rakesh Kumar.
Acknowledgment - I am grateful for my long, continued interaction with Prof. Plemmons who in 2002 first suggested that we take a close look at the then rapidly burgeoning field of computational imaging. That early interaction with him, which led to an invitation to visit Wake in 2003, launched an important set of papers over the next several years on the use of pupil–phase engineering to improve the depth of field, resolution, and dynamic range of an imager. That collaboration, in which a number of his colleagues at Wake participated actively, inspired, at least in a small way, the present work. Like much of the rest of my scientific work, it was supported in part by grants from the US Air Force Office of Scientific Research.

Hankel Tensors: Associated Hankel Matrices and Vandermonde Decomposition

Liqun Qi
Department of Applied Mathematics
The Hong Kong Polytechnic University

Abstract

Hankel tensors arise from applications such as signal processing. In this paper, we make an initial study on Hankel tensors. For each Hankel tensor, we associate it with a Hankel matrix and a higher order two-dimensional symmetric tensor, which we call the associated plane tensor. If the associated Hankel matrix is positive semi-definite, we call such a Hankel tensor a strong Hankel tensor. We show that an m order n-dimensional tensor is a Hankel tensor if and only if it has a Vandermonde decomposition. We call a Hankel tensor a complete Hankel tensor if it has a Vandermonde decomposition with positive coefficients. We prove that if a Hankel tensor is copositive or an even order Hankel tensor is positive semi-definite, then the associated plane tensor is copositive or positive semi-definite, respectively. We show that even order strong and complete Hankel tensors are positive semi-definite, the Hadamard product of two strong Hankel tensors is a strong Hankel tensor, and the Hadamard product of two complete Hankel tensors is a complete Hankel tensor. We show that all the H-eigenvalue of a complete Hankel tensors (maybe of odd order) are nonnegative. We give some upper bounds and lower bounds for the smallest and the largest Z-eigenvalues of a Hankel tensor, respectively. Further questions on Hankel tensors are raised.

Fast Approximate Inversion of Block Triangular Toeplitz Matrix with Applications to Fractional Sub-Diffusion Equations

Haiwei Sun
Department of Mathematics
University of Macau

Abstract
A fast approximate inversion method is proposed for the block lower triangular Toeplitz with tri-diagonal block (BL3TB) matrix. The BL3TB matrix is approximated by a block circulant-like matrix, which can be efficiently inverted using the fast Fourier transforms. The good approximation is proved under a certain condition. As applications, the discretized matrix by a finite difference method for the fractional sub-diffusion equation is shown as a BL3TB matrix and satisfies this condition. Therefore, the proposed method can be efficiently applied to find the numerical solution of the fractional sub-diffusion equation. Numerical experiments are carried out to demonstrate the excellence performance of the proposed method.

The Ostrowski-Reich Theorem for Splitting Iterative Methods

Jinyuan Yuan

Departamento de Mathematica
Universidade Federal do Paraná

Abstract
The Ostrowski-Reich theorem gives the necessary and sufficient conditions of convergence of the SOR method for hermitian and positive definite matrices. Ortega and Plemmons have generalized the theorem to non-hermitian matrices. We also generalize Ortega-Plemmons theorem to singular case for general splitting methods. Some special splitting methods are considered.

Compressive Hyperspectral Imaging of Space Objects

Peter Zhang
Department of Biostatistical Sciences
Wake Forest University

Abstract

Rapidly moving space objects pose a challenge for acquiring their spectral signatures for identification with techniques such as temporal hyperspectral imagers such as liquid crystal tunable filters that require one frame per spectral channel. The coded-aperture snapshot spectral imager (CASSI), developed at Duke University, can multiplex spectral and spatial information, and hence with a single snapshot, after reconstruction one can acquire both a resolved image of a space object and the spectral signatures of its components. The success of CASSI has been demonstrated on ground objects. For space objects, because of wavelength-dependent atmospheric turbulence blurring, CASSI only multiplexes the blurred spectral and spatial information, which poses a much more difficult reconstruction problem. Here, we propose a simplified solution form and a reconstruction algorithm for solving this problem using the alternating direction of the method of multipliers. We demonstrate the method with two simulated space object.

Wi-Fi Access to Internet

SSID: CUGuest

User ID: g******@guest.cuhk.edu.hk

(please use your assigned login ID number and password which are shown on the back-side of your badge)

1) Please choose and click "CUguest" in the list of available wireless networks.

2) After successful connection, open a web browser and visit any website (e.g. www.google.com).

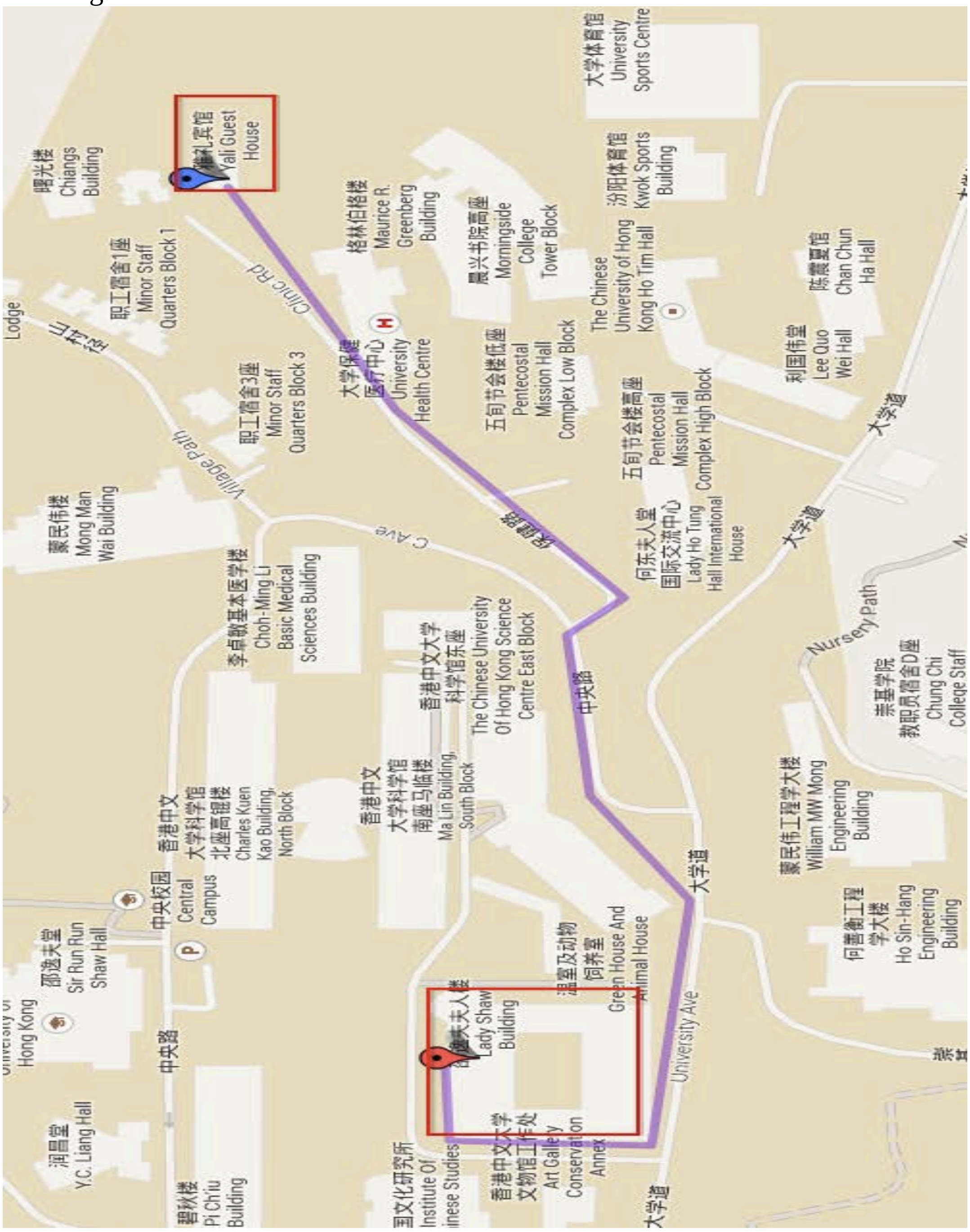
3) The web browser will then automatically lead you to a CUguest Wi-Fi Service Login Page.

4) Please enter your own user ID and password.

5) A window showing "Login successful" will pop up and you can now access the Internet.

Maps and Directions

Yali Guest House ↔ Lady Shaw Building (Workshop Venue on Nov. 17)
(10-minute walk)
Note: LT3 is on the 1/F and on Sunday accessible from the road north of Lady Shaw Building. The Department of Mathematics is located on the 2nd floor of Lady Shaw Building.



Yali Guesthouse ↔ University MTR Station

(1) By Shuttle:

The Chinese University of HK 香港中文大學

University Guesthouse Shuttle 大學賓館客車

From Yali Guesthouse to MTR University Station **

由雅禮賓館開出 至 港鐵大學站 **

0800	1600
0830	1700
0900	1800
0930	1830
1000	1900
1100	1930
1200	2000
1245	2030
------	2100
1330	2130
1400	2200
1500	2245

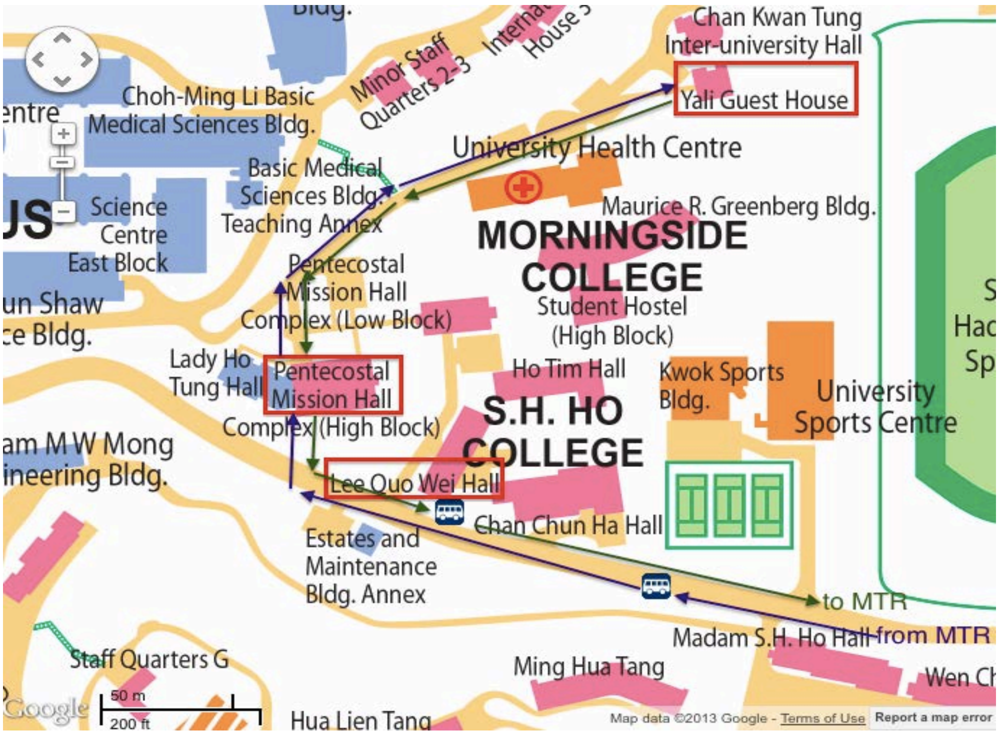
** Please make reservations in advance 須預訂留位

For reservations or further information,
call Yali Guesthouse Reception on 2603 6411
欲預訂客車或作相關查詢，請聯絡雅禮賓館接待處，
電話 2603 6411。

April 2010

(2) By Campus Bus:

Take campus bus 1A or 1B to and from MTR station (last bus 23:25pm from station). The nearest bus stop to the guest house is on University Avenue near Lee Quo Wei Hall (refer to the red square in the map below). It is the last bus stop before the MTR station. There is an elevator in the Pentecostal Mission Hall to take you from Clinic Road (from 4/F to G/F) where the guest house is located down to University Avenue.



(3) By walking (15 minutes):

Yali Guest House ↔ Cheng Yu Tung Building (Workshop Venue on Nov. 18)

Take the shuttle (or campus bus) or walk from Yali Guest House to University MTR station first. Then walk from the University MTR station to Cheng Yu Tung Building (3 minutes).

Banquet

Date: 18 November, 2013 (Monday)
Time: 6:30pm
Venue: Sha Tin 18 Restaurant
4/F, Hyatt Regency Hotel, 18 Chak Cheung Street, Shatin

All invited speakers and their spouses are invited.

The Hyatt Regency Hotel is next to Cheng Yu Tung Building (Workshop Venue on Nov. 18), and is a 5-minute walk from the MTR station.

Compressive phase retrieval

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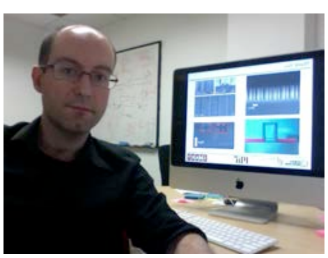
Compressive sensing is a class of image recovery techniques utilizing sparsity priors to recover undersampled signals with high fidelity. In this talk, I will describe several examples of application of compressive sensing to phase retrieval, both interferometric and non-interferometric. For interferometric techniques, also known as "digital holography," I will describe how to localize sparse objects, such as vibrating whiskers and particles in multi-phase flows, with sub-pixel accuracy. For non-interferometric techniques, I will discuss in particular the use of intensity priors in the "transport of intensity equation" method, where the phase is obtained by analogy to a lateral pressure potential in a compressible flow. Transport of intensity is especially interesting in the x-ray regime, where standard interferometry is difficult because common sources are spatially partially coherent and beam splitters-combiners are not available; as a concluding example, I will show how the sparsity prior of quasi-constant object density allows successful x-ray phase recovery despite the low coherence.



George Barbastathis received the Diploma in Electrical and Computer Engineering in 1993 from the National Technical University of Athens (Πολυτεχνείο) and the MSc and PhD degrees in Electrical Engineering in 1994 and 1997, respectively, from the California Institute of Technology (Caltech.) After post-doctoral work at the University of Illinois at Urbana-Champaign, he joined the faculty at MIT in 1999, where he is now Professor of Mechanical Engineering and holds the Singapore Research Professorship in Optics. During the academic year 2013-14 he is on sabbatical leave at the University of Michigan – Shanghai Jiao Tong University Joint Institute (上海交通大学密西根大学学院) in Shanghai, People's Republic of China. He has worked or held visiting appointments at Harvard University, the Singapore-MIT Alliance for Research and Technology (SMART) Centre, and the National University of Singapore. His research interests are three-dimensional and spectral imaging; phase estimation; and gradient index optics theory and implementation with subwavelength-patterned dielectrics. He is member of the Institute of Electrical and Electronics Engineering (IEEE), the American Society of Mechanical Engineers (ASME) and in 2010 he was elected Fellow of the Optical Society of America.