The First International Summer School on Numerical Linear Algebra

July 17 - August 5, 2006

South China Normal University, Guangzhou

The Chinese University of Hong Kong, Hong Kong

Program and Abstracts

Objectives

Numerical **L**inear **A**lgebra arises in many areas of scientific computing and engineering applications and it forms the basis and the core of modern numerical analysis. To attract attention and cultivate interest of young scientists, the "International Summer School on Numerical Linear Algebra" is organized between July 17 – August 5, 2006 at Guangzhou and Hong Kong. The main topics of this summer school include the classical subjects of numerical linear algebra and its modern applications in science and technology.

Organizing Committee

Zhaojun Bai (University of California at Davis, USA)
Zhong-Zhi Bai (Chinese Academy of Sciences, BEIJING)
Raymond H. Chan (The Chinese University of Hong Kong, HONG KONG)
Yong-Zhong Song (Nanjing Normal University, NANJING)
Yi-Min Wei (Fudan University, SHANGHAI)

Local Organizing Committee

Raymond H. Chan (Co-Chair, The Chinese University of Hong Kong, HONG KONG)
Wai-Ki Ching (The University of Hong Kong, HONG KONG)
Wen Li (Co-Chair, South China Normal University, GUANGZHOU)
Wen-Huai Shen (Co-Chair, South China Normal University, GUANGZHOU)
Wei-Wei Sun (City University of Hong Kong, HONG KONG)

Advisory Board

Zhi-Ming Chen (Chinese Academy of Sciences, BEIJING)
Tian-Gang Lei (National Natural Science Foundation of China, BEIJING)
Zhong-Ci Shi (Chinese Academy of Sciences, BEIJING)
Zhou-Ping Xin (The Chinese University of Hong Kong, HONG KONG)
Shing-Tung Yau (The Chinese University of Hong Kong, HONG KONG

Sponsors

- Department of Mathematics, The Chinese University of Hong Kong
- Institute of Mathematical Sciences, The Chinese University of Hong Kong
- South China Normal University
- Institute of Computational Mathematics, Chinese Academy of Sciences
- The National Basic Research Program (No. 2005CB321700), National Natural Science Foundation of China
- Office of Academic Links (China), The Chinese University of Hong Kong

List of Invited Speakers and Participants

1. Professor Tony F. Chan (University of California, Los Angeles, USA)
2. Professor Esmond G. Ng (Lawrence Berkeley National Laboratory, USA)
3. Professor Zheng-Jian Bai (Xiamen University, China)
4. Professor Zhong-Zhi Bai (Chinese Academy of Sciences, Beijing)
5. Professor Raymond H.F. Chan (The Chinese University of Hong Kong, Hong Kong)
6. Professor Wai-Ki Ching (The University of Hong Kong, Hong Kong)
7. Professor Hua Dai (Nanjing University of Aeronautics and Astronautics, Nanjing)
8. Professor Wei-Guo Gao (Fudan University, Shanghai)
9. Professor Daniel W.C. Ho (City University of Hong Kong, Hong Kong)
10. Professor Yue-Kuen Kwok (Hong Kong University of Science and Technology, Hong Kong)
11. Professor Leong Kwan Li (The Hong Kong Polytechnic University, Hong Kong)
12. Professor Wen Li (South China Normal University, Guangzhou)
13. Professor Li-Zhi Liao (Hong Kong Baptist University, Hong Kong)
14. Professor Michael K.P. Ng (Hong Kong Baptist University, Hong Kong)
15. Professor Xingping Sun (Missouri State University, USA)
16. Professor Yi-Min Wei (Fudan University, Shanghai)
17. Professor S.P. Yung (The University of Hong Kong, Hong Kong)

List of Participants

學生名單

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Program-at-a-Glance

<table>
<tr><th>Date & Time</th><th>31 July
(Mon)</th><th>1 August
(Tue)</th><th>2 August
(Wed)</th><th>3 August
(Thu)</th><th>4 August
(Fri)</th></tr>
<tr><td>Venue</td><td colspan="5">LT2, Lady Shaw Building</td></tr>
<tr><td>8:50 – 09:00</td><td>Opening Ceremony</td><td colspan="4"></td></tr>
<tr><td>9:00 – 10:30</td><td colspan="2">Course by Tony Chan</td><td colspan="3">Course by Esmond Ng</td></tr>
<tr><td>10:30 – 11:00</td><td colspan="5">BREAK</td></tr>
<tr><td>11:00 – 12:30</td><td colspan="2">Course by Tony Chan</td><td colspan="3">Course by Esmond Ng</td></tr>
<tr><td>12:30 – 2:00</td><td colspan="5">LUNCH</td></tr>
<tr><td>2:00 – 3:00</td><td>Wai-Ki Ching</td><td>Xingping Sun</td><td rowspan="5">Short course at High Performance Cluster Computing Center at HKBU</td><td>Zhengjian Bai</td><td>S.P. Yung</td></tr>
<tr><td>3:00 – 3:15</td><td colspan="2">BREAK</td><td colspan="2">BREAK</td></tr>
<tr><td>3:15 – 4:15</td><td>Michael Ng</td><td>Daniel Ho</td><td>Yi-Min Wei</td><td>Leong-Kwan Li</td></tr>
<tr><td>4:15 – 4:30</td><td colspan="2">BREAK</td><td colspan="2">BREAK</td></tr>
<tr><td>4:30 – 5:30</td><td>Yue-Kuen Kwok</td><td>Panel Meeting</td><td>Raymond Chan</td><td>Li-Zhi Liao</td></tr>
<tr><td>6:30 – 8:00</td><td></td><td>Conference Banquet</td><td colspan="3"></td></tr>
</table>

Conference Schedule

July 31, 2006 (Monday)

Venue: LT2, Lady Shaw Building

08:30am	Registration at Rm. 101, Lady Shaw Building (Tel: 2609 8608)
08:50 – 09:00am	Opening Speech by Professor Kenneth Young, Pro-Vice-Chancellor, CUHK
09:00 – 10:30am	Tony Chan (University of California, Los Angeles) *Computational Algebraic Problems from Variational PDE Image Processing*
10:30 – 11:00am	Break
11:00 – 12:30pm	Tony Chan (University of California, Los Angeles) *Computational Algebraic Problems from Variational PDE Image Processing*
12:30 – 2:00pm	Lunch
2:00 – 3:00pm	Wai Ki Ching (The University of Hong Kong) *Iterative Methods for Queueing Systems and Markov Chains*
3:00 – 3:15pm	Break
3:15 – 4:15pm	Michael Kwok-Po Ng (Hong Kong Baptist University) *Structured Matrix Computations and Applications*
4:15 – 4:30pm	Break
4:30 – 5:30pm	Yue-Kuen Kwok (Hong Kong University of Science and Technology) *Fundamental Theorem of Asset Pricing and Separating Hyperplane Theorem*

August 1, 2006 (Tuesday)

Venue: LT2, Lady Shaw Building

09:00 – 10:30am	Tony Chan (University of California, Los Angeles) *Computational Algebraic Problems from Variational PDE Image Processing*
10:30 – 11:00am	Break
11:00 – 12:30pm	Tony Chan (University of California, Los Angeles) *Computational Algebraic Problems from Variational PDE Image Processing*
12:30 – 2:00pm	Lunch
2:00 – 3:00pm	Xingping Sun (Missouri State University) *Radial Basis Function Approximation and Applications*
3:00 – 3:15pm	Break
3:15 – 4:15pm	Daniel W.C. Ho (City University of Hong Kong) *Recent Development of Modern Control Theory and Its Application*
4:15 – 4:30pm	Break
4:30 – 5:30pm	Panel Discussion Panelists: Tony Chan and Esmond Ng Moderator: Raymond Chan *New Challenges in Numerical Linear Algebra*
6:30 – 8:30pm	Conference Banquet at John Fulton Building

August 2, 2006 (Wednesday)

Venue: LT2, Lady Shaw Building

09:00 – 10:30am	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
10:30 – 11:00am	Break
11:00 – 12:30pm	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
12:30 – 2:00pm	Lunch
2:00pm	Bus leaves at John Fulton Building (Building H29 on P.19) for Hong Kong Baptist University
2:30 – 5:30pm	Short course at High Performance Cluster Computing Center at Scientific Computing Laboratory, SCT713, Cha Chi Ming Science Tower Hong Kong Baptist University

August 3, 2006 (Thursday)

Venue: LT2, Lady Shaw Building

09:00 – 10:30am	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
10:30 – 11:00am	Break
11:00 – 12:30p,	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
12:30 – 2:00pm	Lunch
2:00 – 3:00pm	Zheng-Jian Bai (Xiamen University) *Optimization Approaches for Inverse Quadratic Eigenvalue Problems*
3:00 – 3:15pm	Break
3:15 – 4:15pm	Yi-Min Wei (Fudan University) *On Mixed and Componentwise Condition Numbers for Moore-Penrose Inverse and Linear Least Squares Problems*
4:15 – 4:30pm	Break
4:30 – 5:30pm	Raymond Hon-Fu Chan (The Chinese University of Hong Kong) *A Unified Tight Frame Approach for Missing Data Recovery in Images*

August 4, 2006 (Friday)

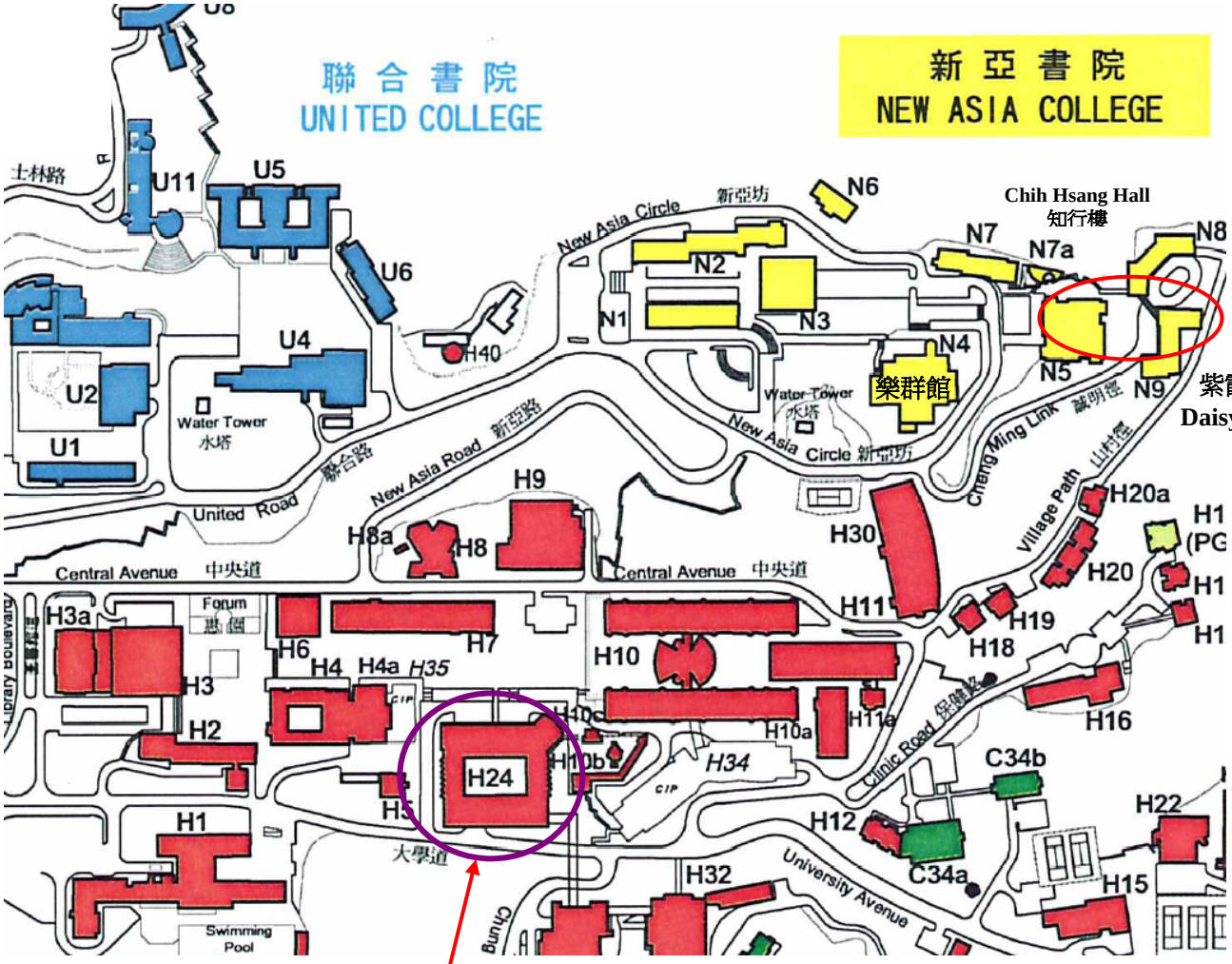
Venue: LT2, Lady Shaw Building

09:00 – 10:30am	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
10:30 – 11:00am	Break
11:00 – 12:30pm	Esmond Ng (Lawrence Berkeley National Laboratory) *Sparse Matrix Computation*
12:30 – 2:00pm	Lunch
2:00 – 3:00pm	S.P. Yung (The University of Hong Kong) *3D Tracking of Neural Axons*
3:00 – 3:15pm	Break
3:15 – 4:15pm	Leong-Kwan Li (The Hong Kong Polytechnic University) *Introduction to Recurrent Neural Networks and Learning Algorithms*
4:15 – 4:30pm	Break
4:30 – 5:30pm	Li-Zhi Liao (Hong Kong Baptist University) *Continuous Methods for Numerical Linear Algebra Problems*

Local Information

Direction between Summer School Hostel and Venues

Male dormitory located at Chih Hsang Hall (知行樓) N5
Female dormitory located at Daisy Li Hall (紫霞樓) N9



(H24 邵逸夫夫人樓)

Location of the Department

The Department of Mathematics is located at the Rm. 220, Lady Shaw Building (H24) in the Chinese University of Hong Kong.

邵逸夫夫人樓 "The Lady Shaw Building" in Chinese

New Asia Student Hostel ↔ Lady Shaw Building

1. On foot (~10 minutes) or
2. by School Shuttle Bus (HK$1 from June to August; HK$5 on Sunday and public holidays).

Fax, Internet and Emergency

Fax service is available at the General Office of Mathematics Department at Room 220, Lady Shaw Building. Fax number is (852) 2603-5154 and phone number is (852) 2609-7988 or 2609-7989. Urgent emails can be directed to dept@math.cuhk.edu.hk.

Computer services are provided in Room 222, Lady Shaw Building. Summer School participants are welcome to use the facilities there. For enquires, please ask the Computer Officer, Mr. Clayton Shiu, at Room 236, Lady Shaw Building. Please use the account name *nla2006* and password *go2cuhk*.

Pease contact local responders below in emergency:
Cai Jianfeng (蔡劍鋒) : 6443-6518
Wang Zexi (王澤璽) : 6578-0858

Canteens and Restaurants

There are over 10 eating places on campus. The two nearest ones are the canteen in the Choh-Ming Li Building (李卓敏基本醫學大樓)(H11) and the restaurant complex in Benjamin Franklin Centre (范克廉樓)(H1). Please refer to the campus map for their locations.

Canteens	**Business hours**
Canteen in Choh-Ming Li Building (H11)	07:45 - 18:00, Monday to Saturday
Benjamin Franklin Centre Staff Canteen (H1)	11:00 - 15:00 and 17:00 - 21:00, Monday to Sunday
Benjamin Franklin Centre Coffee Corner (H1)	07:30 - 19:30, Monday to Saturday
Benjamin Franklin Centre Student Canteen (H1)	07:00 - 21:00, Monday to Friday and Sunday
Benjamin Franklin Centre Fast Food Shop (H1)	07:30 - 21:00, Monday to Saturday
New Asia College Staff Restaurant in Staff Student Centre (樂群館) (N4)	11:00 - 14:30, Monday to Friday
New Asia College Student Canteen in Staff Student Centre (N4)	08:00 - 21:00, Monday to Saturday; 11:00 - 21:00, Sunday & public holidays
Chung Chi College Staff Restaurant in Staff Club (聯誼會) (C10)	13:30 - 14:30, 18:00 - 21:30, Monday to Friday; 11:30 - 14:30, 18:00 - 21:30, Saturday & Sunday
Chung Chi College Student Canteen in Chung Chi Tang (眾志堂) (C12)	07:30 - 20:30, Monday to Sunday

Other Facilities

Bank, supermarket, book store, barber shop and souvenir counter are located at John Fulton Centre (富爾敦樓)(H29). Please refer to the campus map.

Facilities	Floor	Business hours
Hang Seng Bank	1st	09:00 - 17:00, Monday to Friday; 09:00 - 13:00, Saturday
Park'n Shop Supermarket	Ground	08:00 - 21:00, Monday to Sunday
University Book Store	Ground	09:00 - 19:00, Monday to Friday; 09:00 - 13:30, Saturday
Barber Shop and Beauty Parlour	Ground	10:00 - 20:00, Monday to Saturday
Souvenir Counter	Ground	09:00 - 17:00, Monday to Friday; 09:00 - 12:40, Saturday

Campus Transportation

Passengers of the University shuttle buses haven required to tender bus fare on the following days:
- All days in June, July, and August (except course selection and registration days)
(I) Monday to Saturday (except public holidays)
(a) use $1 bus coupons for their bus ride; or
(b) pay a fee of $1 when boarding a bus.

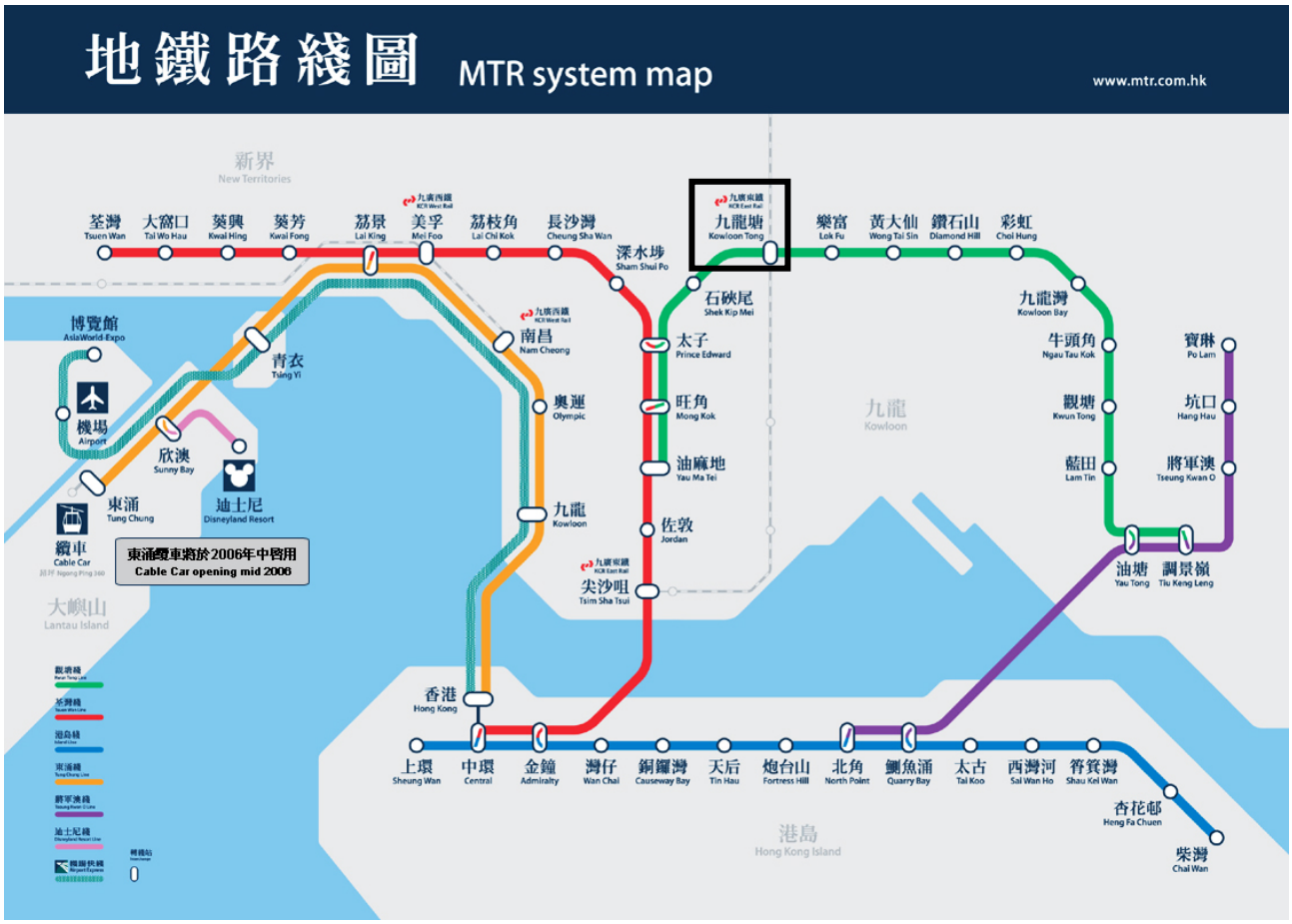
Such coupons come in booklets of 10 at a discounted price of $9 and may be purchased (during office hours) from the University Souvenir Counter at John Fulton Centre and Transport Unit and Security Unit (24-hour).

Lady Shaw Building ↔ KCR University Station

1. On foot (~18 minutes) or
2. by School Shuttle Bus (HK$1 from June to August; HK$5 on Sunday and public holidays). The second campus bus stop is right in front of Sir Run Run Shaw Hall (Building H9 in the middle part of the campus map). The Lady Shaw Building (Building H24 on the campus map) is only one-minute walk south of the Sir Run Run Shaw Hall.

Local Transportation

It is convenient and efficient to go downtown by Kowloon-Canton Railway (KCR) (九廣鐵路列車) (train) and Mass Transit Railway (MTR) (地下鐵路(地鐵)列車) (subway).



Kowloon-Canton Railway (KCR) (九廣鐵路列車)

Time-table for “Shuttle Bus” service from Monday to Saturday

非教學日期段 (Periods of Non-teaching Days)

六月及七月 June and July

實施日期 w.e.f. 二零零六年六月一日 1 Jun 2006

上行路線 Up Routes

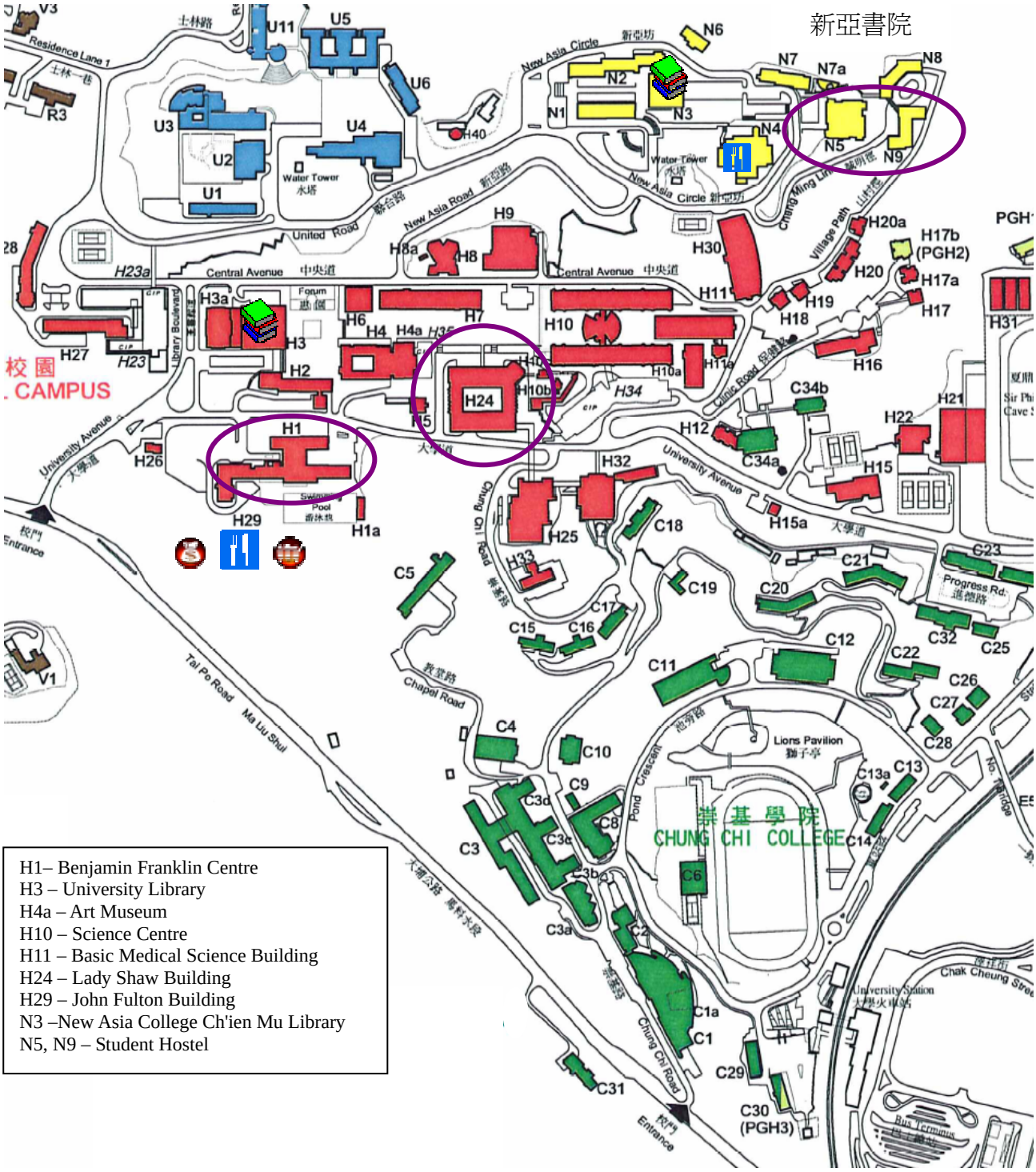
時 Hour	分 Minutes	上行線站 Up Route Stops
7am	45	火車站 Train Station ▸ [賽馬會研究生宿舍 Jockey Club Postgraduate Hall 11:40am] ▸ 大學體育中心 Univ. Sports Centre ▸ 潤昌堂 Y.C.Liang Hall ▸ 馮景禧樓 Fung King-hey Bldg. ▸ 三、四苑 Residences No.3 & 4 ▸ 逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 聯合書院 United College ▸ 新亞書院 New Asia College
8am	15 45	
9am 至 to 5:40pm 逢 every 00 20 40		
6pm	00 *20 40	
7pm 至 to 10:40pm 逢 every 星期一至五 Mon. to Fri. 00, 20, 40 星期六 Sat. 00, 30		火車站 Train Station ▸ [賽馬會研究生宿舍 Jockey Club Postgraduate Hall 11:25pm] ▸ 大學體育中心 Univ. Sports Centre ▸ 潤昌堂 Y.C. Liang Hall ▸ 新亞書院 New Asia College ▸ 聯合書院 United College ▸ 三、四苑 Residences No.3 & 4 ▸ 逸夫書院 Shaw College
11pm	00 25	
	25	火車站 Train Station ▸ 賽馬會研究生宿舍 Jockey Club Postgraduate Hall ▸ 大學體育中心 Univ. Sports Centre ▸ 潤昌堂 Y.C. Liang Hall ▸ 馮景禧樓 Fung King-hey Bldg. ▸ 聯合書院 United College ▸ 新亞書院 New Asia College ▸ 三、四苑 Residences No.3 & 4 ▸ 聯合苑 United College Staff Residence ▸ 十五苑 Residence No. 15 ▸ 十、十一苑 Residences No.10 & 11

下行路線 Down Routes

時 Hour	分 Minutes	下行線站 Down Route Stops
7am	30	新亞書院 New Asia College ▸ 聯合書院 United College ▸ 三、四苑 Residences No.3 & 4 ▸ 逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 大學行政樓 Univ. Admin. Bldg. ▸ 五旬節會樓 (舊研宿) Pentecostal Mission Hall Complex (Former Postgraduate Hall Complex) ▸ 大學體育中心 Univ. Sports Centre ▸ 火車站 Train Station
8am	00	
	05	逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 新亞書院 New Asia College ▸ 聯合書院 United College ▸ 大學行政樓 Univ. Admin. Bldg. ▸ 五旬節會樓 (舊研宿) Pentecostal Mission Hall Complex (Former Postgraduate Hall Complex) ▸ 大學體育中心 Univ. Sports Centre ▸ 火車站 Train Station
	30	
9am 至 to 5:40pm 逢 every 00 20 40		新亞書院 New Asia College ▸ 聯合書院 United College ▸ 三、四苑 Residences No.3 & 4 ▸ 逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 大學行政樓 Univ. Admin. Bldg. ▸ 五旬節會樓 (舊研宿) Pentecostal Mission Hall Complex (Former Postgraduate Hall Complex) ▸ 大學體育中心 Univ. Sports Centre ▸ [賽馬會研究生宿舍 Jockey Club Postgraduate Hall 9:40am] ▸ 火車站 Train Station
6pm	00 20 40	逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 新亞書院 New Asia College ▸ 聯合書院 United College ▸ 大學行政樓 Univ. Admin. Bldg. ▸ 五旬節會樓 (舊研宿) Pentecostal Mission Hall Complex (Former Postgraduate Hall Complex) ▸ 大學體育中心 Univ. Sports Centre ▸ [賽馬會研究生宿舍 Jockey Club Postgraduate Hall 8:00pm 9:00pm 10:00pm] ▸ 火車站 Train Station
7pm 至 to 10:40pm 逢 every 星期一至五 Mon. to Fri. 00, 20, 40 星期六 Sat. 00, 30		
11pm	00	十、十一苑 Residences No. 10 & 11 ▸ 十五苑 Residence No. 15 ▸ 聯合苑 United College Staff Residence ▸ 逸夫書院 Shaw College ▸ 三、四苑 Residences No.3 & 4 ▸ 新亞書院 New Asia College ▸ 聯合書院 United College ▸ 大學行政樓 Univ. Admin. Bldg. ▸ 五旬節會樓 (舊研宿) Pentecostal Mission Hall Complex (Former Postgraduate Hall Complex) ▸ 大學體育中心 Univ. Sports Centre ▸ 賽馬會研究生宿舍 Jockey Club Postgraduate Hall ▸ 火車站 Train Station

[ ] 指定時間內行駛 Service limited to assigned hours

* 不在星期六行走 Not run on Saturday.



Campus Map of The Chinese University of Hong Kong

住宿: 香 港 中 文 大 學 新 亞 書 院 學 生 宿 舍

(男生宿舍：知行樓 & 女生宿舍：紫霞樓)

設備

(一) 宿舍寢室爲雙人及三人冷氣房， 內設單人床連床單枕頭、衣櫥、書桌及書架等， 亦有電話插頭， 但須自備電話。

(二) 本院餐廳在宿舍附近之樂群館， 供應中西食品， 團體可直接與餐廳管理人洽辦。查詢電話 :2603-7432

(三) 宿舍洗衣房有洗衣機、乾衣機及熨衣設備， 使用洗衣機或乾衣機需到宿舍櫃檯繳款，宿舍有曬衣場所供租用團體使用。

(四) 宿舍有公用會客廳及電視室。

(五) 餐廳 ： 本院餐廳在宿舍附近之樂群館低層，供應中西美食

一般規則

(一) 暑期住宿者須遵守本院學生宿舍之管理規則， 如有違反者， 本院有權請其退宿。

(二) 租用團體之團員， 在租宿期間如有意外傷亡或財物損失， 本院概不負責。

(三) 租用團體如損毀本院財物， 須負責賠償。

(四) 租用期滿， 須於該日上午十一時前遷出寢室。

(五) 租用團體如須張貼佈告或佈置場所， 應事先徵得宿舍主任之同意， 事後並須負責清除

(六) 宿舍鎖匙不得轉租他人。未經宿舍主任同意， 寢室亦不得轉讓。

(七) 租用團體之團員不得接待訪客在宿舍內留宿。違反者， 本院有權請其立即退宿。

(八) 租用團體之團員不准進入異性之公用地方。

(九) 就讀小六或以下之兒童例不批准住宿。

(十) 宿舍公物， 應就原地使用， 未經允許不得任意搬動。損壞公物，須照時價賠償。

(十一) 宿舍早晨六時半開門， 晚上關門時間:星期一至五爲十二時;星期六， 日及公眾假期爲一時。

(十二) 宿舍內須保持安靜， 避免喧嘩嘻笑。

(十三) 宿舍內不得賭博並不得藏有麻雀及天九牌等賭具。

(十四) 宿舍內不得收藏或飲用酒類， 不得烹煮食物。不准吸煙。

(十五) 個人財物， 應妥自保管; 如有遺失， 自行負責。

(十六) 在寢室內使用收錄音機或唱機等音響設備， 應將聲浪放低； 晚上十一時後， 早上八時以前， 尤須注意放低音量。

(十七) 本辦法經本院院務委員會通過施行， 修改時同。

注意: 暑假期間乘坐校車須繳費用，現爲每程每位$1.00，需從大學保安組預購車票。

Title & Abstracts

Optimization Approaches for Inverse Quadratic Eigenvalue Problems

Zheng-Jian BAI

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Abstract : The inverse quadratic eigenvalue problem (IQEP) arises in the field of structural mechanics and vibrating structure. It aims to find three matrices, known as the mass, the damping, and the stiffness matrices, respectively such that they satisfy the measured data and preserve the exploitable structural properties such as symmetry, definiteness, sparsity and bandedness, etc., of the original model. The difficulty of this problem lies in the fact that in applications the mass, damping, and stiffness matrices should satisfy the requirement(s) of definiteness and/or bandedness.

In this talk, we first consider the IQEP where the mass matrix should be positive definite, the damping matrix symmetric, and the stiffness matrix positive semidefinite. Based on an equivalent dual optimization version of the IQEP, we present a quadratically convergent Newton-type method. Our numerical experiments confirm the high efficiency of the proposed method.

Next, we discuss the inverse problem for a discrete damped mass-spring system where the mass, damping, and stiffness matrices are all symmetric and tridiagonal. It is shown that the model can be constructed from two real eigenvalues and three real eigenvectors or a complex conjugate eigenpair and a real eigenvector. However, for large model order, the construction from these data may be sensitive to perturbations. To reduce the sensitivity, we fit an least-squares optimization problem to the overdetermined noised data. In addition, the physical realizability of the required model is obtained by solving a positivity-constrained least-squares optimization problem to the overdetermined corrupted eigendata.

A Unified Tight Frame Approach for Missing Data Recovery in Images

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Abstract : In many practical problems in image processing, such as inpainting, noise removal and super-resolution image reconstruction, the observed data sets are often incomplete in the sense that features of interest in the image are missing partially or corrupted by noise. The recovery of missing data from incomplete data is an essential part of any image processing procedures whether the final image is utilized for visual interpretation or for automatic analysis. In this talk, we will discuss our new iterative algorithm for image recovery for missing data which is based on spline tight framelets. We consider in particular two main applications, namely impulse noise removal and super-resolution image reconstruction

Computational Algebraic Problems from Variational PDE Image Processing

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Abstract : Variational PDE models have emerged over the last decade as very effective for image processing. They posses desirable properties such as preserving edge sharpness, good control of geometric features of objects, and a deep mathematical foundation. At the same time, they also present significant computational challenges as such models are highly nonlinear, possibly locally singular/degenerate, in addition to the usual spatial stiffness of PDE problems. In my talks, I'll review some of these issues, as well as some approaches that have been proposed by us and others to deal with them. The techniques include direct optimization algorithms, primal-dual methods, and multigrid methods.

Iterative Methods for Queueing Systems and Markov Chains

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Abstract : Markovian queueing systems are widely used in the modeling of telecommunication systems, manufacturing systems, inventory systems and many other practical systems. Very often, in the system performance analysis, one faces the problem of solving the system steady-state probability distribution of a large number of states. Fast numerical algorithms based on Preconditioned Conjugate Gradient (PCG) method will be presented to solve the problem. Other efficient iterative methods for solving Markov chains will also be discussed.

Recent Development of Modern Control Theory and Its Application

Daniel W.C. HO

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Abstract : There has been a growing interest of application of control theory in networks, circuits, economics, mechanical systems in the last twenty years. Recent development of control and system theory will be briefly reviewed in this talk. Some examples on control and estimator designs of nonlinear descriptor system will be presented. Its applications to sensor fault diagnosis will be illustrated. The latest results on robust stability of singular system with nonlinear perturbation will be discussed. Some other interesting computational results on controlling stochastic systems will also be presented. All the above work are strongly related to the application of numerical linear algebra.

Fundamental Theorem of Asset Pricing and Separating Hyperplane Theorem

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Abstract : An arbitrage opportunity in the financial market is defined as a self-financing trading strategy requiring no initial investment, having no probability of negative value at expiration, and yet having some possibility of a positive terminal payoff. In a frictionless and efficient financial market, there should be no arbitrage opportunity. The "no-arbitrage" principle is a cornerstone in asset pricing theory. This presentation illustrates how to apply the Separating Hyperplane Theorem and other results in Linear Algebra Theory to establish the Fundamental Theorem of Asset Pricing. The Asset Pricing Theorem states that the absence of arbitrage opportunity is equivalent to the existence of a risk neutral measure where the price of a contingent claim is given by the expectation of the terminal payoff of the contingent claim under a risk neutral measure. The risk neutral measure is related to the state prices but not related to the actual probability of occurrence of various states in the financial market.

Introduction to Recurrent Neural Networks and Learning Algorithms

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Abstract : In this talk, we introduce the mathematical model for leaky integrator recurrent neural networks. For a given trajectory, we may use a recurrent neural network dynamic to approximate the trajectory. Learning is a process for which we adjust the neural parameters so that the network output comes close to the trajectory. This process of modifying parameters is called "learning". Williams and Zipser (1989) derived the learning algorithms for trajectories of a discrete-time recurrent neural network but the question of the capability of the recurrent network is still unknown. Then, we consider a learning algorithm for discrete-time recurrent neural networks as a nonlinear numerical optimization problem. We shall also discuss the relations between least square errors and the network sizes. We also compare our results with linear time series models.

Continuous Methods for Numerical Linear Algebra Problems

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Abstract : In this talk, I will start with the introduction of continuous methods for symmetric eigenvalue problems. The attractiveness as well as challenges will be discussed. Then, other areas of numerical linear algebra problems, such as least squares problems and matrix decompositions, will be also addressed.

Sparse Matrix Computation

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Abstract : Sparse matrices arise frequently in scientific and engineering applications. Most of them are in the form ofsystems of linear equations, which tend to be large and sparse. This tutorial will provide an overview of state-of-the-art algorithms for such large sparse linear systems. Opportunities for further research will also be discussed.

Structured Matrix Computations and Applications

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Abstract : In this talk, I will review and discuss structured matrix computations and applications.

Radial Basis Function Approximation and Applications

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Abstract : Radial Basis Functions (RBF) have recently found many applications in a diverse areas of mathematics and engineering, including image processing, machine learning, Monte Carlo methods, neural networks, and numerical solutions of PDE. RBF provide an efficient tool for dealing with scattered data in higher dimensional Spaces. In this talk, we will survey some recent results on RBF approximation and interpolation. We will emphasize the interactions of RBF methods with Numerical Linear Algebra.

On Mixed and Componentwise Condition Numbers for Moore-Penrose Inverse and Linear Least Squares Problems

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Abstract : Classical condition numbers are normwise: they measure the size of both input perturbations and output errors using some norms. To take into account the relative of each data component, and, in particular, a possible data sparseness, componentwise condition numbers have been increasingly considered. These are mostly of two kinds: mixed and componentwise. In this talk, we give explicit expressions, computable from the data, for the mixed and componentwise condition numbers for the computation of the Moore-Penrose inverse as well as for the computation of solutions and residues of linear least squares problems. In both cases the data matrices have full column (row) rank.

Keywords: linear least squares, condition numbers
AMS subject classi¯cations(1991): 15A18, 65F20, 65F25, 65F50.

3D Tracking of Neural Axons

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Abstract : Under an electronic microscope, axons of neural nerves are packed together and fairly hard to trace their 3D structures. In practice, these neural axons are cut into consecutive slices and we attempt to identify which axon from which via these cross-section slices. In this talk, an active contour method (snake method) is used to identify individual axons in each slice and then reconstruct the 3D structure of the whole pack of axons. These active contours come from minimizing some functionals and eventually we need to solve a partial differential equation whose discretization becomes a system of linear equations. A repulsive forcing term is added to assist the tracking.

Experiencing Cluster Computing

High Performance Cluster Computing Centre (Supported by Dell and Intel)
Faculty of Science, Hong Kong Baptist University

Abstract : Using PC cluster in replacing supercomputer for high performance computing is becoming more common in the society. This course will provide a basic understanding about different kinds of PC clusters and their applications.

With the background of setting up PC clusters for computational needs in Science Faculty, HKBU, we will illustrate by examples a variety of research areas which cluster computing was used and the potentials that PC clusters can help in teaching and learning.