International Workshop on Mathematical Issues in Information Sciences

December 19, 2015

Beijing, China

http://lsec.cc.ac.cn/~miis2015

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Workshop Schedule

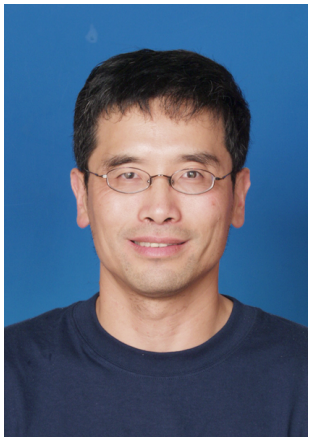
December 19, 2015, Room 204, South Building of AMSS		
8:00 - 8:30	Registration	
8:30 - 8:45	Opening Ceremony	
8:45 - 9:00	Photo Taking	
9:00 - 10:30, Session Chair: Jianwei Huang		
9:00 - 9:45	Galois Comes to Rescue: Robust Receivers for Unifying Detection and Decoding Across the Complex Field and Binary Field	Zhi Ding
9:45 - 10:30	Content-Centric Sparse Multicast Beamforming for Cache-Enabled Cloud RAN	Meixia Tao
10:30 - 11:00	Coffee Break	
11:00 - 12:30, Session Chair: Zhi-Quan Luo		
11:00 - 11:45	Incentive Mechanisms for User-Provided Networks	Jianwei Huang
11:45 - 12:30	The Optimization of Subarray Division in Adaptive Array Signal Processing Problem	Yong Yu
12:30 - 14:30	Lunch (4th floor of Wuke Restaurant)	
14:30 - 16:00, Session Chair: Yu-Hong Dai		
14:30 - 15:15	Optimal Dynamic Resource Allocation for Energy Efficient Transmission in Digital Subscriber Lines	Zhi-Quan Luo
15:15 - 16:00	Complex Quadratic Programming and Its Applications and New Progress in CDT Subproblem	Wenbao Ai
16:00 - 16:30	Coffee Break	
16:30 - 18:00, Session Chair: Zhi Ding		
16:30 - 17:15	Low-Cost Low-Rank Channel Estimation and Transmission Scheme for 5G Massive MIMO Systems	Feifei Gao
17:15 - 18:00	Unique Decomposition and A New Model for the Ground Moving Target Indication Problem	Qingna Li
18:00	Dinner (4th floor of Wuke Restaurant)	

艾文宝，北京邮电大学数学系教授，博士生导师，从事最优化、科学计算、信号处理等领域的高效算法研究，迄今为止发表论文二十多篇，有多篇论文在最优化领域的顶级杂志《Mathematical Programming》和《SIAM J. Optimization》上发表。主要工作如下：1. 将 Karmarkar 投影内点算法改进为无需事先知道最优值或任何一个下界，算法在多项式时间内要么可以自动获得一个下界并逼近最优值，要么会让目标函数值趋向负无穷大。2. 首次给出了具有宽邻域特性的 O(sqrt(n)) 迭代次数的邻域跟踪内点算法，从而一举解决了窄邻域与宽邻域内点算法之间的理论迭代结果与实际计算结果相矛盾这一长期困扰内点算法的问题。3. 在两球问题上得到了一个在算法中可直接检验的强对偶充要条件，并证明了当两球问题有负特征值的时候在对偶最优直线上的最优值与原问题的最优值之间无论在绝对误差还是相对误差上都可能趋向无穷大，从而解决了袁亚湘教授在一篇文章中提出的一个公开性问题。4. 在对称矩阵方程方面，对 Bohnenblust 的非常规的低秩解结果首次给出了一个构造性证明并据此给出了一个多项式时间算法，解决了 Barvinok 提出的一个公开性问题。5. 在四个 Hermitian 矩阵方程方面解决了构造性证明问题并据此给出了一个对四个 Hermitian 矩阵方程求秩一解的多项式时间算法，该算法已经在信号处理的许多问题中获得了应用。

近年来艾文宝教授课题组逐渐转向了信息科学和金融工程中的最优化算法研究，诸如声音定位、手机信号传输、多输入多输出系统、期权价值估计、期货投资、最佳证券投资组合等。

在科研项目方面，分别主持过一个国家面上基金项目和多个省部级项目，且都已经顺利完成。

在教学上，主编了多本教材，是北邮的北京市精品课程《高等数学》的负责人，是北邮教务处教学质量督导组成员。



Zhi Ding (S'88-M'90-SM'95-F'03, IEEE) is a Professor of Electrical and Computer Engineering at the University of California, Davis. He received his Ph.D. degree in Electrical Engineering from Cornell University in 1990. From 1990 to 2000, he was a faculty member of Auburn University and later, University of Iowa. Prof. Ding has held visiting positions in Australian National University, Hong Kong University of Science and Technology, NASA Lewis Research Center and USAF Wright Laboratory. From 2013-2015, he was the founding Executive Dean for the School of Information Science and Technology, Shanghai Tech University. Prof. Ding has active collaboration with researchers from several countries including Australia, China, Finland, Japan, Canada, Taiwan, Korea, Singapore, and Hong Kong.

Dr. Ding is a Fellow of IEEE and has been an active member of IEEE, serving on technical programs of several workshops and conferences. He was associate editor for IEEE Transactions on Signal Processing from 1994-1997, 2001-2004, and associate editor of IEEE Signal Processing Letters 2002-2005. He was a member of technical committee on Statistical Signal and Array Processing and member of technical committee on Signal Processing for Communications (1994-2003). Dr. Ding was the Technical Program Chair of the 2006 IEEE Globecom. He is also an IEEE Distinguished Lecturer (Circuits and Systems Society, 2004-06, Communications Society, 2008-10). He served as a member of the Steering Committee for the IEEE Transactions on Wireless Communications (2007-2009) and its Chair (2009-2011). Dr. Ding is a coauthor of the widely adopted textbook: Modern Digital and Analog Communication Systems, 4th edition (Oxford University Press, 2009).

Feifei Gao received the B.Eng. degree from Xi'an Jiaotong University, Xi'an, China in 2002, the M.Sc. degree from McMaster University, Hamilton, ON, Canada in 2004, and the Ph.D. degree from National University of Singapore, Singapore in 2007. He was a Research Fellow with the Institute for Infocomm Research (I2R), A*STAR, Singapore in 2008 and an Assistant Professor with the School of Engineering and Science, Jacobs University, Bremen, Germany from 2009 to 2010. In 2011, he joined the Department of Automation, Tsinghua University, Beijing, China, where he is currently an Associate Professor.

Prof. Gao's research areas include communication theory, signal processing for communications, array signal processing, and convex optimizations, with particular interests in MIMO techniques, multi-carrier communications, cooperative communication, and cognitive radio networks. He has authored/coauthored more than 70 refereed IEEE journal papers and more than 90 IEEE conference proceeding papers, which have been cited more than 3500 times from Google Scholar. Prof. Gao has served as an Editor of IEEE Transactions on Wireless Communications, IEEE Wireless Communications Letters, International Journal on Antennas and Propagations, and China Communications. He has also served as the symposium co-chair for 2015 IEEE Conference on Communications (ICC), 2014 IEEE Global Communications Conference (GLOBECOM), 2014 IEEE Vehicular Technology Conference Fall (VTC), as well as Technical Committee Members for many other IEEE conferences.

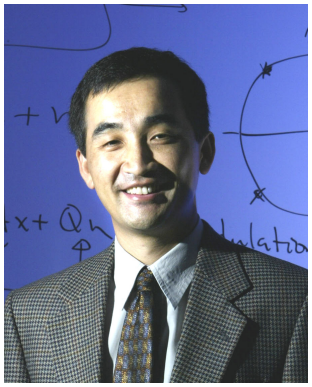
Jianwei Huang (S'01-M'06-SM'11-F'16) is an Associate Professor and Director of the Network Communications and Economics Lab (ncel.ie.cuhk.edu.hk), in the Department of Information Engineering at the Chinese University of Hong Kong. He received Bachelor from Southeast University in 2000, Master and Ph.D. from Northwestern University in 2003 and 2005, and worked as a Postdoc Research Associate at Princeton University during 2005-2007. His main research interests are in the area of network economics and games, with applications in wireless communications, networking, and smart grid. He is a Fellow of IEEE (Class of 2016), and a Distinguished Lecturer of IEEE Communications Society (2015-2016).

Dr. Huang is the co-recipient of 8 Best Paper Awards, including IEEE Marconi Prize Paper Award in Wireless Communications in 2011, and Best (Student) Paper Awards from IEEE WiOpt 2015, IEEE WiOpt 2014, IEEE WiOpt 2013, IEEE SmartGridComm 2012, WiCON 2011, IEEE GLOBECOM 2010, and APCC 2009. He received the CUHK Young Researcher Award in 2014 and IEEE ComSoc Asia-Pacific Outstanding Young Researcher Award in 2009. He has co-authored four books: "Wireless Network Pricing," "Monotonic Optimization in Communication and Networking Systems," "Cognitive Mobile Virtual Network Operator Games," and "Social Cognitive Radio Networks". He is a co-author of five ESI Highly Cited Papers.

Dr. Huang has served as an Editor of IEEE Transactions on Cognitive Communications and Networking (2015-), Editor of IEEE Transactions on Wireless Communications (2010-2015), Editor of IEEE Journal on Selected Areas in Communications - Cognitive Radio Series (2011-2014), Editor and Associate Editor-in-Chief of IEEE Communications Society Technology News (2012-2014). He has served as a Guest Editor of IEEE Transactions on Smart Grid special issue on "Big Data Analytics for Grid Modernization" (2016), IEEE Network special issue on "Smart Data Pricing" (2016), IEEE Journal on Selected Areas in Communications special issues on "Game Theory for Networks" (2017), "Economics of Communication Networks and Systems" (2012), and "Game Theory in Communication Systems" (2008), and IEEE Communications Magazine feature topic on "Communications Network Economics" (2012).

Dr. Huang has served as Vice Chair (2015-2016) of IEEE Communications Society Cognitive Network Technical Committee, Vice Chair (2010-2012) and Chair (2012-2014) of IEEE Communications Society Multimedia Communications Technical Committee, a Steering Committee Member of IEEE Transactions on Multimedia (2012-2014) and IEEE International Conference on Multimedia & Expo (2012-2014), Chair of Meeting and Conference Committee (2012-2013) and Vice Chair of Technical Affairs Committee (2014-2015) of IEEE ComSoc Asia-Pacific Board. He has served as the TPC Co-Chair of IEEE WiOpt 2017, IEEE SDP 2016, IEEE ICCC 2015 (Wireless Communications System Symposium), IEEE SDP 2015, NetGCoop 2014, IEEE SmartGridComm 2014 (Demand Response and Dynamic Pricing Symposium), IEEE GLOBECOM 2013 (Selected Areas of Communications Symposium), IEEE WiOpt 2012, IEEE ICCC 2012 (Communication Theory and Security Symposium), IEEE GlOBECOM 2010 (Wireless Communications Symposium), IWCMC 2010 (Mobile Computing Symposium), and GameNets 2009. He is a frequent TPC member of leading networking conferences such as INFOCOM and MobiHoc. He is the recipient of IEEE ComSoc Multimedia Communications Technical Committee Distinguished Service Award in 2015 and IEEE GLOBECOM Outstanding Service Award in 2010.

Qingna Li is an associate professor in School of Mathematics and Statistics, Beijing Institute of Technology. She received her Bacholor's Degree in 2005 from Hunan University, and Ph.D in Computational Mathematics from Hunan University in 2010, jointly supervised by Hunan University and University of Southampton, UK. Then She worked as a PostDoc in Institute of Computational Mathematics and Scientific/Engineering Computing, Chinese Academy of Sciences. She joined Beijing Institute of Technology in June 2012 as an assistant professor, and worked as an associate professor since June 2013. She visited University of Southampton from January 2008 to January 2012, National University of Singapore in December 2012 and Chinese University of Hong Kong from March 2013 to May 2013. Her current research interests include numerical optimization, especially matrix optimization and sparse optimization, and related applications in finance, statistics, and signal processing. Her research grants included an NSF (2012-2014) about Numerical Algorithm for Rank Constraint Semidefinite Programming, and a PostDoc Funding (2011-2012) about Numerical Methods for Schatten-p Relaxation of Matrix Rank Minimization Problems.



Zhi-Quan Luo received his BSc degree in Applied Mathematics from Peking University, China in 1984. In the same year, he was selected by a joint AMS-SIAM committee and the Ministry of Education of China for graduate study in the United States (S.S. Chen Program). After a one-year training in English and Mathematics, he enrolled in the Massachusetts Institute of Technology where he received a PhD degree in Operations Research in 1989. From 1989 to 2003, Professor Luo held a faculty position with the Department of Electrical and Computer Engineering, McMaster University, Canada, where he also served as the department head from 2000 to 2003, and held a tier-1 Canada Research Chair in Information Processing from 2001 to 2003. Since 2003, he has been a full professor at the Department of Electrical and Computer Engineering, University of Minnesota (Twin Cities) and held an endowed ADC Chair in digital technology.

Professor Luo is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of the Society for Industrial and Applied Mathematics (SIAM). He received the 2010 Farkas Prize from the INFORMS Optimization Society for outstanding contributions to the field of optimization. He also received three Best Paper Awards from the IEEE Signal Processing Society in 2004, 2009 and 2011 respectively, and a 2011 Best Paper Award from the EURASIP.

Professor Luo's research mainly addresses mathematical issues in information sciences, with particular focus on the design, analysis and applications of optimization algorithms. He consults regularly with industry on topics related to signal processing and digital communication. Professor Luo has served as Chair and Past Chair of the IEEE Signal Processing Society Technical Committee on the Signal Processing for Communications and Networking (SPCOM). Professor Luo has published over 200 refereed journal papers, conference papers, books and special issues. He has served as an Associate Editor for many internationally recognized journals including Management Science, IEEE Signal Processing Magazine, SIAM Journal on Optimization, Mathematics of Computation, Mathematics of Operations Research, and others. He is currently the Editor in Chief for IEEE Transactions on Signal Processing.

Meixia Tao received the B.S. degree from Fudan University, Shanghai, China, in 1999, and the Ph.D. degree from Hong Kong University of Science and Technology in 2003. She is currently a Professor with the Department of Electronic Engineering, Shanghai Jiao Tong University, China. Prior to that, she was a Member of Professional Staff at Hong Kong Applied Science and Technology Research Institute during 2003-2004, and a Teaching Fellow then an Assistant Professor at the Department of Electrical and Computer Engineering, National University of Singapore from 2004 to 2007. Her current research interests include content-centric wireless networks, resource allocation, interference management and coordination, and physical layer security.

Dr. Tao is a member of the Executive Editorial Committee of the IEEE Transactions on Wireless Communications. She serves as an Editor for the IEEE Transactions on Communications and the IEEE Wireless Communications Letters. Dr. Tao is the recipient of the IEEE Heinrich Hertz Award for Best Communications Letters in 2013 and the IEEE ComSoc Asia-Pacific Outstanding Young Researcher Award in 2009. She also receives the best paper awards from IEEE/CIC ICCC 2015 and IEEE WCSP 2012.

于永，男，1985年12月生，理学博士，主要从事雷达系统仿真分析、自适应阵列信号处理研究。

Complex Quadratic Programming and Its Applications and New Progress in CDT Subproblem

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The talk is formed by two parts. In the first part we shall introduce some results of complex quadratic programming from us and its applications in information science, and clear up some viewpoints that look right but in fact wrong. In the second part we shall introduce some new progress in the CDT subproblem by us.

Galois Comes to Rescue: Robust Receivers for Unifying Detection and Decoding Across the Complex Field and Binary Field

Zhi Ding

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Traditional wireless communication receivers in the physical layer are responsible for both data symbol detection, in the complex field, and error correction decoding, in the Galois field. Integrated maximum likelihood data recovery across the two fields has proven elusive due to high complexity. Message passing in the spirit of (turbo) belief propagation has been broadly utilized since the 1990's. In this talk, we present a novel receiver methodology to integrate signal detection and forward error correction in multiple-input-multiple-output (MIMO) communications and various diversity transmissions. Moving beyond traditional approaches relying on belief-propagation, we investigate the rather classic but open problem of integrated signal detection and decoding involves novel joint optimization formulations that incorporate binary field parity constraints imposed by the low-density parity check within maximum likelihood detection frameworks for unified optimization.

This novel framework is general and encompasses a number of practical transmission models, including distributed antennas, opportunistic cooperative networking, and signal retransmission as well as their integrations. For multicarrier MIMO signal reception, we present develop and optimize integrated receivers for important wireless network diversities including distributed transmissions, cooperative MIMO, and hybrid-ARQ retransmission systems. By reformulating and relaxing joint detection and decoding problems into convex optimization, we develop high performance receivers that are efficient and are robust to various forms of uncertainties including channel state information. The work contributes practically to improving future wireless services and broaden their applications in many practical fields where concerns involving quality, efficiency, and distributivity are paramount.

Low-Cost Low-Rank Channel Estimation and Transmission Scheme for 5G Massive MIMO Systems

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In this work, we present a new transmission strategy for the multiuser massive MIMO systems, including uplink/downlink channel estimation and user scheduling for data transmission. This scheme exploits the array structure as well as the spatial information of the incoming signal at BS, and generates an alternative low rank signaling model, named as spatial basis expansion model (SBEM). The basis vectors of SBEM are formulated from discrete Fourier Transform (DFT) vectors and can be efficiently deployed by the fast Fourier transform (FFT). With SBEM, both uplink and downlink channel estimation of multiusers can be carried out with very few amount of training resources, which significantly reduces the training overhead and the feedback cost for the downlink training. Moreover, the channel estimation of different users could be spatially separated from orthogonal beams, which immediately relieve the pilot contamination problem. Compared to the existing low rank modeling, the newly proposed SBEM does not require knowledge of massive channel statistics and does not suffer from high complex eigenvalue decomposition of the massive covariance matrices. Another key benefit of SBEM is that due to reciprocity of electromagnetic waves, the beam directions are also reciprocal for uplink and downlink transmission. Hence, SBEM is not only applicable for TDD system but may also present a low complexity solution for the FDD systems. Lastly, some efficient user scheduling algorithms for data transmissions are designed based on different optimization criterions.

Incentive Mechanisms for User-Provided Networks

Jianwei Huang

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The fast growing mobile data demands and the proliferation of advanced mobile devices lead to the emergence of user-provided networks (UPNs), which improve user experiences by exploiting the diverse communication needs and resources of different users. The success of UPNs, however, relies on carefully designed incentive mechanisms that effectively encourage voluntary participation and cooperation of users. Motivated by recently launched UPN business models, in this talk we will introduce two new mobile UPN incentive mechanisms that take users' energy consumption and data usage costs into consideration. The first one is motivated by the social bandwidth trading scheme pioneered by Karma (https://yourkarma.com/), and we design an optimal hybrid pricing scheme that combines usage-based data pricing and quota reimbursement for network-assisted mobile UPNs. The second one is motivated by the crowd-sourced Internet connectivity enabled by OpenGarden (https://opengarden.com/), and we design a virtual currency based scheme that incentivizes cooperation in autonomous mobile UPNs. For more information, please see
http://ncel.ie.cuhk.edu.hk/content/user-provided-networks.

Unique Decomposition and A New Model for the Ground Moving Target Indication Problem

Qingna Li

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Ground moving target indication (GMTI) is the main task in wide-area surveillance radar system. In this paper, we study GMTI from the mathematical point of view. The mathematical description for GMTI is to decompose a complex matrix into a low rank matrix and a sparse matrix (referred as GMTI decomposition), where the sparse matrix enjoys some special structure. Our first contribution is to prove the uniqueness of GMTI decomposition. We then propose a so-called phase-based RPCA model to fully describe GMTI. The alternating direction method of multipliers (ADMM) is applied to solve the resulting nonconvex complex matrix optimization problem. Great challenges come from the subproblem of the sparse matrix, which is a complex optimization problem. An inexact two-step algorithm is proposed to tackle such difficulty. Simulation results indicate the superior efficiency and the significant improvement of the new model.

Optimal Dynamic Resource Allocation for Energy Efficient Transmission in Digital Subscriber Lines

Zhi-Quan Luo

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Linear matrix precoding, also known as vectoring, is a well-known technique to mitigate multiuser interference in the downlink Digital Subscriber Line (DSL) transmission. While effective in canceling interference, vectoring does incur major computational overhead in terms of a matrix vector multiplication at each data frame, resulting in significant energy consumption when the number of lines is large. To facilitate energy efficient transmission, it has been recently proposed (in the G.fast standard) that each data frame is divided into a normal operating interval (NOI) and a discontinuous interval (DOI). In the NOI, all lines (or users) are involved in a common vectoring group, which requires a large matrix precoder, while in a DOI, the lines are subdivided into multiple small non-overlapping vectoring subgroups, which are transmitted in a TDMA manner within the data frame. Because of the use of small matrix precoders for the small vectoring subgroups in DOI, the energy efficiency can be significantly improved. In this paper, we consider several key dynamic resource allocation (DRA) problems in DSL: given the instantaneous buffer state, determine the number of transmission opportunities allocated to each line, the optimal NOI and DOI size in each data frame as well as the optimal grouping in DOI. We formulate these optimal DRA problems and propose efficient real-time algorithms for three main tasks: given a data frame, allocate transmission opportunities for all lines, design grouping strategy in DOI, and optimally adjust the durations of the NOI and the vectoring subgroups in the DOI. The simulation results show the efficiency and the effectiveness of our algorithms.

This is a joint work with

Nan Zhang, School of Mathematical Sciences, Peking University, China

Zhiqiang Yao, College of Information Engineering, Xiangtan University, China

Yixian Liu, Huawei Technologies Co. Ltd., China

Stephen Boyd, Department of Electrical Engineering, Stanford University, U.S.A.

Content-Centric Sparse Multicast Beamforming for Cache-Enabled Cloud RAN

Meixia Tao

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The driving forces behind the exponential growth of mobile data traffic have fundamentally shifted from being "connection-centric" communications, such as phone calls and text messages, to the explosion of "content-centric" communications, such as video streaming and content sharing.In this talk, I will present a content-centric transmission design in a cloud radio access network (cloud RAN) by incorporating multicasting and caching. Users requesting a same content form a multicast group and are served by a same cluster of base stations (BSs) cooperatively. Each BS has a local cache and it acquires the requested contents either from its local cache or from the central processor (CP) via backhaul links. We investigate the dynamic content-centric BS clustering and multicast beamforming with respect to both channel condition and caching status. We first formulate a mixed-integer nonlinear programming problem of minimizing the weighted sum of backhaul cost and transmit power. Then we reformulate an equivalent sparse multicast beamforming (SBF) problem. By adopting smoothed ℓ_0-norm approximation and other techniques, the SBF problem is transformed into the difference of convex (DC) programs and effectively solved using the convex-concave procedure algorithms. Simulation results demonstrate that the proposed content-centric transmission offers significant reduction in total network cost than the conventional user-centric design under the considered content request model.

The Optimization of Subarray Division in Adaptive Array Signal Processing Problem

Yong Yu

Signal Processing Department

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The antenna of the new generation of phased array radar is huge, and generally contain hundreds or even thousands of elements. Anti-interference by ADBF or clutter suppression by STAP on the element level, could significantly increase the system load, and even hard to achieve. Considering the system cost and computation load of signal processing in practical, large array need to be divided into proper subarrays, to reduce the required receiving channels. In this article, mathematical modeling of optimal subarray division, and also the influence to the performance of interference or clutter suppression are considered. In addition, the mathematical solution method of optimal subarray division is researched too, which could provide theoretical and engineering algorithm to be realized on large scale array radar equipment.

Conference Site

Conference Site:	Room 204, South Building of Academy of Mathematics and Systems Science (AMSS), Chinese Academy of Sciences (CAS)
Chinese Name:	中科院数学与系统科学研究院南楼 204 会议室
Address:	No. 55, Zhong Guan Cun East Road, Hai Dian District, Beijing, CHINA
Chinese Address:	北京市海淀区中关村东路 55 号

Registration

Registration will take place on **December 19 from 8:00 to 8:30** (right before the opening ceremony) outside the conference room.

Internet

The Wi-Fi is available. To use it, first search the wireless connection, find "AMSS" and click it; then input the workshop code "Q6C4V4C3" and your personal information.

Contact Information

If you need any help, please contact the conference secretary:

- Dr. Ya-Feng Liu, yafliu@lsec.cc.ac.cn.

Local Map


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四环
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出口
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The organizing committee wishes you a pleasant stay in Beijing!