

INTERDISCIPLINARY WORKSHOP ON DATA AND IMAGE SCIENCES

NATIONAL CENTRAL UNIVERSITY, TAIWAN
AUGUST 15, 2018

VENUE: DEPARTMENT OF MATHEMATICS, HONG-JING BUILDING M-107

【ORGANIZERS】

NORDEN E. HUANG
(INNOVATION CENTER, FIQ, QINGDAO)
THOMAS YIZHAO HOU
(CALIFORNIA INSTITUTE OF TECHNOLOGY, USA)
KUO-CHIN FAN
(DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION ENGINEERING, NCU, TAIWAN)
I-LIANG CHERN
(DEPARTMENT OF MATHEMATICS, NTU, TAIWAN)
MING-CHIH LAI
(DEPARTMENT OF APPLIED MATHEMATICS, NCTU, TAIWAN)
JANN-LONG CHERN
(DEPARTMENT OF MATHEMATICS, NCU, TAIWAN)

【SPEAKERS】

- (1) **NORDEN E. HUANG** (INNOVATION CENTER, FIQ, QINGDAO)
/ ON HOLO-HILBERT SPECTRAL ANALYSIS: FROM TURBULENCE TO BRAIN WAVES /
- (2) **THOMAS YIZHAO HOU** (CALIFORNIA INSTITUTE OF TECHNOLOGY, USA)
/ SPARSE COMPRESSION FOR ELLIPTIC OPERATORS AND GRAPH LAPLACIANS WITH ROUGH
MULTISCALE COEFFICIENTS /
- (3) **ADAM HUANG** (RESEARCH CENTER FOR ADAPTIVE DATA ANALYSIS, NCU, TAIWAN)
/ CLINICAL NEURODIAGNOSIS: IMPROVING TIME ESTIMATION FOR MR PERFUSION /
- (4) **ALBERT FANNJIANG** (UC DAVIS, USA)
/ TBA /
- (5) **SIH-HUEI CHEN**
(DEPARTMENT OF COMPUTER SCIENCE & INFORMATION ENGINEERING, NCU, TAIWAN)
/ PROBABILISTIC LATENT VARIABLE MODEL FOR LEARNING DATA REPRESENTATION /
- (6) **MEI-HENG YUEH** (DEPARTMENT OF MATHEMATICS, NTNU, TAIWAN)
/ COMPUTATIONAL CONFORMAL GEOMETRY WITH APPLICATIONS TO COMPUTER GRAPHICS /
- (7) **CHING-CHERNG SUN** (DEPARTMENT OF OPTICS AND PHOTONICS, NCU, TAIWAN)
/ 3D 室內圖資技術與展望 /
- (8) **CHIH-WEI HUANG** (DEPARTMENT OF COMMUNICATION ENGINEERING, NCU, TAIWAN)
/ DEEP LEARNING FOR MOBILE TRAFFIC MANAGEMENT /
- (9) **YU-CHENG ZHANG** (DEPARTMENT OF MATHEMATICS, NCU, TAIWAN)
/ TOWARD SEMANTIC LOOP CLOSURE IN SIMULTANEOUS LOCALIZATION AND MAPPING SYSTEMS /

【CONTACT US】

JU-TING CHAN (TEL: 03-4227151#65124)
TINA CHAN (TEL: 03-4227151#34951)
ALMA TIEN (TEL: 03-4227151#35002)

【SPONSORS】

RESEARCH CENTER FOR ADAPTIVE DATA ANALYSIS, NCU, TAIWAN
COLLEGE OF ELECTRICAL ENGINEERING & COMPUTER SCIENCE, NCU, TAIWAN
NATIONAL CENTER FOR THEORETICAL SCIENCES, TAIWAN
DEPARTMENT OF MATHEMATICS, NCU, TAIWAN
MINISTRY OF SCIENCE AND TECHNOLOGY, TAIWAN
CENTER FOR MATHEMATICS AND THEORETICAL PHYSICS, NCU, TAIWAN

Interdisciplinary Workshop on Data and Image Sciences, National Central University, Taiwan, August 15, 2018

Program:

時間	Wednesday, August 15, 2018
地點	國立中央大學數學系鴻經館 M107
9 : 30—9 : 50	Registration
9 : 50—10 : 00	Opening : Kuo-Chin Fan (Dean of College of Electrical Engineering and Computer Science)
10 : 00—10 : 40	Title : <i>On Holo-Hilbert Spectral Analysis: From turbulence to brain waves</i> Norden E. Huang (Innovation Center, FIQ, Qingdao)
10 : 50—11 : 30	Title: <i>Sparse Compression for Elliptic Operators and Graph Laplacians with Rough Multiscale Coefficients.</i> Thomas Yizhao Hou (California Institute of Technology , USA)
11 : 30—11 : 50	Break
11 : 50—12 : 20	Title: <i>Clinical NeuroDiagnosis: Improving Time Estimation for MR Perfusion</i> Adam Huang (Research Center for Adaptive Data Analysis, NCU, Taiwan)
12 : 20—13 : 30	Lunch

13 : 30—14 : 10	Title: <i>TBA</i> Albert Fannjiang (UC Davis, USA)
14 : 15—14 : 45	Title: <i>Probabilistic Latent Variable Model for Learning Data Representation</i> Sih-Huei Chen (Department of Computer Science & Information Engineering, NCU, Taiwan)
14 : 50—15 : 20	Title: <i>Computational Conformal Geometry with Applications to Computer Graphics</i> Mei-Heng Yueh (Department of Mathematics, NTNU, Taiwan)
15 : 20—15 : 40	Break
15 : 40—16 : 10	Title: <i>3D 室內圖資技術與展望</i> Ching-Cherng Sun (Department of Optics and Photonics, NCU, Taiwan)
16 : 15—16 : 45	Title: <i>Deep Learning for Mobile Traffic Management</i> Chih-Wei Huang (Department of Communication Engineering, NCU, Taiwan)
16 : 50—17 : 20	Title: <i>Toward Semantic Loop Closure in Simultaneous Localization and Mapping Systems</i> Yu-Cheng Zhang (Department of Mathematics, NCU, Taiwan)
18 : 00—20 : 00	Interdisciplinary Discussions of Data and Image Science

On Holo-Hilbert Spectral Analysis: From turbulence to brain waves

Norden E. Huang

Innovation Center, FIQ, Qingdao

Traditionally, spectral analysis is defined as transform the time domain data to frequency domain. It is achieved through integral transforms based on additive expansions of a priori determined basis, under linear and stationary assumptions. For nonlinear processes, the data can have both amplitude and frequency modulations generated by intra-wave and inter-wave interactions involving both additive and nonlinear multiplicative processes. Under such conditions, the additive expansion could not fully represent the physical processes resulting from multiplicative interactions. Unfortunately, all existing spectral analysis methods are based on additive expansions, based either on a priori or adaptive bases. While the adaptive Hilbert spectral analysis could accommodate the intra-wave nonlinearity, the inter-wave nonlinear multiplicative mechanisms that include cross-scale coupling and phase lock modulations are left untreated. To resolve the multiplicative processes, we propose a full informational spectral representation: The Holo-Hilbert Spectral Analysis (HHSA), which would accommodate all the processes: additive and multiplicative, intra-mode and inter-mode, stationary and non-stationary, linear and nonlinear interactions, through additional dimensions in the spectrum to account for both the variations in frequency and amplitude modulations (FM and AM) simultaneously. Applications to wave-turbulence interactions and other data will be presented to demonstrate the usefulness of this new spectral representation.

Sparse Compression for Elliptic Operators and Graph Laplacians with Rough Multiscale Coefficients.

Thomas Yizhao Hou

California Institute of Technology , USA

We introduce the sparse operator compression to compress a self-adjoint elliptic operator with rough multiscale coefficients. The operator compression is achieved by using localized basis functions, that are energy minimizing functions on local patches. On a regular mesh with mesh size h , the localized basis functions have supports of diameter $O(h \log(1/h))$, and give optimal compression rate of the solution operator. We show that our method achieves the optimal compression rate of the solution operator. We then discuss how to generalize this operator compression to develop a fast solver for graph Laplacians with rough coefficients using a novel energy decomposition method. This decomposition framework naturally reflects the intrinsic geometric information of the operator that inherits the localities of the topological structure. Utilizing this information, we propose a multiresolution operator compression scheme for the inverse operator of a symmetric positive definite matrix with controllable compression error and condition number. This is a joint work with Pengchuan Zhang, De Huang, and Ka Chun Lam.

Clinical NeuroDiagnosis: Improving Time Estimation for MR Perfusion

Adam Huang

Research Center for Adaptive Data Analysis, NCU, Taiwan

The aim of this talk is to analyze the numerical stability and accuracy of different time estimation techniques for MR perfusion. Intravenous thrombolysis and mechanical thrombectomy are the only approved treatments for acute ischaemic stroke, but must be administered in a narrow therapeutic window of up to 4.5 and 6 h, respectively. More recent studies suggest that this window may extend up to 24 h in carefully selected patients based on infarct volume estimation. The infarct/ischaemic lesions are estimated mainly by a time-to-max (T_{max}) bolus arrival time delay. However, choosing an arterial input function (AIF) for the deconvolution computation of T_{max} remains a critical and challenging step. Alternatively, estimating time-to-peak (TTP) directly from the intensity signal alleviates the burden of finding AIF and the subsequent interpreting/estimation variations. We report the accuracy on the estimates of TTP with different methods using simulation and real MR perfusion data.

(8/15 Wed. 13 : 30 — 14 : 10)

TBA

Albert Fannjiang

UC Davis, USA

Probabilistic Latent Variable Model for Learning Data Representation

Sih-Huei Chen

Department of Computer Science & Information Engineering, NCU,
Taiwan

Probabilistic framework has emerged as a powerful technique for representation learning. In this talk, we will introduce probabilistic latent variable model-based representation learning methods that involve both discrete and continuous latent spaces. For a discrete latent space, a hierarchical representation that is based on the Gaussian hierarchical latent Dirichlet allocation (G-hLDA) will be introduced for capturing the latent characteristics of low-level features. Representation is learned by constructing an infinitely deep and branching tree-structured mixture model, which effectively models the subtle differences among classes. For a continuous latent space, a novel complex-valued latent variable model, named the complex-valued Gaussian process latent variable model (CGPLVM), will be introduced for discovering a compressed complex-valued representation of complex-valued data. The key concept of CGPLVM is that complex-valued data is approximated by a low-dimensional complex-valued latent representation through a function that is drawn from a complex Gaussian process. Additionally, CGPLVM is extended to preserve both global and local data structures while promoting discrimination. A new objective function that incorporates a locality-preserving and a discriminative term for complex-valued data is presented. Then, a deep collaborative learning framework that is based on a variational autoencoder (VAE) and a Gaussian process (GP) will be introduced to represent multimedia data with greater discriminative power than previously achieved. A Gaussian process classifier is incorporated into the VAE to guide a VAE-based representation, which distinguishes variations of data among classes and achieves the dual goals of reconstruction and classification. The experimental results demonstrate the superior performances, especially for situations with only a small number of training data.

Computational Conformal Geometry with Applications to Computer Graphics

Mei-Heng Yueh

Department of Mathematics, NTNU, Taiwan

Computational conformal geometry is an interdisciplinary field based on the theories of conformal geometry as well as computational algorithms. It has been widely applied to carry out the 3D image processing tasks, such as surface parameterization, registration, and alignment. Especially when the geometry is complicated, a parameterization of the surface can be used to simplify the shape of the domain. In this talk, I will introduce an efficient numerical algorithm for the computation of surface conformal parameterization, and demonstrate applications on 3D animation and medical image visualization.

(8/15 Wed. 15 : 40 — 16 : 10)

3D 室內圖資技術與展望

Ching-Cherng Sun

Department of Optics and Photonics, NCU, Taiwan

Deep Learning for Mobile Traffic Management

Chih-Wei Huang

Department of Communication Engineering, NCU, Taiwan

In 5G networks, heterogeneous networks (HetNets) with small cells is a promising architecture to be deployed. The traffic offloading among macro and small cells is inevitably an essential issue. Based on the cloud controlling structure, it is possible to design proactive strategies, so operation issues can be predicted and treated before suffering performance degradation. At the same time, the much more complex nature of 5G resource management happens to be a suitable target to apply advanced machine learning approaches. In the talk, research utilizing deep learning on mobile traffic forecasting and energy-efficient offloading will be introduced. Suggestions for future 5G resource management works will also be provided.

Toward Semantic Loop Closure in Simultaneous Localization and Mapping Systems

Yu-Cheng Zhang

Department of Mathematics, NCU, Taiwan

Simultaneous localization and mapping (SLAM) is a problem in robotics aiming to model the environment and estimate the pose of a device within it at the same time. Developed solution is the core technology for emerging applications such as self-driving cars, automated guided vehicles (AGV), and domestic robots. Inevitably, the performance of SLAM algorithms relies highly on input signals from optical equipment ranging from cameras, laser rangefinders, and LIDAR. Loop closure, the function detecting visited locations to correct accumulated errors, is a crucial element in a SLAM system. Conventionally, geometric features are used to interpret the scenes for similarity estimation. In scenarios with nearly identical scenes existing, the feature-based approaches remain ineffective. Semantic objects and the comparison of multi-frame, therefore, can be integrated into the process and present a new level of environmental information. In this article, we first provide an overview of the SLAM system. Then the semantic object-assisted and the time and spatial sequence comparison approach are proposed to improve the similarity measurement in the SLAM process. By integrating recognized objects like landmarks and signs, we can classify similar scenes better and significantly improve building-scale indoor mapping results. The performance of systems adopting various optical technologies is also compared in this work.