2020 TWSIAM Annual Meeting

第八屆台灣工業與應用數學會年會

大 會 手 冊

國立成功大學 國際會議廳

{

TIME : '7/24(五)-7/25(六)'

WEBSITE : 'https://twsiam2020.emath.tw'

}

主辦單位

Twsiam 台灣工業與應用數學會 Taiwan Society for Industrial and Applied Mathematics

成大數學系 NCKU Mathematics

協辦單位

MRPC 數學研究推動中心 Mathematics Research Promotion Center

目錄

TWSIAM 研討會宗旨與回顧

第八屆台灣工業與應用數學年會，將於7/24、7/25在成功大學國際會議廳舉辦，會中將有數學、工程、科技及工業界之專業人士參與，分享理論研究及實務應用，期能促成不同領域的合作與交流，進而拓展研究人員的視野，厚植科研實力，帶動產業及社會發展。本年會舉辦已有七年之久，歷年來之舉辦單位如下：

2019年
第七屆台灣工業與應用數學會年會－國立清華大學計算與建模科學研究所主辦。

2018年
第六屆台灣工業與應用數學會年會－台灣科技大學機械工程學系主辦。

2017年
第五屆台灣工業與應用數學會年會－政治大學應用數學系主辦。

2016年
第四屆台灣工業與應用數學會年會－中興大學應用數學系主辦。

2015年
第三屆台灣工業與應用數學會年會－義守大學應用數學系主辦。

2014年
第二屆台灣工業與應用數學會年會－東華大學應用數學系主辦。

2013年
第一屆台灣工業與應用數學會年會－靜宜大學財務與計算數學系主辦。

學術委員會：（依姓名筆畫順序）

王偉仲（國立臺灣大學數學系）
吳宗芳（國立高雄大學應用數學系）
吳金典（國立交通大學應用數學系）
陳明志（國立台灣科技大學機械工程系）
舒宇宸（國立成功大學數學系）
賴明治（國立交通大學應用數學系）

籌組委員：

舒宇宸（國立成功大學數學系）
許瑞麟（國立成功大學數學系）
林敏雄（國立成功大學數學系）
沈士育（國立成功大學數學系）
王辰樹（國立成功大學數學系）
陳旻宏（國立成功大學數學系）
劉育佑（國立成功大學數學系）

海報論文委員：

黃楓南（國立中央大學數學系）
舒宇宸（國立成功大學數學系）

成功大學數學系簡介

民國45年，本校改制為成功大學的同時，正式成立「數學系」，旨在培育數學理論及應用之人才，為科技本土化奠基；民國69年，為進一步提升數學研究人才的培育，成立「應用數學研究所碩士班」，並在民國82年，成立「應用數學研究所博士班」。

成大數學系參考台灣大學數學系、美國加州大學、Purdue及Cornell大學數學系的作法，擬定課程地圖、課程規劃、跨領域課程及訂定大學部與研究所銜接課程。除了提供本系所學生的專業數學課程，數學系同時也負責全校微積分基礎課程及提升學生的數學能力。

數學系的教師認真負責地致力於教學及輔導工作。除了致力於課程教學，數學系老師也關心學生學習與生活的狀況，盡力協助每一位學生做好個人的生涯規劃。其中有多位優秀教師表現出色，並獲得榮譽與肯定。

數學系的教師除了負責教學工作培育數學人才，也同時積極地在純數學及應用數學從事學術研究，廣泛的研究領域包括：代數、分析、幾何、數值分析、科學計算、作業研究、機率論及統計等。其中有多位優秀學者在各研究領域表現出色，備受數學界矚目並獲得肯定。

大會議程

第一天：109.07.24(星期五)

時間	議程		地點
08:30~09:20	來賓報到、現場註冊、領取資料(會員領取選舉票)		國際會議廳會議大廳
09:20~09:40	司儀宣佈會議開始		國際會議廳第一演講室
	介紹來賓、來賓致詞、主任致詞、理事長致詞		國際會議廳第一演講室
09:40~10:30	大會演講 主題：Optimization and Machine Learning 主持人：賴明治教授 主講人：國立臺灣大學資訊工程學系 林智仁教授		國際會議廳第一演講室
10:30~10:50	Coffee Break		會議大廳
10:50~12:50	Session 1	Session 2	Session 3
	第一演講室	第二演講室	第三演講室
	主題：Mathematics and Machine Learning	主題：AI and Data Science	主題：Uncertainty Quantification and Industrial Statistics
	主持人：賴明治教授	主持人：李育杰教授	主持人：陳瑞彬教授
	10:50~11:15王鈺強教授 台灣大學電機工程學系	10:50~11:35陳宏銘教授 臺灣大學電信工程研究所	10:50~11:35洪英超教授 政治大學統計系
	11:15~11:40李彥寰教授 臺灣大學資訊工程學系	11:35~12:00陳駿丞博士 中央研究院資訊科技創新研究中心	11:35~12:00李宜真教授 成功大學統計系
	11:40~12:05魏澤人教授 交通大學AI學院	12:00~12:25李政德教授 成功大學統計學系	12:00~12:25林長鋆教授 中興大學應用數學系
	12:05~12:30蔡炎龍教授 政治大學應用數學系	12:25~12:50李育杰教授 交通大學應用數學系	12:25~12:50陳瑞彬教授 成功大學統計系
12:50~14:00	午餐		一樓多功能廳
14:00~16:00	Session 4	Session 5	Session 6
	第一演講室	第二演講室	第三演講室
	主題：Computational Fluid Dynamics (CFD)	主題：Numerical PDE & Linear Algebra	主題：Differential Equation and Dynamic System
	主持人：陳明志教授	主持人：卓建宏教授	主持人：吳恭儉教授
	14:00~14:25王謹誠教授 元智大學機械工程學系	14:00~14:45林敏雄教授 成功大學數學系	14:00~14:45夏俊雄教授 台灣大學數學系
	14:25~14:50吳毓庭教授 成功大學工程科學系	14:45~15:10劉青松教授 高雄大學應用數學系	14:45~15:10梁育豪教授 高雄大學應用數學系
	14:50~15:15陳明志教授 台灣科技大學機械工程系	15:10~15:35陳孟豁教授 中正大學數學系	15:10~15:35戴佳原博士 NCTS
		15:35~16:00葉均承教授 高雄師範大學數學系	15:35~16:00呂明杰博士 成功大學
16:00~16:20	Group Photo / Coffee Break		團體照地點/會議大廳
16:20~17:20	TWSIAM會員大會、年會主辦單位傳承、宣佈第四屆理監事名單		國際會議廳第一演講室
18:00~21:00	晚宴		晚宴地點

第二天(學生日)：109.07.25(星期六)

時間	議程	地點
08:30~09:00	來賓報到	歷史文物館
09:00~10:40	學生社群分享 臺灣海洋大學、中央大學、交通大學、成功大學、淡江大學	歷史文物館
10:40~11:00	Coffee Break	歷史文物館
11:00~12:00	海報論文得獎作品分享	歷史文物館
12:00~13:00	午餐 / 賦歸	歷史文物館

大會演講

Optimization and Machine Learning

Chih-Jen Lin

Department of Computer Science
National Taiwan University

講者介紹：

Chih-Jen Lin is currently a distinguished professor at the Department of Computer Science, National Taiwan University. He obtained his B.S. degree from National Taiwan University in 1993 and Ph.D. degree from University of Michigan in 1998. His major research areas include machine learning, data mining, and numerical optimization. He is best known for his work on support vector machines (SVM) for data classification. His software LIBSVM is one of the most widely used and cited SVM packages. For his research work he has received many awards, including best paper awards in some top computer science conferences. He is an IEEE fellow, a AAAI fellow, and an ACM fellow for his contribution to machine learning algorithms and software design. More information about him can be found at http://www.csie.ntu.edu.tw/~cjlin.

演講摘要：

Optimization plays an important role in many machine learning methods, but significant differences between the two areas exist. These differences have caused difficulties for applied mathematicians (including those working on numerical optimization) to make real impact on machine learning. In this talk I will humbly share some past experiences in working on both areas. Through the discussion of empirical risk minimization that covers from simple linear classification to complicated deep neural networks, we will see that incorporating properties of machine learning problems is essential in designing useful optimization methods.

總覽

Session 1 : Mathematics and Machine Learning

Meta-Learning in Deep Learning & Computer Vision

王鈺強教授
Yu-Chiang Frank Wang

台灣大學電機工程學系
Department of Electrical Engineering, National Taiwan University

Meta-learning, or learning-to-learn, is among the machine learning techniques which aims to design models that can learn new skills or adapt to new environments with a few training examples. In contrast to standard supervised learning which requires training with a large amount of (labeled) data for solving a task of interest, meta-learning improves the learning algorithm itself given the experience of multiple learning episodes. It has been observed that meta-learning tackles a wide range of learning tasks with data and computation limitations, as well as the fundamental issue of generalization. In this talk, we will discuss definitions of meta-learning, followed by its relations to topics like transfer learning, multi-task learning, and hyperparameter optimization. We will take few-shot learning in computer vision as the specific application domain, and point out potential challenges and future research directions.

Keywords：Deep learning, machine learnin, meta-learning, computer vision

Iteration Complexity of Expectation Maximization in Poisson Inverse Problems

李彥寰教授
Chien-Ming Lin[1] and Yen-Huan Li[1,2]

臺灣大學資訊工程學系
[1]Department of Computer Science and Information Engineering, National Taiwan University
[2]Department of Mathematics, National Taiwan University

Poisson inverse problems arise in many real-world applications, such as positron emission tomograpy, astronomical imaging, and network flow analysis. Expectation maximization (EM) is a standard approach to solving a Poisson inverse problem. The asymptotic convergence of EM was established more than three decades ago. The convergence speed of EM, however, had remained unclear. We show that EM attains an ε−approximate solution in $O((1/\varepsilon)\log D)$ iterations. Moreover, we give an online algorithm for Poisson inverse problems that attains an ε−approximate solution in $O((1/\varepsilon^2)D\log D)$ iterations; we argue the algorithm is the first provably converging online version of EM. As a byproduct, we also give the first non-asymptotic analysis of a portfolio selection algorithm due to Thomas Cover (T. M. Cover. An algorithm for maximizing expected log investment return. IEEE Trans. Inf. Theory. 1984.), which is of independent interest.

Keywords：Expectation maximization, Poisson inverse problem, portfolio selection, Soft-Bayes

A Shape Aware Network Architecture and Its Applications

魏澤人教授
Tzer-Jen Wei

交通大學AI 學院
College of Artificial Intelligence, National Chiao Tung University

Deep Convolutional Neural Network has shown great success in lots of tasks in computer vision and image processing, including classification, detection, segmentation, generation, translation and more. Convolutional networks typically work on pixels and images are treated as bitmaps. We propose an architecture of convolutional networks which by design corresponds to curves and enclosed regions on spatial domain. By rendering bitmaps, the outputs can be fed into convolutional neural models, and incorporated with other superivesd, semi-supervised, or self supervised frameworks, curve and regions features can be extracted. Applications include vector graphics generation, super resolution and image quantization.

Keywords：Deep Learning, Computer Vision

Mathematical Aspects of Deep Learning

蔡炎龍教授
Yen-Lung Tsai

政治大學應用數學系
Department of Mathematical Sciences, National Chengchi University

Deep learning has received considerable attention in recent years, and there are also many interesting applications. However, how neural works work is still regarded as a black box by many people. We discuss the possible role of mathematics in opening this black box. Moreover, we survey relevant research results and introduce some of our related works.

Session 2 : AI and Data Science

Autofocus

陳宏銘教授
Homer H. Chen

臺灣大學電信工程研究所
Department of Electrical Engineering, National Taiwan University

講者介紹：

Homer H. Chen received the Ph.D. degree in Electrical and Computer Engineering from University of Illinois at Urbana-Champaign.

Dr. Chen's professional career has spanned industry and academia. Since August 2003, he has been with the College of Electrical Engineering and Computer Science, National Taiwan University, where he is Distinguished Professor. Prior to that, he held various R&D management and engineering positions with U.S. companies over a period of 17 years, including AT&T Bell Labs, Rockwell Science Center, iVast, and Digital Island (acquired by Cable & Wireless). He was a U.S. delegate for ISO and ITU standards committees and contributed to the development of many new interactive multimedia technologies that are now part of the MPEG-4 and JPEG-2000 standards. His current research is related to multimedia signal processing, computational photography and display, and music data mining.

Dr. Chen is an IEEE Fellow. He currently serves on the IEEE Signal Processing Society Awards Committee and the Senior Editorial Board of the IEEE Journal on Selected Topics in Signal Processing. He was a General Co-chair of the 2019 IEEE International Conference on Image Processing. He served on the IEEE Signal Processing Society Fourier Award Committee and the Fellow Reference Committee from 2015 to 2017. He was a Distinguished Lecturer of the IEEE Circuits and Systems Society from 2012 to 2013. He was an Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology from 2004 to 2010, the IEEE Transactions on Image Processing from 1992 to 1994, and Pattern Recognition from 1989 to 1999. He served as a Guest Editor for the IEEE Transactions on Circuits and Systems for Video Technology in 1999, the IEEE Transactions on Multimedia in 2011, the IEEE Journal of Selected Topics in Signal Processing in 2014, and Springer Multimedia Tools and Applications in 2015.

演講摘要：

It is important for any imaging device to accurately and quickly find the in-focus lens position so that sharp images can be captured without human intervention. In this overview talk, I will talk about the design criteria and considerations for both contrast detection autofocus (CDAF) and phase detection autofocus (PDAF) and highlight some key milestone techniques. In particular, I will close the talk by presenting how deep learning can be applied to push the performance of autofocus to an unprecedented level.

The Challenges and Opportunities of Visual Intelligence: From the Perspective of Face Recognition Technology

陳駿丞博士
Jun-Cheng Chen

中央研究院資訊科技創新研究中心
Research Center for Information Technology Innovation, Academia Sinica

講者介紹：

Jun-Cheng Chen currently is an assistant research fellow at the research center for information technology innovation, Academia Sinica. He received his bachelor’s and master’s degrees in 2004 and 2006, respectively, both from Department of Computer Science and Information Engineering, National Taiwan University, Taipei. He received his Ph.D. degree from the University of Maryland, College Park, in 2016. He is a postdoctoral research fellow at the University of Maryland Institute for Advanced Computer Studies from 2017 to 2019. His current research interests include computer vision and machine learning with applications to face recognition and facial analysis. He was a recipient of the 2006 Association for Computing Machinery Multimedia Best Technical Full Paper Award.

演講摘要：

Recent developments in deep convolutional neural networks (DCNNs) have shown impressive performance improvements on various object detection/ recognition problems (e.g., the performance of face recognition has achieved surpassing human performance on some standard challenging benchmarks). This has been made possible due to the availability of large annotated data and a better understanding of the nonlinear mapping between images and class labels, as well as the affordability of powerful graphics processing units (GPUs). These developments in deep learning have also improved the capabilities of machines in understanding faces and automatically executing the tasks of face detection, pose estimation, landmark localization, and face recognition from unconstrained images and videos. Besides these exciting advancements of technologies, it also raises a serious concern about the fairness, transparency, accountability, and security of these intelligent systems. In this talk, I will provide a brief overview of the development of deep-learning methods used for face recognition. I will also discuss about the potential concerns about the challenges and opportunities related to the model bias, model security, and data privacy.

Explainable Detection of Fake News and Cyberbullying on Social Media

李政德教授
Cheng-Te Li

成功大學統計學系
Institute of Data Science, National Cheng Kung University

講者介紹：

Prof. Li is now an Associate Professor at Institute of Data Science, National Cheng Kung University (NCKU), Tainan, Taiwan. He received his Ph.D. degree from Graduate Institute of Networking and Multimedia, National Taiwan University. Before joining NCKU, he was an Assistant Research Fellow at CITI, Academia Sinica. Prof. Li's research interests include Machine Learning and Data Mining, Natural Language Processing, Social Network Analysis, and Recommender Systems. He had published a series of papers in top conferences, including, KDD, TheWebConf, SIGIR, CIKM, ACL, IJCAI, and ACM Multimedia. Prof. LI's academic recognitions include: 2019 K. T. Li Young Researcher Award, 2018 MOST Young Scholar Fellowship (The Columbus Program), 2016 Exploration Research Award of Pan Wen Yuan Foundation, 2012 Facebook Fellowship, and 2010 Microsoft Research Asia Fellowship.

演講摘要：

Social media ubiquitously penetrates into people's daily life and allows interactions between people. User-generated text data not only enables novel applications, but also provides user digital footprints for us to analyze a variety of human behaviors. In this talk, we will share two of our recent studies on combating anti-social behaviors: detecting fake news and identifying cyberbullying behaviors on social media. We will reveal three important insights. First, it is possible to predict anti-social behaviors without social network information. Second, graph neural networks (GNN) is effective in improving the performance of such two tasks. Third, our models can provide model explainability to understand the language use of anti-social behaviors. In the end of this talk, we will point out future directions on fighting with fake news and cyberbullying in social media.

Sharing Models without Sharing Data: Distributed Consensus Reduced Support Vector Machine

李育杰教授
Yuh-Jye Lee

交通大學應用數學系
Department of Applied Mathematics, National Chiao Tung University

Nowadays, machine learning performs astonishingly in many different fields. The more data we have, our machine learning methods will show better results. However, in some cases, the data owners may not want to or not allow to share the data they have. On the other hand, we may encounter extremely large data sets that even cannot be stored in a single machine. In order to deal with these two problems, we propose the distributed consensus reduced support vector machine (DCRSVM) for binary classification. Image that we have a set of local working units and one center master. The DCSVM allows the local working units share the local models without sharing their own data. Iteratively, by sharing and updating the local models, the center master will generate a consensus final model. The performance of the consensus model is approximately as good as the model trained by using all local working units' data together. Similarly, training an extremely large dataset, we can divide the dataset into many partitions and dispatch the partitions to many computation units. Thus, our proposed method can satisfy the requirement of no data sharing.

Session 3 : Uncertainty Quantification and Industrial Statistics

Locating Infinite Discontinuities in Computer Experiments

洪英超教授
Ying-Chao Hung

政治大學統計系
Department of Statistics, National Chengchi University

Identification of input configurations so as to meet a pre-specified output target under a limited experimental budget has been an important task for computer experiments. Such a task often involves the development of response models and design of experimental trials that rely on the models exhibiting continuity and differentiability properties. Motivated by two canonical examples in systems and manufacturing engineering, we propose a strategy for locating the boundary of the response surface in computer experiments, wherein on one side the response is finite, whereas on the other side is infinite, leveraging ideas from active learning and quasi-Monte Carlo methods. The strategy is illustrated on an example from computer networks engineering and one from precision manufacturing and shown to allocate experimental trials in a fairly effective manner. We conclude by discussing extensions of the proposed strategy to characterize other types of output discontinuity or non-differentiability in high-cost experiments, including jump discontinuities in the target output response or pathological structures such as kinks and cusps.

Sequential Bayesian Design for Accelerated Life Tests

李宜真教授
I-Chen Lee

成功大學統計系
Department of Statistics, National Cheng Kung University

To ensure the product can last long enough in the field, the accelerated life test is a useful experiment to obtain the product's lifetime information and then make prediction at the normal use condition. Due to the limits of budget, machines and time, it is important to design an efficient experiment to obtain enough lifetime information. By using the Bayesian technique, this study proposes efficient sequential Bayesian strategies based on multiple experimental machines when there are more than two machines in a lab, called the batch sequential design. This study also uses the simulation way to explore the performance of the proposed strategies and compare the performance to the existing sequential Bayesian design based on only one machine.

Forward Stepwise Random Forest Analysis for Experimental Designs

林長鋆教授
Chang-Yun Lin

中興大學應數系
Department of Applied Mathematics and Institute of Statistics,
National Chung Hsing University

In experimental designs, it is usually assumed that the data follow normal distributions and the models have linear structures. In practice, experimenters may encounter different types of responses and uncertain model structures. If this is the case, traditional methods, such as the ANOVA and regression, are not suitable for data analysis and model selection. We introduce the random forest analysis, which is a powerful machine learning method capable for analyzing various types of data with complicated model structures. To perform model selection and factor identification with the random forest method, we propose a forward stepwise algorithm and develop python codes based on maximizing the OOB score and R2 score. Three examples with different types of designs and responses are provided. We compare the performance of the proposed method and some frequently used analysis methods. Results show that the forward stepwise random forest analysis requires simplest data preprocessing and selects models that have high prediction accuracy.

Finding Optimal Points for Expensive Functions Using Adaptive RBF-based Surrogate Model via Uncertainty Quantification

陳瑞彬教授
Ray-Bing Chen

成功大學統計系
Department of Statistics and Institute of Data Science,
National Cheng Kung University

Global optimization of expensive functions has important applications in physical and computer experiments. It is a challenging problem to develop efficient optimization scheme, because each function evaluation can be costly and the derivative information of the function is often not available. We propose a novel global optimization framework using adaptive radial basis functions (RBF) based surrogate model via uncertainty quantification. The framework consists of two iteration steps. It first employs an RBF-based Bayesian surrogate model to approximate the true function, where the parameters of the RBFs can be adaptively estimated and updated each time a new point is explored. Then it utilizes a model-guided selection criterion to identify a new point from a candidate set for function evaluation. The selection criterion adopted here is a sample version of the expected improvement criterion. We conduct simulation studies with standard test functions, which show that the proposed method has some advantages, especially when the true function has many local optima. In addition, we also propose modified approaches to improve the search performance for identifying optimal points.

Session 4 : Computational Fluid Dynamics (CFD)

Numerical Study of DBD Plasma Actuator for Flow Control of a Flapping Wing

王謹誠教授
Chin-Cheng Wang[1,2], Ying-Chen Tsai[2], and Min-Fung Chang[2]

元智大學機械工程學系
[1]Department of Vehicle Engineering,
National Taipei University of Technology, Taiwan
[2]Department of Mechanical Engineering, Yuan Ze University, Taiwan

The phenomenon of dynamic stall on a flapping wing is an important and practical problem. The predominant feature of dynamic stall is the leading-edge vortex (LEV) formation and shedding over the upper surface of the wing. This is accompanied by a sudden loss of lift. On the other hand, researchers have been increasing interest in dielectric barrier discharge (DBD) plasma actuators for active flow control over the past decades. In this study, we use DBD plasma actuator at the leading edge, mid chord, and trailing edge of a flapping wing to improve aerodynamic performance, such as lift enhancement and drag reduction. Numerical simulation is performed using the open-source computational fluid dynamics (CFD) software OpenFOAM. For a flapping wing with plasma actuation, the reduced-order model is incorporated into the momentum equations to solve the plasma induced electric body force. For the flow regime, the k-w turbulence model is adopted to address the interaction between plasma and fluid flows. The benchmark case will be validated with published experimental results. There would be a good improvement of lift associated with the use of plasma-based flow control devices and as such holds considerable promise for the future.

Keywords：flapping wing, dynamic stall, dielectric barrier discharge plasma actuator

Pseudo-spectrum Method Applied to Large Eddy Simulation of Elongated Wind Farms

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A pseudo-spectrum-based large-eddy simulation (LES) model, coupled with a dynamic actuator-disk model, is used to investigate the turbine power production and the turbine wake distribution in elongated wind farms where the streamwise turbine spacing of 7, 9, 12, 15, and 18 rotor diameters are considered. Two incoming flow conditions, three wind turbine arrangements, as well as the five turbine spacings are involved in this study, which leads to a total of 30 LES wind farm scenarios. The two incoming flow conditions have the same mean velocity of 9 m s-1 but different turbulence intensity levels (i.e., 7% and 11%) at the hub height level. The considered turbine arrangements are the perfectly-aligned, laterally-staggered, and vertically-staggered layouts. The simulated results show the turbine power production has a significant improvement by increasing the streamwise turbine spacing. With increasing the streamwise turbine spacing from 7 to 18 rotor diameters, the overall averaged power outputs are raised by about 27% in the staggered wind farms and about 38% in the aligned wind farms. The wind farm scenarios with the turbine spacing of 12d or greater in a large wind farm can lead to an increasing trend in the power production from the downstream turbines in the high-turbulence inflow condition, or also avoids the degradation of the power output on the turbines with the low-turbulence inflow condition.

Keywords：Large Eddy Simulation, Streamwise Turbine Spacing, Elongated Wind Farm, Turbine Power Production

Pseudospectral Matrix Element Modeling for Flow Past a Long Flexible Cylinder

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The present study simulates the complex oscillation of a long flexible cylinder. An in-house numerical model was developed using pseudopsectral methods coupled with the direct-forcing immersed boundary (DFIB) method to investigate this phenomenon. The domain decomposition method and coordinate transformation were also applied to optimize the proposed numerical model. The model was validated first by simulations of flow through a fixed cylinder in a free stream. The preciseness and convergence analysis are presented in the validation section. The domain decomposition method was used to divide the computational domain into smaller domains. A solid body can be identified more precisely using the adopted PSME-DFIB model. This model was used to simulate the flow-induced vibration of an elastically mounted rigid cylinder. The variation of vibration frequency and maximum amplitude with respect to Reynolds number and reduced velocity was investigated in the lock-in region and compared against published results. When solids move through grids, the coordinate transformation can eliminate noise in the resultant force, as determined by the numerical integral. In addition, the in-house model was used to investigate the flow-induced vibration of an infinitely long flexible cylinder at various wavelengths, cylinder tensions and lower Reynolds numbers. A short-wavelength cylinder was considered due to the feasibility of simulations. Periodic boundary conditions were utilized. The effects of cylinder vibration on the flow patterns were also explored in detail.

Keywords：Pseudospectral matrix element method (PSME), direct-forcing immersed boundary method (DFIB), domain decomposition, coordinate transformation, flow-induced vibration

Session 5 : Numerical PDE & Linear Algebra

Structured Low-rank Approximation and Its Applications

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Recovering a structured low-rank matrix nearest to a given matrix is an essential but challenging task. Its work is to retrieve valuable information from a dataset while keeping the desired physical structure. This talk addresses two types of low-rank approximation associated with discrete type datasets and quantum physics with rigorous convergence analysis.Applications include cluster analysis, pattern discovery, and quantum entanglement. Compared with state-of-the-art optimization techniques, our proposed procedures, despite the simplicity, are more efficient and accurate. These methods might serve as a building block for any other low-rank approximation with more complicated structures.

A Numerical Method for Computing the Ground State of the Modified Gross-Pitaevskii Equation

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In this talk, we will introduce the modified Gross-Pitaevskii equation for modeling the Bose-Einstein condensate with a higher order interaction. We will discuss its numerical method and some numerical results. A great advantage of this method is that it converges quadratically and is positivity preserving in the sense that the vectors approximating the ground state vector are strictly positive in each iteration.

Fluid-structure Interactions: One-field Monolithic Fictitious Domain Method and Its Parallelization

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In this research we implement the parallelization of the method: one-field monolithic fictitious domain (MFD), an algorithm for simulation of general fluid-structure interactions (FSI). In this algorithm only one velocity field is solved in the whole domain (one-field) based upon the use of an appropriate L^2 projection. ”Monolithic” means the fluid and solid equations are solved synchronously (rather than sequentially). For simulation of fluid-structure interactions on 3D domain the algorithm and the solving of the linear systems arising from the discretization need to be parallelized in order to reduce the simulation time from several months to few days. At the initial stage of the research we focus on parallelizing the algorithm on uniform meshes. The implemented parallel algorithm is then extended to the simulations on nonuniform meshes, where an adaptive mesh refinement scheme is used to improve the accuracy and robustness. Our goal is to provide an efficient, robust algorithm which can handle the difficult fluid-structure interactions such as the collision of multiple immersed solids in fluid where the high resolution mesh is necessary for resolving the phenomena near the collision and fluid-structure interfaces.

Simulation for Computational Forensics

葉均承教授
Chun-Chen Yeh

高雄師範大學數學系
Department of Mathematics, National Kaohsiung Normal University

The speaker using the versatile software LS-DYNA as the platform to develop computational mechanics modeling and conduct supercomputer simulations and use it to reconstruct some explosion and implosion event. The speaker will introduce the work on the airplane bombing and submarine implosion.

All the dynamic nonlinear implosion phenomena can be visualized by video animations obtained from our supercomputer simulations, which are also compared with an artistically rendered video animation or the real photographic evidence.

Session 6 : Differential Equation and Dynamic System

On the Development of Mathematical Theory of Synchronization

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Department of Mathematics, National Taiwan University

Synchronization is a pervasive phenomena which has been observed in biological, chemical, physical and social systems. The first reported observation of synchronization dates back to the 17th century; a Dutch scientist, Christiaan Huygens has discovered in 1665 that two pendulum clocks hanging on the wall have always ended up swinging in exactly the opposite direction from each other. Since then, various synchronization phenomena have been reported. In this talk, we shall introduce the development of the mathematical theory in the past 70 years and some scientific applications of synchronization theory.

Flocking Motion on the Nonidentical Discrete-Time Cucker-Smale Models

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The phenomena of collective motions such as flocking of birds, schooling of fish and swarming of bacteria are often observed in complex biological systems. Among many models for investigating the above mentioned systems, the one introduced by Cucker and Smale has quickly attracted much attention. In this talk, we will discuss the flocking motion on the discrete-time Cucker-Smale model in which agents having their free-will accelerations. We prove theoretically that if the free-will accelerations of agents are summable, then the flocking motion occurs by letting the strength of the interaction between agents strong enough. Some numerical simulations to support our theoretical results will also be presented. This is a joint work with Prof. Jonq Juang.

A Trilogy of Ginzburg-Landau Spiral Waves on Spherical Geometries

戴佳原博士
Jia-Yuan Dai

國家理論科學研究中心
National Center for Theoretical Sciences

Spiral waves are important patterns observed in biological and chemical systems including the ventricles with disorganized electrical activity and the Belousov-Zhabotinsky reaction. However, even on the existence of spiral waves, only a few rigorous results are available. Among various models describing spiral waves, I focus on the significant complex Ginzburg-Landau equation, because its global gauge symmetry offers an advantage for mathematical analysis.

The framework of my research is a trilogy: existence, (in-)stability, and delay feedback stabilization. The existence of spiral waves results from a global bifurcation analysis. The (in-)stability of spiral waves follows by an explicit construction of shooting curves. Then I adopt a noninvasive delay feedback control to stabilize some unstable spiral waves.

Relativistic Boltzmann Equation: Large Time Behavior and Finite Speed of Propagation

呂明杰博士
Ming-Jiea Lyu

成功大學
Department of Mathematics, National Cheng Kung University

In this talk, we will study the asymptotic behavior of the relativistic Boltzmann equation in the whole space R_x^3 under the closed to equilibrium setting. We obtained the existence, uniqueness and large time behavior of the solution without imposing any Sobolev regularity (both the spatial and velocity variables) on the initial data. Moreover, we recognize the finite speed of propagation of the solution, which reflects the difference in essence between the relativistic Boltzmann equation and the classical Boltzmann equation. This work is jointed with Prof. Yu-Chu Lin and Kung-Chien Wu.

交通資訊

自行開車（國道路線）

・南下：沿國道一號南下 →下大灣交流道右轉 → 沿小東路直走即可抵達本校。
【自國道三號南下者，轉國道8號（西向），可接國道一號（南向）】
・北上：沿國道一號北上 → 下仁德交流道左轉 → 沿東門路(西向)往台南市區直走 → 遇林森路或長榮路右轉(北向)，即可抵達本校。
【自國道三號北上者，轉86號快速道路（西向），可接國道一號（北向）】

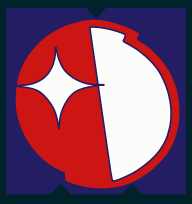
搭乘火車

於台南站下車後，自後站出口（大學路），大學路左側即為本校光復校區。

搭乘高鐵

搭乘台灣高鐵抵台南站者，可至高鐵台南站二樓轉乘通廊或一樓大廳1號出口前往台鐵沙崙站搭乘台鐵區間車前往台南火車站，約30分鐘一班車，20分鐘可到達台南火車站；成功大學自台南火車站後站步行即可到達。

校園地圖資訊



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