

20  
23



T

W

S

I

A

M

11th 台灣 TAIWAN  
工業與應用數學會年會  
TWSIAM Annual Meeting



活動時間：112年5月20日（六）至5月21日（日）

活動地點：國立臺灣師範大學公館校區

主辦單位：國立臺灣師範大學理學院

台灣工業與應用數學會

國立臺灣師範大學數學系

協辦單位：國立臺灣師範大學天文與重力中心



## 目 錄

一、 研討會主旨	3
二、 主辦單位	3
三、 大會議程	4
四、 講題與摘要	6
大會演講	11
領域論壇	15
最佳化 Optimization	15
量子計算 Quantum Computing	20
工程力學與計算 Engineering Mechanics and Computation	25
機器學習與影像應用 Machine Learning and Imaging Applications	29
天文與重力 Astronomy and Gravitation	34
STEM 跨領域 Interdisciplinary STEM	39
科學普及教育 Popular Science	43
數據科學 Data Science	46
學生社群分享 Student Community Sharing	51
產業中的數學	58
五、 贊助廠商	61
六、 活動場地資訊	62



## 一、研討會主旨

2023 年國立臺灣師範大學理學院暨數學系接受台灣工業與應用數學會 (Taiwan Society for Industrial and Applied Mathematics 簡稱 TWSIAM) 委託主辦「第十一屆台灣工業與應用數學會年會 (2023 TWSIAM Annual Meeting)」，此次會議的主題是天文重力，目的是促成與會中應用數學、工程領域、科技領域及工業與產業界之專業人士可以交換以及分享相關課題的研究心得與經驗，進而促成跨領域的合作與交流，並培養及開拓新進研究人員及學生的視野及見識。今年有幾個新的嘗試，包含「產業中的數學」、「天文與重力」、「量子計算」與「STEM 跨領域」等領域論壇，希望藉由此特別論壇媒合產業界與學界的產學合作。同時也會多邀請對數學有興趣的高中教師及高中生一起參與，讓高中生能看到數學在工業上的應用，開拓學生的視野及見識，進而吸引更多對數學有興趣的高中生加入用數學的研究。本年會舉辦已有十年之久，歷年來之舉辦單位如下：

- 2022 年第十屆 — 國立陽明交通大學應用數學系主辦。
- 2021 年第九屆 — 國立高雄大學應用數學系主辦。
- 2020 年第八屆 — 國立成功大學數學系主辦。
- 2019 年第七屆 — 國立清華大學計算與建模科學研究所主辦。
- 2018 年第六屆 — 國立臺灣科技大學機械工程學系主辦。
- 2017 年第五屆 — 國立政治大學應用數學系主辦。
- 2016 年第四屆 — 國立中興大學應用數學系主辦。
- 2015 年第三屆 — 義守大學應用數學系主辦。
- 2014 年第二屆 — 國立東華大學應用數學系主辦。
- 2013 年第一屆 — 靜宜大學財務與計算數學系主辦。

## 二、主辦單位

國立臺灣師範大學理學院

台灣工業與應用數學會

國立臺灣師範大學數學系

### 三、大會議程

#### 2023 TWSIAM Annual Meeting 議程表

Day 1: Sat, May 20, 2023.

時間	活動		地點
08:30-09:20	來賓報到、現場註冊、領取資料		中正堂
09:20-09:40	開幕典禮：介紹來賓、來賓致詞、理事長致詞		國際會議廳
09:40-10:20	Keynote Speaker：潘斯文教授 Multi-scale models of cerebral blood flow and metabolism Chair：TWSIAM 理事長陳明志		國際會議廳
10:20-11:00	Keynote Speaker：劉小菁處長 Application of mathematics and AI methods in Satellite Images Chair：理學院院長陳界山		國際會議廳
11:00-11:30	Group Photography Coffee Break		國際會議廳 數學館 1 樓側門
11:30-12:30	海報論文 1 分鐘快講 壁報論文		國際會議廳 中正堂
12:30-13:50	午餐		中正堂
Sessions	最佳化 Optimization	量子計算 Quantum Computing	工程力學與計算 Engineering Mechanics and Computation
Venue	數學館 M210	數學館 M212	數學館 M310
13:50-14:15	Speaker: Adil Bagirov Chair: 許瑞麟	Speaker: 賴青沂 Chair: 游至仕	Speaker: 陳陽泉 Chair: 王謹誠
14:15-14:40	Speaker: Yoon Mo Jung Chair: 許瑞麟	Speaker: 謝明修 Chair: 游至仕	
14:40-15:05	Speaker: 林仁彥 Chair: 張毓麟	Speaker: 陳建隆 Chair: 游至仕	Speaker: 羅弘岳 Chair: 王謹誠
15:05-15:30	Speaker: Jan Harold Alcantara Chair: 張毓麟	Speaker: 林家祥 Chair: 游至仕	Speaker: 蔡加正 Chair: 王謹誠
15:30-15:50	Coffee Break		數學館 1 樓側門
15:50-17:10	特別論壇 - 產業中的數學 Speakers: 黃翁賢、秦唯植、鍾碧真、胡鈞傑 Chair: 跨域科技產業創新研究學院院長高文忠		國際會議廳
17:10-17:40	TWSIAM 會員大會、傳承下屆年會主辦單位		國際會議廳
17:40~	晚宴		中正堂





## 2023 TWSIAM Annual Meeting 議程表

Day 2: Sun, May 21, 2023.

時間	活動			地點
08:30-09:20	來賓報到、現場註冊、領取資料			中正堂
09:20-10:00	Keynote Speaker：李悅寧教授 Origin of the statistical properties of the star-forming interstellar medium Chair：陳建隆教授			國際會議廳
10:00~10:20	Coffee Break			數學館 1 樓側門
Sessions	機器學習與影像應用 Machine Learning and Imaging Applications	天文與重力 Astronomy and Gravitation	STEM 跨領域 Interdisciplinary STEM	
Venue	數學館 M210	數學館 M212	數學館 M310	
10:20-10:45	Speaker: 魏澤人 Chair: 蔡炎龍	Speaker: 林豐利 Chair: 卜宏毅	Speaker: 林志鴻 Chair: 楊凱琳	
10:45-11:10	Speaker: 林佳威 Chair: 蔡炎龍	Speaker: 吳建宏 Chair: 卜宏毅	Speaker: 林坤誼 Chair: 楊凱琳	
11:10-11:35	Speaker: 謝博文 Chair: 胡偉帆	Speaker: 林明楷 Chair: 李悅寧	Speaker: 賴以威 Chair: 林志鴻	
11:35-12:00	Speaker: 陳縉儂 Chair: 胡偉帆	Speaker: 卜宏毅 Chair: 李悅寧	Speaker: 李睿紘 Chair: 林志鴻	
12:00-13:20	壁報論文			中正堂
12:00~13:20	午餐			中正堂
Sessions	科學普及教育 Popular Science	數據科學 Data Science	學生社群分享 Student Community Sharing	
Venue	數學館 M210	數學館 M212	數學館 M310	
13:20~13:45	Speaker: 嚴志弘 Chair: 郭君逸	Speaker: 陳瑞彬 Chair: 呂翠珊	Speaker: 李岳鴻 Chair: 李應德	
13:45-14:10		Speaker: Pierre-Louis Poirion Chair: 呂翠珊	Speaker: 洪悅慈 Chair: 李應德	
14:10-14:35	Speaker: 莊惟棟 Chair: 郭君逸	Speaker: 溫啟仲 Chair: 呂翠珊	Speaker: 施重宇 Chair: 李應德	
14:35-15:00		Speaker: Yeonjong Shin Chair: 呂翠珊	Speaker: 周彥廷 Chair: 李應德	
15:00~15:20	Coffee Break			數學館 1 樓側門
15:20~16:30	主題論壇 邀請國科會複審委員分享交流			國際會議廳
16:30~17:00	閉幕及頒獎			國際會議廳

## 四、講題與摘要

### 大會演講

Speaker: 潘斯文教授

Title: Multi-scale models of cerebral blood flow and metabolism

Chair: 陳明志

Speaker: 劉小菁處長

Title: Application of mathematics and AI methods in Satellite Images

Chair: 陳界山

Speaker: 李悅寧教授

Title: Origin of the statistical properties of the star-forming interstellar medium

Chair: 陳建隆

### 領域論壇

#### 最佳化 Optimization

Organizer : 陳界山 ( 國立臺灣師範大學數學系 )

Organizer : 張毓麟 ( 國立臺灣師範大學數學系 )

Speaker : Adil Bagirov ( Federation University, Australia )

Title : A method for global minimization of DC functions

Speaker : Yoon Mo Jung ( Department of Mathematics, Sungkyunkwan University, Korea )

Title : Optimization Models for Trend Filtering

Speaker : 林仁彥 ( 國立成功大學工業與資訊管理學系 )

Title : Assortment Management and Marketing Efforts by Customer Behaviors

Speaker : Jan Harold Alcantara ( Research Fellow, RIKEN, Japan )

Title : Global Convergence and Acceleration of Fixed Point Iterations of Union Upper Semicontinuous Operators with Applications to Feasibility Problems and Optimization



## 量子計算 Quantum Computing

Organizer：游至仕 ( 國立臺灣師範大學物理學系 )

Speaker：賴青沂 ( 國立陽明交通大學電機工程學系 )

Title：Quantum error correction from the perspective of coding theory

Speaker：謝明修 ( 鴻海研究院 )

Title：Good Quantum LDPC Codes with Linear Time Decoders

Speaker：陳建隆 ( 國立臺灣師範大學數學系 )

Title：On the Generating Quantum Feature Maps for SVM Classifier

Speaker：林家祥 ( 國立成功大學電機工程學系 )

Title：HyperQUEEN: Hyperspectral Quantum Deep Network for Satellite  
Image Restoration

## 工程力學與計算 Engineering Mechanics and Computation

Organizer：吳祚任 ( 國立中央大學水文與海洋科學研究所 )

Speaker：陳陽泉 ( University of California, Merced )

Title：Fractional Calculus: The Core Motivation and Real Applications

Speaker：羅弘岳 ( 國立臺灣大學工程科學及海洋工程學系 )

Title：Applied Mathematics and Water Wave Mechanics

Speaker：蔡加正 ( 國立臺灣海洋大學海洋工程科技中心 )

Title：The eigenfunction matching method for water wave scattering by  
variable structures and bottoms

## 機器學習與影像應用 Machine Learning and Imaging Applications

Organizer：蔡炎龍 ( 國立政治大學應用數學系 )

Organizer：胡偉帆 ( 國立中央大學數學系 )

Speaker：魏澤人 ( 陽明交通大學智慧計算與科技研究所 )

Title : Exploring With Denoising Diffusion Probabilistic Models

Speaker : 林佳威 ( 陽明交通大學應用數學系 )

Title : A Two-Phase Optimal Mass Transportation Technique for 3D Brain  
Tumor Detection and Segmentation

Speaker : 謝博文 ( 國立中興大學應用數學系 )

Title : Retinex decomposition for low-light image enhancement

Speaker : 陳縉儂 ( 國立臺灣大學資訊工程學系 )

Title : Towards Conversational AI

## 天文與重力 Astronomy and Gravitation

Organizer : 李悅寧 ( 國立臺灣師範大學地球科學系 )

Organizer : 卜宏毅 ( 國立臺灣師範大學物理學系 )

Speaker : 林豐利 ( 國立臺灣師範大學物理學系 )

Title : Weak Cosmic Censorship and Second Law of Black Hole  
Thermodynamics in Generic Gravity Theories

Speaker : 吳建宏 ( 中央研究院物理研究所 )

Title : Bayesian inference in cosmology

Speaker : 林明楷 ( 中央研究院天文及天文物理研究所 )

Title : Hopes and challenges in modern planet formation

Speaker : 卜宏毅 ( 國立臺灣師範大學物理學系 )

Title : Spacetime concept in general relativity and Black hole image

## STEM 跨領域 Interdisciplinary STEM

Organizer : 楊凱琳 ( 國立臺灣師範大學數學系 )

Organizer : 林志鴻 ( 國立臺灣師範大學科教所 )

Speaker : 林志鴻 ( 國立臺灣師範大學科學教育研究所 )

Title : 從 anomaly detection 談 AI 人才培訓

Speaker : 林坤誼 ( 國立臺灣師範大學科技應用與人力資源發展學系 )



Title : STEM 創新人才培育的趨勢與課題

Speaker : 賴以威 ( 國立臺灣師範大學電機工程學系 )

Title : 以數學為核心之跨域 STEM 實作教材、課程設計

Speaker : 李睿紘 ( 德州儀器 )

Title : STEM 在數學與科學的連結

## 科學普及教育 Popular Science

Organizer : 王婷瑩 ( 國立臺灣師範大學數學系 )

Organizer : 郭君逸 ( 國立臺灣師範大學數學系 )

Speaker : 嚴志弘 ( 嘉義大學應用數學系 )

Title : 數學科普在台推廣現況

Speaker : 莊惟棟 ( 明道大學課程與教學研究所 )

Title : 撲克牌的數學奧秘

## 數據科學 Data Science

Organizer : 呂翠珊 ( 國立臺灣師範大學數學系 )

Organizer : 陳界山 ( 國立臺灣師範大學數學系 )

Speaker : 陳瑞彬 ( 國立成功大學統計學系 )

Title : Category Tree Gaussian Process for Computer Experiments with  
Many-Category Qualitative Factors and Application to Cooling  
System Design

Speaker : Pierre-Louis Poirion ( Research Fellow, RIKEN, Japan )

Title : Random-subspaces Newton method for unconstrained non-convex  
optimization

Speaker : 溫啟仲 ( 淡江大學數學學系 )

Title : Is “the seven year itch” real? – Regression analysis of randomized  
response event time data

Speaker : Yeonjong Shin ( Department of Mathematical Sciences, KAIST,

Korea )

Title : Towards Trustworthy Scientific Machine Learning: Theory, Algorithms, and Applications

### 學生社群分享 Student Community Sharing

Organizer : 范佳銘 ( 國立海洋大學河海工程系 )

Organizer : 李應德 ( 國立海洋大學河海工程系 )

Speaker : 李岳鴻 ( 成功大學數學系 )

Title : 成功大學數學系學生社群分享

Speaker : 洪悅慈 ( 陽明交通大學應數系 )

Title : 陽明交通大學應數系學生社群分享

Speaker : 施重宇 ( 中央大學數學系 )

Title : 中央大學數學系學生社群分享

Speaker : 周彥廷 ( 海洋大學河工系 )

Title : 海洋大學河工系學生社群分享

### 產業中的數學

Special Forum: Mathematics in Industry

Host : 高文忠院長 ( 跨域科技產業創新研究學院 )

Speaker : 黃翁賢 ( 日月光集團研發副理 )

Title : 機器學習之工業影像瑕疵檢測應用

Speaker : 秦唯植 ( 新愛世科技股份有限公司首席資料科學家 )

Title : Evaluating Credit Risk Models Using KS Statistic and Its Limitations

Speaker : 鍾碧真 ( 羅氏大藥廠醫藥學術副處長 )

Title : 醫藥產業中的數學—大數據的應用

Speaker : 胡鈞傑 ( 全球人壽大數據發展處處長 )

Title : Data Science in Transglobe Life Insurance



## 大會主講

Venue: 國際會議廳

Date	Time	Speaker	Title of the Talk	Chair
May 20	09:40-10:20	潘斯文	Multi-scale models of cerebral blood flow and metabolism	陳明志
May 20	10:20-11:00	劉小菁	Application of mathematics and AI methods in Satellite Images	陳界山
May 21	09:20-10:00	李悅寧	Origin of the statistical properties of the star-forming interstellar medium	陳建隆

# Multi-scale models of cerebral blood flow and metabolism

Stephen Payne

Institute of Applied Mechanics, National Taiwan University

E-mail: [stephenpayne@ntu.edu.tw](mailto:stephenpayne@ntu.edu.tw)

## Abstract

The human brain relies on a continuous sufficient supply of blood to maintain the body's multiple functions through the delivery of oxygen to brain tissue. Even short interruptions can lead to a rapid lack of oxygen and cell death with severe consequences to brain function. Such interruptions are implicated in a range of diseases, most obviously stroke but also neurodegenerative diseases such as dementia. However, our knowledge of the cerebral vasculature remains surprisingly incomplete, and the very large number of blood vessels involved also makes understanding the brain's response to physiological challenges very difficult. Computational models of cerebral blood flow have a long history of attempting to understand the brain's behaviour in both healthy and diseased conditions, although only recently has it been possible to model the whole brain in a fully 3D manner. In this talk, I will present the work that has been done to construct these whole-brain simulations, in particular the use of multi-scale methods to bridge the different length scales and their application in stroke. I will discuss how these models can now be used to consider multiple time scales, which will be needed to consider longer-term clinical diseases such as dementia. Finally, I will focus on how these models can be applied in the next few years directly in clinical scenarios to assist clinicians in diagnosis, prognosis, and treatment of multiple brain diseases.





# Application of mathematics and AI methods in Satellite Images

劉小菁  
國家太空中心

## Abstract

Satellite images are vital for numerous applications such as agriculture, urban planning, and environmental monitoring. The growing demand for enhanced image quality and accuracy has led to the application of mathematical methods and artificial intelligence (AI) techniques in satellite image processing, focusing on image enhancement, de-blurring, de-noising, and object recognition and classification.

Mathematical methods, including Image De-blurring, Image Contrast Enhancement, and Noise Removal with Blind Deconvolution, significantly improve satellite image quality, enabling the extraction of valuable information. The FORMOSAT-5 image processing system has incorporated de-blurring and de-noising technology. Since 2019, The Image Processing Division of Taiwan Space Agency (IPS-TASA) team has been continuously refining the processing system to achieve optimal image quality. This paper will introduce various de-blurring, de-noising and fusion techniques employed by the team. In addition, the team is working on enhancing the processing speed by exploring multi-threading methods to further improve user's need.

AI methods have demonstrated considerable potential in satellite image application, particularly in object recognition and classification. The IPS-TASA team employs AI techniques in applications such as:

- (1) The Change of Taiwan West Coast: monitoring coastal changes to assess environmental impacts and identify trends for future planning.
- (2) Rice Detection: identifying rice fields and monitoring growth stages to facilitate efficient agricultural practices.
- (3) Aircraft or Ship Detection: detecting and tracking aircraft and ships for security, surveillance, and traffic management.
- (4) Segmentation of Landscape and Cities: categorizing images into roads, urban and non-urban areas, and trees for urban planning, resource management, and environmental monitoring.

The Deep Network Training and Evaluation scheme, crucial for AI application in satellite imagery, will also be introduced. This scheme ensures their effectiveness and accuracy in processing satellite images.

As a result, the integration of mathematical methods and AI techniques has revolutionized satellite image processing, leading to improved image quality and valuable information extraction. The continuous development of these methods will contribute significantly to the understanding and management of our planet's resources and environment.

# Origin of the statistical properties of the star-forming interstellar medium

Yueh-Ning Lee

Department of Earth Sciences, National Taiwan Normal University

E-mail: [ynlee@ntnu.edu.tw](mailto:ynlee@ntnu.edu.tw)

## Abstract

Star formation happens inside the turbulent interstellar medium. Stars are elementary units of the visible Universe, while each individual star holds different characteristics. The mass being one of the most prominent stellar properties, how the exact value is determined at the end of the star formation process is still a complicated question. The interstellar medium is governed by the turbulent flow, magnetic field, cosmic rays, and interstellar ionizing radiation. How self-gravity dominates over various processes at some certain scale and sets the final stellar mass is a non-linear process that involves several mechanisms. The stellar mass distribution is described with the Initial Mass Function (IMF). In this talk, I will give an overview of our current understanding of the IMF and some statistical properties of the turbulent star-forming gas.



## 領域論壇：最佳化

### Session: Optimization

Venue: 數學館 M210

Time	Speaker	Title of the Talk	Chair
13:50–14:15	Adil Bagirov	A method for global minimization of DC functions	許瑞麟
14:15–14:40	Yoon Mo Jung	Optimization Models for Trend Filtering	許瑞麟
14:40–15:05	林仁彥	Assortment Management and Marketing Efforts by Customer Behaviors	張毓麟
15:05–15:30	Jan Harold Alcantara	Global Convergence and Acceleration of Fixed Point Iterations of Union Upper Semicontinuous Operators with Applications to Feasibility Problems and Optimization	張毓麟

# A method for global minimization of DC functions

Adil Bagirov

Centre for Smart Analytics, Institute of Innovation, Science and Sustainability,  
Federation University Australia, Ballarat, Victoria, Australia.

E-mail: [a.bagirov@federation.edu.au](mailto:a.bagirov@federation.edu.au)

## Abstract

In this talk, we consider the difference-of-convex (DC) optimization problems subject to box constraints. First, we discuss necessary and sufficient conditions for local and global optimality. Then we present a method for global minimization of DC functions. This method is based on the use of  $\varepsilon$ -subdifferentials of DC component functions. The method is the combination of the local optimization methods and a special procedure for escaping from stationary points (including local minimizers) of the DC optimization problems. Results of numerical experiments will be reported.

**Keywords** Global optimization, Nonsmooth optimization, DC optimization

Joint work with K. Joki, S. Taheri and M. Mäkelä



T

W

S

I

A

M

# Optimization Models for Trend Filtering

Yoon Mo Jung

Department of Mathematics, Sungkyunkwan University

E-mail: yoonmojung@skku.edu

## Abstract

Trend filtering is a regression problem to estimate underlying trends in time series data. It is necessary to investigate data in various disciplines. We propose a trend filtering method by adaptive piecewise polynomials. More specifically, we adjust the location and the number of breakpoints or knots to obtain a better fitting to given data. The numerical results on synthetic and real data sets show that it captures distinct features such as abrupt changes or kinks and provides a simplified form and brief summary of given data.

**Keywords** Trend filtering, Piecewise polynomial regression, Nonlinear regression

# Assortment Management and Marketing Efforts by Customer Behaviors

Jen-Yen Lin

Department of Industrial and Information Management, National Cheng Kung University

E-mail: jylinor@gs.ncku.edu.tw

## Abstract

In e-commerce, it is crucial to provide customers with customized product assortments. With the advancement of the internet, more and more consumer purchase data is being stored. Retailers can utilize this data to select customized product combinations for customers from alternative items, while leveraging market effectiveness management to enhance customers' willingness to purchase. This study proposes a robust optimization method that integrates product assortment planning and market effectiveness management, which serves as a basis for formulating sales product strategies for retailers.

In this presentation, we will discuss a mathematical model that describes how to provide customers with a robust product assortment. This mathematical model is based on a three-layer optimization problem constructed using the NML approach, and is solved using fractional programming.

**Keywords** Customized assortment, marketing effort, multinomial logit model, robust optimization



# Global Convergence and Acceleration of Fixed Point Iterations of Union Upper Semicontinuous Operators with Applications to Feasibility Problems and Optimization

Jan Harold Alcantara

Center for Advanced Intelligence Project, RIKEN

E-mail: [jan.harold.alcantara@gmail.com](mailto:jan.harold.alcantara@gmail.com)

## Abstract

We propose a unified framework to analyze fixed point iterations of a set-valued operator that is the union of a finite number of upper semicontinuous maps, each with a nonempty closed domain and compact values. We discuss global convergence, local linear convergence under a calmness condition, and component identification, and further propose acceleration strategies that drastically improve the convergence speed. Our framework is applied to analyze a class of proximal algorithms for minimizing the sum of a piecewise smooth function and the difference between pointwise minimum of finitely many weakly convex functions and a piecewise smooth convex function. When realized on two-set feasibility problems, this algorithm class recovers alternating and averaged projections as special cases, and our framework thus equips these classical methods with global convergence and possibilities for acceleration on a broad class of nonconvex feasibility problems. By specializing the framework to a nonconvex feasibility problem reformulation of the linear complementarity problem, we show global convergence to a solution from any initial point, with a local linear rate, of the alternating projection as well as the averaged projection methods, which is difficult to obtain on nonconvex problems. Numerical results further exemplify that the proposed acceleration algorithms significantly improve upon their non-accelerated counterparts in efficiency. This is a joint work with Ching-pei Lee.

**Keywords** fixed point algorithm, upper semicontinuity, proximal algorithms, feasibility problems, linear complementarity problem

## 領域論壇：量子計算

### Session: Quantum Computing

Venue: 數學館 M212

Time	Speaker	Title of the Talk	Chair
13:50–14:15	賴青沂	Quantum error correction from the perspective of coding theory	游至仕
14:15–14:40	謝明修	Good Quantum LDPC Codes with Linear Time Decoders	游至仕
14:40–15:05	陳建隆	On the Generating Quantum Feature Maps for SVM Classifier	游至仕
15:05–15:30	林家祥	HyperQUEEN: Hyperspectral Quantum Deep Network for Satellite Image Restoration	游至仕



T

W

S

I

A

M



# Quantum error correction from the perspective of coding theory

Ching-Yi Lai

Institute of Communications Engineering, National Yang Ming Chiao Tung University

E-mail: [cylai@nycu.edu.tw](mailto:cylai@nycu.edu.tw)

## Abstract

Quantum states are vulnerable and quantum operations are imperfect. Quantum error correction techniques are necessary for reliable quantum computation and communication. This talk begins with a tutorial on quantum error correction from coding theory. Then I will introduce recent developments in fundamental theories, code constructions, and decoding techniques.

# Good Quantum LDPC Codes with Linear Time Decoders

Min-Hsiu Hsieh

Hon Hai Research Institute

E-mail: minhsiuh@gmail.com

## Abstract

We construct a new explicit family of good quantum low-density parity-check codes which additionally have linear time decoders. Our codes are based on a three-term chain  $(\mathbb{F}2^{m \times m})^V \xrightarrow{\delta^0} (\mathbb{F}2^m)^E \xrightarrow{\delta^1} \mathbb{F}2^F$  where  $V$  ( $X$ -checks) are the vertices,  $E$  (qubits) are the edges, and  $F$  ( $Z$ -checks) are the squares of a left-right Cayley complex, and where the maps are defined based on a pair of constant-size random codes  $C_A, C_B : \mathbb{F}2^m \rightarrow \mathbb{F}2^\Delta$  where  $\Delta$  is the regularity of the underlying Cayley graphs.

One of the main ingredients in the analysis is a proof of an essentially-optimal robustness property for the tensor product of two random codes.

## References

- [1] I. Dinur, M.-H. Hsieh, T.-C. Lin, and T. Vidick, *Good Quantum LDPC Codes with Linear Time Decoders*, arXiv:2206.07750, 2022.



# On the Generating Quantum Feature Maps for SVM Classifier

Jann-Long Chern

Department of Mathematics, National Taiwan Normal University

E-mail: [chern@gapps.ntnu.edu.tw](mailto:chern@gapps.ntnu.edu.tw)

## Abstract

In this talk, we compare two techniques for generating quantum feature maps that can be used in quantum-enhanced support vector machines, which rely on kernel methods to access high dimensional Hilbert spaces efficiently. The first approach involves using a genetic algorithm with a multi-objective fitness function, which employs a penalty method to maximize classification accuracy while minimizing the gate cost of the quantum feature map's circuit. The second method employs a variational quantum circuit and focuses on constructing an ansatz based on unitary matrix decomposition. We present numerical results and comparisons that demonstrate how the fitness function can reduce gate cost while maintaining high accuracy. We also show that conducting the circuit through unitary matrix decomposition leads to even better performance. Additionally, we propose some ideas for reducing and optimizing circuit gate cost while maintaining perfect accuracy. This is a joint work with Bang-Shien Chen.

# HyperQUEEN: Hyperspectral Quantum Deep Network for Satellite Image Restoration

Chia-Hsiang Lin

Department of Electrical Engineering, National Cheng Kung University

E-mail: [chiahsiang.steven.lin@gmail.com](mailto:chiahsiang.steven.lin@gmail.com)

## Abstract

Quantum science just winning the 2022 Nobel Prize in Physics is of high potential to lead future development of remote sensing technologies. Given the very limited number of entangled quantum bits (qubits) even in the most advanced quantum computers, processing remotely sensed hyperspectral image (featured by its large data volume) using current quantum computer does not seem to be technically feasible. Even if the quantum image state can be well processed to the quantum state of the target image (QSTI), it cannot be perfectly retrieved/output as the QSTI will collapse to some eigenstate once it is measured. Owing to these challenges, current quantum image processing technologies can only achieve classification-level applications requiring just a few output qubits. We design a hyperspectral quantum deep network (HyperQUEEN) to encode the hyperspectral information using very few qubits, as well as to learn the mapping from some measuring statistics (associated with the collapsed-QSTI) to the target image (instead of directly retrieving the unobservable QSTI), thereby solving the challenges. HyperQUEEN is the first quantum architecture that makes a breakthrough to blindly reconstruct NASA's damaged hyperspectral images, which means a lot for the upcoming space era. As the immature quantum facility nowadays does not yet allow us to fully exhibit its high potential, we are not aiming at developing state-of-the-art methods, but are demonstrating the feasibility of quantum hyperspectral remote sensing. Mathematical analysis guiding our design toward the low-rank quantum deep network, together with comprehensive experiments, will also be presented.



## 領域論壇：工程力學與計算

Session: Engineering Mechanics and Computation

Venue: 數學館 M310

Time	Speaker	Title of the Talk	Chair
13:50–14:40	陳陽泉	Fractional Calculus: The Core Motivation and Real Applications	王謹誠
14:15–14:40	羅弘岳	Applied Mathematics and Water Wave Mechanics	王謹誠
14:40–15:05	蔡加正	The eigenfunction matching method for water wave scattering by variable structures and bottoms	王謹誠

# Fractional Calculus: The Core Motivation and Real Applications

YangQuan Chen

Department of Mechanical Engineering, University of California, Merced

E-mail: [yangquan.chen@ucmerced.edu](mailto:yangquan.chen@ucmerced.edu)

## Abstract

Fractional calculus is about differentiation/integration of non-integer orders. Rejecting fractional calculus is like saying there is no other numbers between two neighboring integers. In this tutorial talk, I will explain the core motivation of fractional calculus by first showing the “core motivation” of (integer-order) calculus invented by Newton and Leibnitz which could be traced back to the time of Heraclitus of Ephesus. My concise messages are that the “integer order calculus” is driven by “the desire and the need” of “quantification of changes” while “non-integer order calculus” is by “the desire and the need of understanding complexities”. I then propose the FOT – fractional order thinking and the “better than the best” type of defense of fractional calculus. I will also show some compelling applications in real world as time allows.

## References

- [1] J. V. Grabiner, *The Changing Concept of Change: The Derivative from Fermat to Weierstrass*, Mathematics Magazine, Vol. 56, No. 4 (Sep., 1983), pp. 195–206, <https://www.maa.org/sites/default/files/0025570x04690.di021131.02p02223.pdf>
- [2] H. Sun and Y. Zhang and D. Baleanu and W. Chen and Y. Chen, *A new collection of real world applications of fractional calculus in science and engineering*, Commun. Nonlinear Sci. Numer. Simul., 64 (2018), 213–231, <https://doi.org/10.1016/j.cnsns.2018.04.019>



# Applied Mathematics and Water Wave Mechanics

Peter H.-Y. Lo 羅弘岳

Department of Engineering Science and Ocean Engineering, National Taiwan University

E-mail: peterhylo@ntu.edu.tw

## Abstract

Historically speaking, there is a close tie between applied mathematics and water wave mechanics. In this talk, a brief introduction to the mathematical modelling of water waves will be presented. Particular interest will be paid to the study of tsunamis generated by an underwater landslide. By analyzing the Laplace equation subject to linearized boundary conditions and also the linearized wave equation, several insights can be gained into the wave generation process of landslide tsunamis: 1) the tsunami generated by an underwater landslide consists of a free wave component that propagates freely and a locked wave component that follows the landslide; 2) the leading wave of the free wave component is primarily governed by the volume enclosed by the landslide, not its exact shape; 3) the locked wave component possesses the same amount of wave energy as the free wave component; 4) the locked wave component may appear deceptively small in wave amplitude but with large flow velocities; 5) a maximum total wave energy exists as a function of the landslide travel time, which corresponds to the worst-case scenario. This talk shall outline the mathematical derivation for the above findings and seeks to highlight the practical value of the mathematical analysis.

**Keywords** water wave mechanics, tsunamis, Laplace equation, wave equation

## The eigenfunction matching method for water wave scattering by variable structures and bottoms

Chia-Cheng Tsai

Bachelor Degree Program in Ocean Engineering and Technology and Center of Excellence for Ocean Engineering, National Taiwan Ocean University, Keelung 202301, Taiwan

### Abstract

In this talk, I will introduce my recent studies on the eigenfunction matching method (EMM) for solving problems of water wave scattering. These include problems of viscous or inviscid waves scattering and/or breaking by arbitrary bottoms, tension-leg, and/or surface-piercing structures. The Bragg reflections of oblique water waves by series of periodic surface-piercing structures and bottoms are also reported. By the assumption of small wave amplitude, the linear wave theory is employed in the EMM formulations. In the solution procedure, the tension-leg or surface-piercing structures and bottoms are sliced into a number of shelves separated by abrupt steps. On each shelf, the solution is composed of eigenfunctions with unknown coefficients that represent the wave amplitudes. By the conservations of mass and momentum, a system of linear equations is obtained and then solved by a sparse-matrix solver. The proposed EMM is validated by several examples in the literatures. Numerical results indicate that the EMM are accurate up to four decimal places.

**Keywords:** Eigenfunction matching method; Step approximation; Tension-leg structure; Surface-piercing structure; Weak viscous Bernoulli's equation; Oblique wave; Bragg reflection; Wave breaking





## 領域論壇：機器學習與影像應用

Session: Machine Learning and Imaging Applications

Venue: 數學館 M210

Time	Speaker	Title of the Talk	Chair
10:20-10:45	魏澤人	Exploring With Denoising Diffusion Probabilistic Models	蔡炎龍
10:45-11:10	林佳威	A Two-Phase Optimal Mass Transportation Technique for 3D Brain Tumor Detection and Segmentation	蔡炎龍
11:10-11:35	謝博文	Retinex decomposition for low-light image enhancement	胡偉帆
11:35-12:00	陳縉儂	Towards Conversational AI	胡偉帆

# Exploring With Denoising Diffusion Probabilistic Models

Tzer-jen Wei

College of Artificial Intelligence, National Yang Ming Chiao Tung University

E-mail: [tjwei@nycu.edu.tw](mailto:tjwei@nycu.edu.tw)

## Abstract

Recent advances in DDPM (Denoising Diffusion Probabilistic Models) allow us to generate high-fidelity and quality images using deep models. It is the current state-of-the-art of image generative models and beats GAN-based models in various tasks.

This talk will first briefly overview DDPM, including its relationship to score-based generative models, the diffusion process, stochastic differential equations, classifier guidance, and classifier-free guidance methods.

We will then introduce a few simple experiments to explore the conditional probability space corresponding to the diffusion models. We can see the denoising process by running the algorithm on low-dimensional spaces. We can use a technique akin to classifier guidance to guide the model to generate images with arbitrary geometric shapes or that satisfy other easily defined conditions by combining an unconditional DDPM with some known probability density. We will investigate related issues in a classifier-free guidance setting and contrast the outcomes.

**Keywords** Denoising Diffusion Probabilistic Models, score based generative model

## References

- [1] HO, Jonathan; SALIMANS, Tim. Classifier-free diffusion guidance. arXiv preprint arXiv:2207.12598, 2022.
- [2] DHARIWAL, Prafulla; NICHOL, Alexander. Diffusion models beat gans on image synthesis. Advances in Neural Information Processing Systems, 2021, 34: 8780-8794.
- [3] Khrulkov, Valentin and I. Oseledets. "Understanding DDPM Latent Codes Through Optimal Transport." ArXiv abs/2202.07477 2022.



# A Two-Phase Optimal Mass Transportation Technique for 3D Brain Tumor Detection and Segmentation

Jia-Wei Lin

Department of Applied Mathematics, National Yang Ming Chiao Tung University

E-mail: [jiaweilin@nycu.edu.tw](mailto:jiaweilin@nycu.edu.tw)

## Abstract

The goal of optimal mass transportation (OMT) is to transform any irregular 3D object (i.e., a brain image) into a cube without creating significant distortion, which is utilized to preprocess irregular brain samples to facilitate the tensor form of the input format of the U-net algorithm. The BraTS 2021 database newly provides a challenging platform for the detection and segmentation of brain tumors, namely, the whole tumor (WT), the tumor core (TC) and the enhanced tumor (ET), by AI techniques. We propose a two-phase OMT algorithm with density estimates for 3D brain tumor segmentation. In the first phase, we construct a volume-mass-preserving OMT via the density determined by the FLAIR grayscale of the scanned modality for the U-net and predict the possible tumor regions. Then, in the second phase, we increase the density on the region of interest and construct a new OMT to enlarge the target region of tumors for the U-net so that the U-net has a better chance to learn how to mark the correct segmentation labels. The application of this preprocessing OMT technique is a new and trending method for CNN training and validation..

**Keywords** Optimal mass transportation, Brain tumor segmentation, Machine learning

## References

- [1] W.-W. Lin, T. Li, T.-M. Huang, J.-W. Lin, M.-H. Yueh, S.-T. Yau, *A Two-Phase Optimal Mass Transportation Technique for 3D Brain Tumor Detection and Segmentation*, , Internatio MICCAI Brainlesion Workshop, (2022), 400-409.

# Retinex decomposition for low-light image enhancement

Po-Wen Hsieh

Department of Applied Mathematics, National Chung Hsing University

E-mail: pwhsieh@nchu.edu.tw

## Abstract

Images captured in inadequate lighting conditions often suffer from uneven illumination, low contrast, and poor visibility. Such degraded images not only lead to unpleasing images for human vision but can also degrade the performance of algorithms in many computer vision applications. In this talk, we will introduce a Retinex-based variational model for low-light image enhancement. The proposed model can effectively improve the visibility of low-light images while achieving noise suppression. A number of numerical experiments and comparisons with other popular enhancement methods are conducted to demonstrate the high performance of our method.

**Keywords** Retinex model, image enhancement, adaptive variational model



# Towards Conversational AI

Yun-Nung Chen

Department of Computer Science and Information Engineering, National Taiwan University

E-mail: [yvchen@csie.ntu.edu.tw](mailto:yvchen@csie.ntu.edu.tw)

## Abstract

Conversational AI is an exciting field that aims to create intelligent machines capable of carrying out human-like conversations. In recent years, advancements in deep learning and natural language processing (NLP) have led to significant progress in this area. One important breakthrough is the development of GPT and its variants (e.g. ChatGPT), which have shown remarkable performance in conversation generation. This talk aims to explain the technology behind ChatGPT and discuss the strengths and limitations of ChatGPT, including ethical considerations and potential biases. By the end of this talk, you will have a better understanding of the potential of Conversational AI and how ChatGPT can make a difference in your work. [This summary was partially generated by ChatGPT.]

## 領域論壇：天文與重力

### Session: Astronomy and Gravitation

Venue: 數學館 M212

Time	Speaker	Title of the Talk	Chair
10:20-10:45	林豐利	Weak Cosmic Censorship and Second Law of Black Hole Thermodynamics in Generic Gravity Theories	卜宏毅
10:45-11:10	吳建宏	Bayesian inference in cosmology	卜宏毅
11:10-11:35	林明楷	Hopes and challenges in modern planet formation	李悅寧
11:35-12:00	卜宏毅	Spacetime concept in general relativity and Black hole image	李悅寧



T

W

S

I

A

M

# Weak Cosmic Censorship and Second Law of Black Hole Thermodynamics in Generic Gravity Theories

Feng-Li Lin

Department of Physics, National Taiwan Normal University

E-mail: [linfl@ntnu.edu.tw](mailto:linfl@ntnu.edu.tw)

## Abstract

Roger Penrose proposed the weak cosmic censorship conjecture to hide the naked singularity of a black hole behind its horizon. This can be understood as implied by the second law of black hole thermodynamics, which states that the area of a black hole horizon can never be decreased. However, it is unclear if this conjecture holds for generic theories of gravity. In this talk, I will show that the answer is positive.

# Bayesian inference in cosmology

Kin-Wang Ng

Institute of Physics, Academia Sinica

E-mail: [nkw@phys.sinica.edu.tw](mailto:nkw@phys.sinica.edu.tw)

## Abstract

I will give a brief introduction to the Bayesian statistical method and how we use the method to infer cosmological parameters such as the matter content, the expansion rate, and the age of the Universe from cosmological observations such as supernovae, cosmic microwave background, and large-scale structures.



T

W

S

I

A

M



# Hopes and challenges in modern planet formation

Min-Kai Lin

Institute of Astronomy and Astrophysics, Academia Sinica

E-mail: [mklin@asiaa.sinica.edu.tw](mailto:mklin@asiaa.sinica.edu.tw)

## Abstract

With the discovery of over 5000 extra-solar planets to date, the formation and evolution of planets and planetary systems is one of the most rapidly developing fields of astrophysics. In the standard ‘bottom-up’ scenario, planets form from planetesimals — km or larger-sized bodies. Planetesimals form from small, mm-cm size pebbles, which themselves form from micro-sized dust grains immersed in gaseous protoplanetary disks around young stars. I will describe several obstacles, but also new possibilities, on the road from dust to planets from recent theoretical modeling of planetesimal formation in modern models of protoplanetary disks.

# Spacetime concept in general relativity and Black hole image

Hung-Yi Pu

Department of Physics, National Taiwan Normal University

E-mail: [hypu@gapps.ntnu.edu.tw](mailto:hypu@gapps.ntnu.edu.tw)

## Abstract

The theory of general relativity proposes that gravitation is a result of spacetime curvature. This talk will provide a brief overview of the mathematical structure used to describe spacetime in this framework. Additionally, we will delve into the intriguing concept of black holes and explore how recent observations by the Event Horizon Telescope align with general relativity predictions. By the end of this talk, you will gain a better understanding of the intricate relationship between spacetime and gravity, as well as the latest advancements in observational astronomy.



T

W

S

I

A

M

## 領域論壇：STEM 跨領域 Session: Interdisciplinary STEM

Venue: 數學館 M310

Time	Speaker	Title of the Talk	Chair
10:20-10:45	林志鴻	從 anomaly detection 談 AI 人才培訓	楊凱琳
10:45-11:10	林坤誼	STEM 創新人才培育的趨勢與課題	楊凱琳
11:10-11:35	賴以威	以數學為核心之跨域STEM 實作教材、課程設計	林志鴻
11:35-12:00	李睿紘	STEM 在數學與科學的連結	林志鴻

# 從 anomaly detection 談 AI 人才培訓

林志鴻

國立臺灣師範大學 科學教育研究所

E-mail: john.jrhunglin@ntnu.edu.tw

## Abstract

由於AI風潮的崛起，讓產業界對於AI人才的需求與日俱增。也讓人才培訓成爲一個受關注的焦點。講者具備學界與業界的工作經驗，因此從STEM的角度(Science、Technology、Engineering、and Mathematics)出發，透過半導體製作過程中的異常偵測(Anomaly detection)爲例，來探討AI人才培訓的相關議題。前半段先說明異常偵測的意義與重要性，接續說明如何設計Autoencoder來偵測異常值，並分享過程中遇到的困難。後半段從STEM角度提出AI人才需具備能力，最後進行討論。



## STEM 創新人才培育的趨勢與課題

林坤誼

國立臺灣師範大學 科技應用與人力資源發展學系/

STEM 整合教育國際博士學位學程

E-mail: linkuenyi@ntnu.edu.tw

### Abstract

STEM 教育的風潮在不同教育階段皆受到大量的關注，本次分享將分別針對大學教育階段以及 K-12 年級教育階段的趨勢與課題進行探討。在大學教育階段主要談論 STEM 創新人才培育的趨勢，以及國內、外各大學所採取的創新策略與做法。在 K-12 年級教育階段，則主要透過幾份重要的文獻分析研究，以談論未來推動 STEM 教育所應該關切的重要課題。透過本次的分享，期望能夠讓與會者掌握不同教育階段的 STEM 教育之趨勢與課題。

# 以數學為核心之跨域STEM 實作教材、課程設計

賴以威

國立臺灣師範大學電機工程學系

E-mail: iweilai@ntnu.edu.tw

## Abstract

講者將分享所屬新創團隊數感實驗室近年來從事STEM 課程、教材開發之經驗。包括教案開發流程，教材實作，課程推廣之過程與所需相關專業人才、合作。透過此分享，期許能邀請更多教育專業團隊一同投入STEM 領域之推廣。



領域論壇：科學普及教育  
Session: Popular Science

Venue: 數學館 M210

Time	Speaker	Title of the Talk	Chair
13:20–14:10	嚴志弘	數學科普在台推廣現況	郭君逸
14:10–15:00	莊惟棟	撲克牌的數學奧秘	郭君逸

## 數學科普在台灣的推廣現況

嚴志弘

國立嘉義大學 應用數學系

E-mail: chyen@mail.ncyu.edu.tw

數學科普是將複雜的數學概念、問題以生動有趣的方式呈現給大眾，以提高大眾對數學的認識和興趣。在台灣，數學科普的推廣已逐漸受到重視，尤其隨著以素養為導向的 108 課綱全面實施後，自主、探究、跨域、創新等成為了教育改革的主要方向，而數學科普作為一種能夠將數學知識與現實生活結合起來的活動型態，也對數學學習和數學教育帶來了正面的影響。

本演講將從以下三個方面探討數學科普在台灣的推廣現況：

第一，數學科普的推廣機構與活動。目前，台灣的數學科普推廣機構主要有教育部、國科會、地方政府、展館、學校、企業、學會、社群、團隊和個人等。推廣活動則包括展覽、年會、比賽、表演、擺攤、營隊、研習、課程、出書、嘉年華、工作坊或體驗坊等多種形式。

第二，數學科普的推廣效果與挑戰。數學科普的推廣在某種程度上已經提高了大眾對數學的認知和興趣，但是在數學教育的實際應用或影響，以及培養相關人才方面，仍面臨著挑戰。

第三，未來數學科普的發展趨勢。隨著科技的發展和社會的變化，數學科普也將朝著在地化、專業化、和互動性強的方向發展。

總結來說，近年來數學科普在台灣的推廣取得了一定的成果，但仍需要進一步努力，也迫切需要政府、學校等各單位，以及老師、家長、學生等個人的大力支持和參與，如此將有助於培養更多的數學人才，為教育改革和社會發展做出更大的貢獻。





# 撲克牌的數學奧秘

莊惟棟

明道大學課程與教學研究所

E-mail: wtmathmagic@gmail.com

(請自行攜帶一副撲克牌)

## Abstract

52張撲克牌，從數字、張數、遊戲來看，倚賴數學知識能變化出千萬種奇蹟。2021精選離散數學論文、各年度的數學日魔數秀，皆由撲克牌的數學核心而來，請準備好一副牌，來見證數學奇蹟的時刻。

## 領域論壇：數據科學

### Session: Data Science

Venue: 數學館 M212

Time	Speaker	Title of the Talk	Chair
13:20–13:45	陳瑞彬	Category Tree Gaussian Process for Computer Experiments with Many-Category Qualitative Factors and Application to Cooling System Design	呂翠珊
13:45–14:10	Pierre-Louis Poirion	Random-subspaces Newton method for unconstrained non-convex optimization	呂翠珊
14:10–14:35	溫啓仲	Is “the seven year itch” real? – Regression analysis of randomized response event time data	呂翠珊
14:35–15:00	Yeonjong Shin	Towards Trustworthy Scientific Machine Learning: Theory, Algorithms, and Applications	呂翠珊



# Category Tree Gaussian Process for Computer Experiments with Many-Category Qualitative Factors and Application to Cooling System Design

Ray-Bing Chen

Department of Statistics & Institute of Data Science, National Cheng Kung University

E-mail: [rbchen@ncku.edu.tw](mailto:rbchen@ncku.edu.tw)

## Abstract

In computer experiments, Gaussian process (GP) models are commonly used for emulation. However, when both qualitative and quantitative factors are in the experiments, emulation using GP models becomes challenging. In particular, when the qualitative factors contain many categories in the experiments, existing methods in the literature become cumbersome due to the curse of dimensionality. Motivated by the computer experiments for the design of a cooling system, a new tree-based GP is proposed that emulates computer models with many-category qualitative factors, which we call category tree GP. The proposed method incorporates a tree structure to split the categories of the qualitative factors, and GP or mixed-input GP models are employed for modeling the simulation outputs in the leaf nodes. The splitting rule takes into account the cross-correlations between the categories of the qualitative factors, which have been shown by a recent theoretical study to be a crucial element for improving the prediction accuracy. In addition, a pruning procedure based on the cross-validation error is proposed to ensure the prediction accuracy. The application to the design of a cooling system indicates that the proposed method not only enjoys marked computational advantages and produces accurate predictions, but also provides valuable insights into the cooling system by discovering the tree structure.

# Random-subspaces Newton method for unconstrained non-convex optimization

Pierre-Louis Poirion

RIKEN Center for Advanced Intelligence Project, Tokyo, Japan

E-mail: pierre-louis.poirion@riken.jp

## Abstract

In this talk, we present a randomized subspace regularized Newton method for a non-convex function. We show that our method has global convergence under appropriate assumptions, and its convergence rate is the same as that of the full regularized Newton method. Furthermore, we can obtain a local linear convergence rate, under some additional assumptions, and prove that this rate is the best we can hope when using random subspace.



T

W

S

I

A

M

# Is “the seven year itch” real? – Regression analysis of randomized response event time data

Chi-Chung Wen

Department of Mathematics, Tamkang University

E-mail: ccwen@mail.tku.edu.tw

## Abstract

The randomized response techniques (RRTs), including the related-question RRT of Warner (1965) and the unrelated-question RRT of Greenberg et al. (1969), have been utilized to reduce under-reporting of sensitive characteristics in survey studies by enhancing privacy protection. Currently, the RRT is mainly applied for prevalence estimation of some sensitive event. This work extends the application of the RRT to the analysis of time-to-event outcome. We apply the proposed method to the Taiwan extramarital sex data surveyed by the RRT to make statistical inferences on the time to the incidence of extramarital sex since marriage. In final, we discuss the authenticity of “the seven year itch” based on the Taiwan survey data.

# Towards Trustworthy Scientific Machine Learning: Theory, Algorithms, and Applications

Yeonjong Shin

Department of Mathematical Sciences, KAIST, Korea

E-mail: [yeonjong\\_shin@kaist.ac.kr](mailto:yeonjong_shin@kaist.ac.kr)

## Abstract

Machine learning (ML) has achieved unprecedented empirical success in diverse applications. It now has been applied to solve scientific problems, which has become an emerging field, Scientific Machine Learning (SciML). Many ML techniques, however, are very complex and sophisticated, commonly requiring many trial-and-error and tricks. These result in a lack of robustness and interpretability, which are critical factors for scientific applications. This talk centers around mathematical approaches for SciML, promoting trustworthiness. The first part is about how to embed physics into neural networks (NNs). I will present a general framework for designing NNs that obey the first and second laws of thermodynamics. The framework not only provides flexible ways of leveraging available physics information but also results in expressive NN architectures. The second part is about the training of NNs, one of the biggest challenges in ML. I will present an efficient training method for NNs - Active Neuron Least Squares (ANLS). ANLS is developed from the insight gained from the analysis of gradient descent training.



領域論壇：學生社群分享  
Session: Student Community Sharing

Venue: 數學館 M310

Time	Speaker	Title of the Talk	Chair
13:20–13:45	李岳鴻	成功大學數學系學生社群分享	李應德
13:45–14:10	洪悅慈	陽明交通大學應數系學生社群分享	李應德
14:10–14:35	施重宇	中央大學數學系學生社群分享	李應德
14:35–15:00	周彥廷	海洋大學河工系學生社群分享	李應德

# 學生社群活動分享

李岳鴻

應用數學所，國立成功大學

E-mail: 118091023@ncku.edu.tw

## Abstract

### 1. 碩士生迎新活動

我們邀請碩士班二年級及以上的學長姐分享他們在修課策略，決定指導教授，確認研究題目及心態調整上面的經驗。旨在於讓碩士班一年級的新生學弟妹能更快速了解他們將會面臨到的挑戰，並且整頓好自己的心態以面對往後的研究生生活。

### 2. 碩士生模擬口試

我們邀請該學期即將口試畢業的碩士生於正式口試之前給學弟妹一場短講，講述他們的研究成果。一來得以讓學弟妹們了解碩士口試的難度大約在哪裡，也能從中學習學術簡報技巧。同時我們也邀請博士班的學長姐們給予學弟妹口試上的建議，包括撰寫摘要的心得，論文報告內容的取捨，以及演講技巧的建議等等。讓參與的研究生們，無論是碩士生或是博士生，都能夠從中獲得不少的寶貴經驗。

### 3. 研究生生存經驗分享

我們邀請有特殊專長的研究生來分享他們在課餘時間的生活，如沖泡咖啡，健身等等，讓其他同學及學弟妹了解到在研究生時期時，如何同時兼顧身心平衡也是相當重要的一項課題。

**Keywords** 碩士新生，碩士口試，研究生生活





# NYCU TWSAIM Student Community Sharing

Yueh-Tzu Hung

Department of Applied Mathematics, NYCU

E-mail: [yzh.sc10@nycu.edu.tw](mailto:yzh.sc10@nycu.edu.tw)

## Abstract

Our student community is dedicated to fostering communication among peers and teachers, creating an environment where students with shared interests and goals can learn from each other. To achieve this, we aim to integrate mathematics with other disciplines, broadening students' perspectives and improving their practical math skills. In this talk, we will share the activities that we have conducted during the current semester, highlighting our efforts to promote cross-disciplinary collaboration and enhance our students' learning experiences.

# NCU Student Chapter of SIAM: Annual Report

施重宇 Chung-Yu Shih

Department of Mathematics, National Central University

E-mail: davidavidshih11@gmail.com

## Abstract

工業與應用數學會國立中央大學學生分會(NCU.SIAM) 在黃楓南老師的指導下，這一個學年中依然持續活動，不同於上個學年度嘗試以各項技能、技術及學科為主題來進行活動，因為人員改組及時間規劃，我們將活動的重心轉向學生研究以及成果分享，更多的去協助學生，給學生在不同項目的學習中有機會可以多方的探詢自己的興趣。前期長時間的磨合，我們經歷了多次的失敗及研究項目的改變，但與學生之間也逐漸的掌握了合作的默契，我們也在這樣的過程中不斷的互相學習。

活動方面，感謝俞韋老師的邀請，我們為大學生舉辦了暑期研究成果分享，除了鼓勵學生繼續將研究推進外，也希望藉此向其他同學推廣TWSIAM 及NCTS 等單位給出的機會。另外，因俞老師的推薦，我們有機會與中央大學人文藝術中心以及中華民國數學會合作，為電影舉辦映後座談，與不同科系的學生討論關於數學家與菲爾茲獎。另外，我們依然保持每個月持續舉辦SIAM News 分享會，感謝蔡昇甫老師與鄒駿祥老師的加入，因為每個月都固定聚一聚，這個分享會逐漸發展為一個可以公布新活動並與不同領域的老師們閒聊討論的平台。

特別感謝SIAM 及TWSIAM 的贊助及各位老師的協助，也感謝參與我們活動的每一位學生，在新的一個學年NCU.SIAM 也會繼續努力。

**Keywords** 工業與應用數學會國立中央大學學生分會, NCU.SIAM



周彥廷

國立臺灣海洋大學 河海工程學系

E-mail: [11052019@mail.edu.tw](mailto:11052019@mail.edu.tw)

指導老師: 范佳銘主任、李應德老師

輔導顧問: 陳正宗特聘講座教授

## 摘要

今年我們海大分會的活動導向維持傳統方式，2022/8/9 舉辦新苗交流會，邀請美國密西西比大學數學系陳清祥教授、台大土木楊德良、林聰悟、洪宏基教授等師長，參與開學前的師生學術交流討論會。2022/8/26 社員高浩真同學參加結構工程研討會，高浩真同學支承運動方面的研究成果也獲選振噪研討會第一名的肯定。2022/9/27 以及 2022/10/4 舉辦海大河工 2 年級聯合工數教學，讓學弟妹們能對數學有更紮實的學習，也在服務的過程中推廣我們的社群，鼓勵大家來參加我們舉辦的各式活動，並且徵求新的社群成員，以及介紹 TwSIAM 海大分會社群的運作。2022/10/15-10/19 參加在韓國濟州島舉辦的 ACFD 國際會議，我們社群的碩二生戴暉宸也有做投搞並且上台做全英文報告。2022/10/21 正式舉辦新幹部的徵選，讓大二學生有機會進入研究室學習並且提升研究能力，並鼓勵他們未來參與學校級的暑期專題。2022/11/11-11/14 我和高浩真、戴暉宸同學參加在台師大舉辦的 IC3MT 國際會議，觀摩及學習機械領域傑出的學者並做交流，2022/11/17-19 社員高浩真、戴暉宸同學參加計算力學論壇以及力學會議。2022/11/24 為工數修課的大二生們做期中考前的總複習。2022/11/18 社員高浩真、戴暉宸同學參加葉超雄老師紀念論壇。2022/12/16 參加海大大專生暑期計畫頒獎典禮，社群成員曹美娜同學及楊佳穎同學分別獲工學院第三名及佳作。

而不同於以往的是，今年我們社群的輔導顧問海洋大學陳正宗特聘講座教授申請一年休假，前往台灣大學土木系做訪問學者，雖然因此沒有在海大開課，但我們也在暑假期間多了與台大學生一起進行研究成果交流分享的機會，感受不同學校的讀書氛圍，提升自己的研究能力，鼓勵自己不落人後。除了舉辦比較大型的暑期討論會，在 TwSIAM 的經費以及實驗室累積下來的軟硬體的設備支持下，使我們能在此期間密集的學術討論，獲益良多，社群成員們的研究成果更不僅在振噪研討會及 TwSIAM 年會得到肯定，在這一學年度社員曹美娜跟著學長戴暉宸學習相關的研究議題做出的成果也投稿國際期刊 MRC 接受並刊登，社員浩真的一系列研究成果也一路在各式研討會分享也有獲得獎肯定，最終也被國際期刊 JOM 接受並刊登。TwSIAM 海大學生分會，今後也會往這樣的方向繼續發展，維持良好的傳統文化，期望能發掘更多年輕的學術同好，一起進步的同時，亦達到推廣數學之目的。

**關鍵字：**振噪會議、TwSIAM、學術交流、推廣數學

## References

- [1] J. T. Chen, Y. T. Lee, W. C. Tai and M. N. Tsao, *Analytical solutions for the Laplace problem of an eccentric domain*, Mech. Res. Comm.,127(2023), 104012.
- [2] J. T. Chen, H. C. Kao, J. W. Lee and Y. T. Lee, *Support motion of a finite bar with a viscously damped boundary*, J. Mechanics, 38(2022), pp.473-490.
- [3] J. T. Chen, C. Y. Yang, Y. T. Chou, C. N. Tsang, *Animation of cycloid and spiral curves in companion with instantaneous center of rotation and radius of curvature*, Journal of Chinese Institute of Engineers, Revised(2023).
- [4] 陳正宗、戴暉宸、高浩真、高聖凱, *Stokes 轉換與 Cesaro 和在 Fourier 級數逐項微分不合法時的應用* 數學傳播, Accepted (2023).

## 特別論壇：產業中的數學

### Special Forum: Mathematics in Industry

Venue: 國際會議廳

Time	Speaker	Title of the Talk	Chair
15:50-17:10	黃翁賢	機器學習之工業影像瑕疵檢測應用	高文忠
	秦唯植	Evaluating Credit Risk Models Using KS Statistic and Its Limitations	
	鍾碧真	醫藥產業中的數學—大數據的應用	
	胡鈞傑	Data Science in Transglobe Life Insurance	



# 機器學習之工業影像瑕疵檢測應用

黃翁賢

日月光集團

## Abstract

工業製造業每日生產各種大量產品，若人工目測檢驗每個產品將十分耗時費力。為提高生產效能，與降低人力成本，我們引進影像瑕疵自動檢測技術，並運用機器學習之物件檢測模型 (Object Detection) 自動化辨別瑕疵產品。為達到產線高品質的應用需求，採取監督式學習方式，蒐集各種製程的瑕疵類型並人工標註，訓練出高準確度之瑕疵分類模型。然而隨科技演進，為因應先進產品的高精度需求，生產產品如基板線距更窄、空間更小、堆疊層越來越薄，亦造成產品變異快速，瑕疵種類變化多端，甚至產生多種瑕疵重疊或新種類型瑕疵，而造成人類與電腦皆無法輕易判斷。此時監督式學習技術因無訓練新種的變異資料更易判斷錯誤，造成公司資源成本損耗，因此迫切需建立符合產線實際應用的技術。此文章內容將分享我們的實際經驗：(1) 如何運用Active Learning建立有效率地標註資料方式以減少訓練成本，(2) 引入Variational AutoEncoder想法，增加模型辨識的穩定性，並讓模型可判斷出從未訓練過的變異資料之能力。此實驗結果顯示我們所提出架構，不只可降低人力標註成本，減少模型訓練資源，並提升辨別異常產品能力。

# Quantitative Method in Alpha Intelligence

秦唯植

新愛世科技股份有限公司

E-mail: weizhi@syncace.co

## Abstract

This presentation discusses the application of quantitative methods in Alpha Intelligence, comparing applied work in the industry with academic work in mathematical economics. The talk also examines the Kolmogorov-Smirnov (KS) statistic as a measure of risk model performance and its limitations in real-world applications. The key take-aways highlight the usefulness of mathematical skills in the industry and emphasize the importance of practicality and a trial-and-error approach.



## 醫藥產業中的數學—大數據的應用

Brenda Chung 鍾碧真

羅氏大藥廠醫藥學術處

E-mail: [brenda.chung@roche.com](mailto:brenda.chung@roche.com)

### Abstract

近幾年醫療課技的進展飛速，推估 2025 年時，全球醫療相關資料將累積至龐大的數量 (10,500 exabytes)。醫療數據與一般的大數據有甚麼不同？究竟有甚麼特殊性和魔力，讓全球生技醫藥產業趨之若鶩？從一個外商藥廠資深主管的角度，台灣有甚麼獨特的優勢？

# Data Science in Transglobe Life Insurance

胡鈞傑

全球人壽大數據發展處

E-mail: [jjwho123@gmail.com](mailto:jjwho123@gmail.com)



T

W

S

I

A

M



## 五、贊助廠商



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



**國泰人壽**  
Cathay Life Insurance



**徐有庫紀念基金會**  
FAR EASTERN Y.Z. HSU FOUNDATION



**CAD MEN**  
Taiwan Auto-Design Co. (TADC)  
虎門科技股份有限公司



**皮托科技**  
PITOTECH CO., LTD.



**TEXAS  
INSTRUMENTS**



**廣天國際有限公司**  
Kuang Tien International Co., Ltd.

**TeraSoft** 鈦思科技  
www.terasoft.com.tw

## 六、活動場地資訊

