Forum "Math-for-Industry" 2018

- Big Data Analysis, AI, Fintech, Math in Finances and Economics -

November 17-21, 2018

Organized by

Fudan University, Shanghai, China

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Zhejiang University, China

Jin Cheng

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Southeast University, China

Organization Committee

Keynote Speech

Shige Peng

Academician of CAS, Shandong University, China

Plenary Talk

Samuel Drapeau

Shanghai Jiaotong University, China

Weiguo Gao

Fudan University, China

Keiichi Goshima

Institute for Monetary and Economic Studies, Bank of Japan, Japan

Lê Minh Hà

Vietnam Institute for Advanced Study in Mathematics, Vietnam

Naoyuki Ishimura

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Tadashige Iwao

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Sergey Kabanikhin

Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of the RAS, Russia

Takayuki Osogami

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Pan Qin

Dalian University of Technology, China

Jun Sekine

Osaka University, Japan

Taiji Suzuki

The University of Tokyo, Japan

Shigeo Takahashi

University of Aizu, Japan

Eric Ulm

Victoria University of Wellington, New Zealand

Jonathan Wylie

City University of Hong Kong, HKSAR, China

Dinghua Xu

Shanghai University of Finance and Economics & Zhejiang Sci-Tech University, China

Songping Zhu

University of Wollongong, Australia

Young Researchers Talk

Nathan Gold

York University, Fields Institute, Canada

Ling Guo

Shanghai Normal University, China

Guanghui Hu

Beijing Computaional Science Research Center, China

Maxim Shishlenin

Sobolev Institute of Mathematics of the Siberian Branch of the RAS, Russia

Yutaro Kabata

Institute of Mathematics for Industry, Kyushu University, Japan

Xiliang Lv

Wuhan University, China

Taku Moriyama

Institute of Mathematics for Industry, Kyushu University, Japan

Min Zhong

Southeast University, China

Hotel Information

Fuxuan Hotel

400 Guoding Rd., Yangpu District, Shanghai, China

Howard Johnson Caida Plaza Shanghai

188 Wudong Rd., Yangpu District, Shanghai, China

Conference Information

Conference Hall

Main: Room 2001 (20F, except for Nov. 20 morning)/Room 2201 (22F, only on Nov. 20 morning)

Poster Session & Coffee Break: Room 2201 (22F)

East Guanghualou, Fudan Univesrity, 220 Handan Rd., Yangpu District, Shanghai, China

Sponsors

111 Project and "The Belt and Road" Project (Ministry of Education, State Administration of Foreign Experts Affairs, China)

Tianyuan Fund for Mathematics (National Natural Science Foundation of China)

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WIFI Information

SSID: eduroam available

SSID: fudanwireless

1. open any webpage
2. input **UserID: fdmath2018** & **Password: math2001**

Meal Service

Lunch (12:45 - 14:00, Nov. 17 - 21)

1F, Danyuan Restaurant in Fudan Campus

Dinner (17:45 - 19:30, Nov. 16 & Nov. 18 - 20)

3F, Danyuan Restaurant in Fudan Campus

Banquet (17:45 - 19:30, Nov. 17)

2F, Fudan Yanyuan Hotel, 270 Zhengtong Rd., near Fudan Campus

Notice: Need Meal Tickets for Lunch!

Shuttle Bus Service

Pudong Intel. Airport - hotel (15:30 - 16:30, Nov. 16)

Exit of International Arrivals, T1, Pudong Intel. Airport

Howard Johnson Caida Plaza Shanghai - conference hall (9:00, Nov. 17 - Nov. 21)

Lobby of Howard Johnson Caida Plaza Shanghai

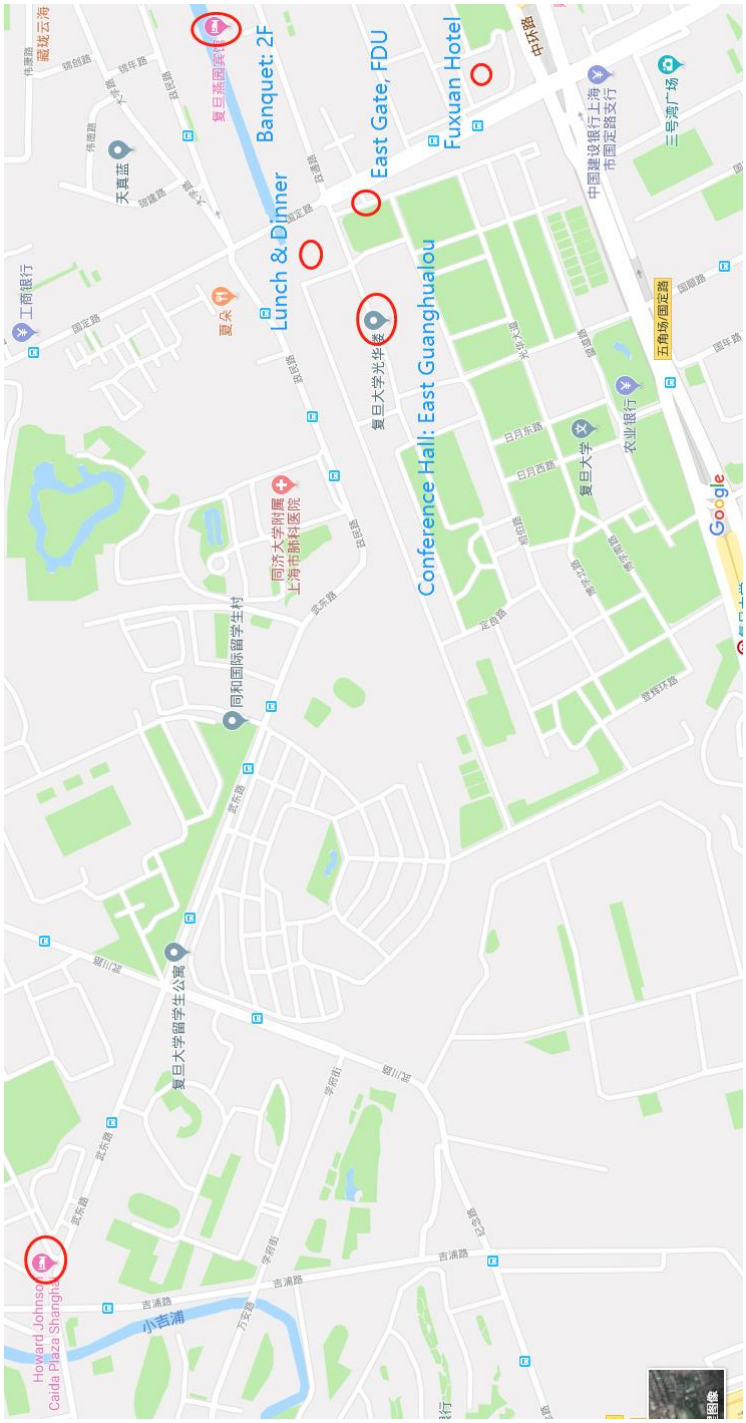
Conference hall - Pudong Intel. Airport (14:00, Nov. 21)

Conference hall

Other Notices

Please wear your name tag during the workshop and related activities.

Please turn off or sound off your cell phone during the forum.



Program at a glance

	Nov. 16 (FRI)	Nov. 17 (SAT)	Nov. 18 (SUN)	Nov. 19 (MON)	Nov. 20 (TUE)	Nov. 21 (WED)
09:30 – 09:45		Opening Ceremony	Naoyuki Ishimura	Songping Zhu	Shigeo Takahashi	Taiji Suzuki
09:45 – 10:45		Shige Peng	Jun Sekine	Keiichi Goshima	Dinghua Xu	Tadashige Iwao
10:45 – 11:00		Group Photo				
11:00 – 11:30		Coffee Break				
11:30 – 12:15		Sergey Kabanikhin	Samuel Drapeau	Eric Ulm	Pan Qin	Takayuki Osogami
12:15 – 12:45		Ling Guo	Nathan Gold	Taku Moriyama	Yutaro Kabata	Closing Ceremony
12:45 – 14:00		Lunch				
14:30 – 15:15	Registration	APCMfi Executive Meeting	Jonathan Wylie	Lê Minh Hà	Poster Session	
15:15 – 15:45			Weiguo Gao	Maxim Shishlenin		
15:45 – 16:00		Free Discussion		Coffee Break		
16:00 – 16:15		APCMfi Meeting	Free Discussion			
16:15 – 16:45				Guanghui Hu		
16:45 – 17:15			IMI Meeting	Min Zhong		
17:15 – 17:45		Free Discussion		Xiliang Lv		
17:45 – 19:30	Dinner	Banquet	Dinner			

Registration

November 16 (Friday)

14:30 – 17:45 **Lobby** of Fuxuan Hotel/Howard Johnson Caida Plaza Shanghai

November 17 (Saturday)

09:00 – 09:30 **Room 2001**, East Guanghualou, Fudan University

Program

November 17, 2018
Saturday

09:30 – 09:45 **Opening Ceremony (Room 2001)**

Chair Prof. Jin Cheng

Opening address Prof. Tatsien Li
Academician of CAS, Fudan University, China

Prof. Meng Chen
Dean of School of Mathematical Sciences, FDU, China

09:45 – 10:45 **Keynote Speech (Room 2001)**

Chair Prof. Tatsien Li

09:45 Shige Peng

Title: Spatial and Temporal Probabilistic Uncertainties and Nonlinear G-Write Noises

10:45 – 11:00 **Group Photo (Guanghua Square)**

11:00 – 11:30 **Coffee Break (Room 2201)**

November 17, 2018
Saturday

11:30 – 12:45 Invited Talk (Room 2001)

Chair Prof. Shige Peng

11:30 Sergey Kabanikhin

Title: Big Data and Multidimensional Analogs of Gelfand-Levitan-Krein Equations

12:15 Ling Guo

Title: Quantifying Total Uncertainty in Physics-Informed Neural Networks for Solving Forward and Inverse Stochastic Problems

12:45 – 14:00 Lunch (1F, Danyuan Restaurant)

14:30 – 15:45 APCMfi Executive Meeting (Room 2001)

16:00 – 17:15 APCMfi Meeting (Room 2001)

17:45 – 19:30 Banquet (2F, Fudan Yanyuan Hotel)

November 18, 2018
Sunday

09:30 – 11:00 Invited Talk (Room 2001)

Chair Prof. Masato Wakayama

09:30 Naoyuki Ishimura

Title: Time Evolution of Copulas and Its Applications

10:15 Jun Sekine

Title: The XVA Issues and Related BSDEs

11:00 – 11:30 Coffee Break (Room 2201)

11:30 – 12:45 Invited Talk (Room 2001)

Chair Prof. Sergey Kabanikhin

11:30 Samuel Drapeau

Title: Option Prices of Pegged Exchange Rates: the HKD-USD Puzzle

12:15 Nathan Gold

Title: Machine Learning for the Analysis of Liquidity Commonality and Volatility Changes in Financial Markets

12:45 – 14:00 Lunch (1F, Danyuan Restaurant)

November 18, 2018
Sunday

14:30 – 16:00 Invited Talk (Room 2001)

Chair Prof. Shigeo Takahashi

14:30 Jonathan Wylie

Title: Detecting Changes in Data with Long-Range Dependence

15:15 Weiguo Gao

Title: Dimensionality Increment Techniques in Numerical Algorithms

16:00 – 16:45 Free Discussion

16:45 – 17:45 IMI International Advisory Board Meeting (Room 2001)

17:45 – 19:30 Dinner (3F, Danyuan Restaurant)

November 19, 2018
Monday

09:30 – 11:00 Invited Talk (Room 2001)

Chair Prof. Tomoyuki Shirai

09:30 Songping Zhu

Title: Various Barrier Options - a Typical Example of Mathematics Applied in Finance

10:15 Keiichi Goshima

Title: Nowcasting Business Trends With Text-Based Indexes

11:00 – 11:30 Coffee Break (Room 2201)

11:30 – 12:45 Invited Talk (Room 2001)

Chair Prof. Songping Zhu

11:30 Eric Ulm

Title: Analytic Solution for Ratchet Guaranteed Minimum Death Benefit Options Under a Variety of Mortality Laws

12:15 Taku Moriyama

Title: Nonparametric Statistical Inference and Density Estimation

12:45 – 14:00 Lunch (1F, Danyuan Restaurant)

November 19, 2018
Monday

14:30 – 15:45 Invited Talk (Room 2001)

Chair Prof. Victor Isakov

14:30 Lê Minh Hà

Title: National Program for Development in Mathematics in Vietnam 2010-2020: An Overview

15:15 Maxim Shishlenin

Title: Coefficient Inverse Problems for Parabolic Equations: Application to Medicine and Finance

15:45 – 16:15 Coffee Break (Room 2201)

16:15 – 17:45 Invited Talk (Room 2001)

Chair Prof. Jijun Liu

16:15 Guanghui Hu

Title: Uniquenss and Stability for the Recovery of Time-Depenent Source Terms

16:45 Min Zhong

Title: A Multiscale Radial Basis Function Method for Severely Ill-Posed Problems on Spheres

17:15 Xiliang Lv

Title: Randomized Kaczmarz Method for Linear Inverse Problems

17:45 – 19:30 Dinner (3F, Danyuan Restaurant)

November 20, 2018
Tuesday

09:30 – 11:00 Invited Talk (Room 2201)

Chair Prof. Lê Minh Hà

09:30 Shigeo Takahashi

Title: Biclustering Multivariate Data for Finding Correlated Data Samples and Dimensions

10:15 Dinghua Xu

Title: Data Modeling in Functional Clothing Design: Forward and Inverse Problems Approaches

11:00 – 11:30 Coffee Break (Room 2201)

11:30 – 12:45 Invited Talk (Room 2201)

Chair Prof. Naoyuki Ishimura

11:30 Pan Qin

Title: Discovery of Cancer Driver Gene Sets and Prediction of Anticancer Drug Response with High Throughput Sequencing Data

12:15 Yutaro Kabata

Title: Singularity Theory of Mappings and Its Applications

12:45 – 14:00 Lunch (1F, Danyuan Restaurant)

November 20, 2018
Tuesday

14:30 – 17:45 Poster Session (Room 2201)

Chair Prof. Robert McKibbin

1 Kazuhiro Araki (Kyushu University, Japan)
Title: Regrowth of Blood Capillaries in the Mathematical Model of Angiogenesis

2 Yu Chen (Fudan University, China)
Title: Numerical Method for Unique Continuation of Elliptic Equations

3 Yibin Ding (Zhejiang University, China)
Title: Inverse Coefficient Problem for Telegrapher's Equations on a Tree-Shaped Network

4 Kengo Fujita (Kyushu University, Japan)
Title: Mathematical Modeling of the Information Processing Mechanism of the Brain Using Phase Oscillators and Entropy

5 Megumi Furuta (Kyushu University, Japan)
Title: Triple Biquadratic Power Residue Symbols in the Gaussian Number Field

6 Minjung Gim (NIMS, Korea)
Title: Mathematical Improvement of Defect Detection Algorithm of CNC Process

7 Joon Heo (NIMS, Korea)
Title: Comparable Selection Algorithm in Real Estate Market

8 Le Quoc Huy (Kyushu University, Japan)
Title: Solving LWR via BDD Strategy: Modulus Switching Approach

9 Dosang Joe (NIMS, Korea)
Title: Problem Solving Process and Cases of Industrial Mathematics by NIMS

10 Naoki Kitazawa (Kyushu University, Japan)
Title: On Smooth Maps with Good Geometric Properties whose Codimensions are Negative

November 20, 2018
Tuesday

14:30 – 17:45 Poster Session (Room 2201)

11 Hiroaki Kurihara (Kyushu University, Japan)
Title: On Extension of Handlebody-Knots

12 Nguyen Thi Hoai Linh (Kyushu University, Japan)
Title: Stochastic Differential Equation Models on Fish Schooling

13 Xiaoman Liu (Southease University, China)
Title: Image Restoration From Noisy Incomplete Frequency Data by Alternative Iteration Scheme

14 Boliang Lu (Shanghai University of Fina. & Econ., China)
Title: Stability of a Class of Hybrid Neutral Stochastic Differential Equations with Unbounded Delay

15 Koya Mihara (Kyushu University, Japan)
Title: A Cp Criterion Using a Stabilized Weight for Semiparametric Casual Inference

16 Pradeep Kumar Mishra (Kyushu University, Japan)
Title: Fast Secure Matrix Multiplications Over Ring-Based Homomorphic Encryption

17 Yuta Mori (Kyushu University, Japan)
Title: Mathematical Model of Pill Bug's Turn Alternation on Slope

18 Pingping Niu (Fudan University, China)
Title: On Periodic Parameter Identification in Stochastic Differential Equations

19 Yunyoung Park (NIMS, Korea)
Title: Locomotion of a Single-Flagellated Bacterium in a Viscous Fluid

20 Hyeongki Park (Kyushu University, Japan)
Title: A Hinged Linkage Mechanism That Follows Discrete Integrable Equations

November 20, 2018
Tuesday

14:30 – 17:45 Poster Session (Room 2201)

21 Le Thi Thai (Kyushu University, Japan)
Title: The Stability of Interface at Tangential Discontinuity Velocity in a Shallow Water

22 Yusuke Ueda (Kyushu University, Japan)
Title: Sparse Precision Matrix Estimation by Alternating Direction Method of Multipliers Based on Kullback-Leibler Divergence

23 Xiaolu Xu (Dalian University of Technology, China)
Title: R Package for Cancer Driver Genes Detection

24 Ye Yuan (Kyushu University, Japan)
Title: Experimental Studies in IoT Implementation of Post-Quantum Cryptography

25 Yaohua Zang (Zhejiang University, China)
Title: A SDE Framework for Propagation Networks

26 Mengmeng Zhang (Southease University, China)
Title: Identification of a Time-Dependent Source Term in Distributed Order Time-Fractional Equation From Nonlocal Observation

27 Xiaohui Zhou (Shanghai University of Fina. & Econ., China)
Title: Local Wavelet Transform On The Smooth Surface Of Rotation Class

28 Sebastian Elias Graiff Zurita (Kyushu University, Japan)
Title: Discrete Euler's Elastica - Characterization and Application

17:45 – 19:30 Dinner (3F, Danyuan Restaurant)

November 21, 2018
Wednesday

09:30 – 11:00 Invited Talk (Room 2001)

Chair Prof. Jun Sekine

09:30 Taiji Suzuki

Title: Adaptivity of Deep ReLU Network for Learning in Besov Spaces

10:15 Tadashige Iwao

Title: Issues of Agriculture as an Industry and Fujitsu Challenges to Utilize Artificial Intelligence

11:00 – 11:30 Coffee Break (Room 2201)

11:30 – 12:15 Invited Talk (Room 2001)

Chair Prof. Osamu Saeki

11:30 Takayuki Osogami

Title: Knowledge Discovery and Data Mining, Machine learning

12:15 – 12:30 Closing Ceremony (Room 2001)

Chair Prof. Jin Cheng

Closing address Prof. Osamu Saeki
Director of IMI, Kyushu University, Japan

12:45 – 14:00 Lunch (1F, Danyuan Restaurant)

Abstract of Keynote Speech

Spatial and Temporal Probabilistic Uncertainties and Nonlinear G-Write Noises

Shige Peng

Shandong University, China

In the our time of internet, how to understand and measure spatial financial risk becomes a quite challenging problem. But the research results in this field is much less than those for temporal financial risks. One of important raison is that we are more familiar with time-indexed stochastic processes. We have many models based on Brownian motion, Poisson process, SDE and BSDE and time consistent nonlinear expectations, such as robust pricing and risk measuring.

In this talk, we present a new tool understand and calculate the corresponding spatial risk measures. we have introduced a new type of G-Gaussian random fields, which contain a type of spatial white noise as a special case. Based on this result, we also have introduced a spatial-temporal G-white noise. Different from the case of linear expectation, in which the probability measure need to be known, under the uncertainty of the probability measure, the spatial white noises are intrinsically different from the temporal one.

Abstract of Invited Talk

Option Prices of Pegged Exchange Rates: the HKD-USD Puzzle

Samuel Drapeau

Shanghai Jiaotong University, China

Foreign exchange markets are by far the largest markets in the world in terms of volume. Option pricing there relies on the principle that the underlying – the exchange rate – is a free floating one for which the classical Black and Scholes and derivates thereof are used. It is an interesting fact that many foreign exchange markets are eventually pegged – Bulgaria, China, Hong-Kong, Switzerland, Thailand – at least for a long periods of time. Surprisingly, even though the underlying is fixed, there is an active option market taking place on those currencies. We document this puzzling fact and propose a simple model to explain it. Taking as classical example the Hong-Kong/US dollars pegged exchange, we calibrate this model over 10 years of option data and provide some insights on what could be the motivation of agents on this markets to trade such options.

This is a joint work with Tan Wang and Tao Wang from Shanghai Advanced Institute of Finance.

Dimensionality Increment Techniques in Numerical Algorithms

Weiguo Gao

Fudan University, China

Problems of different sizes may have "almost" equivalent solutions. Most numerical algorithms are doing dimensionality reduction. Through the examples of linear system expansion, eigenpair optimization, variable selection and deep neural network, we show that dimensionality increment techniques can be useful to formulate mathematically "easier" problems. For example, the large size problem has better condition numbers or less local minima, which makes it not sensitive to the algorithms and initial guesses. We still need to develop efficient algorithms to reduce the computational costs in each iteration and to avoid the slow convergence.

Machine Learning for the Analysis of Liquidity Commonality and Volatility Changes in Financial Markets

Nathan Gold

York University, Fields Institute, Canada

Liquidity commonality and volatility changes are common features of financial markets throughout the world. While it has long been known that liquidity and volatility are correlated components of the market, the question of the causal relationship between liquidity changes and volatility changes remains open to debate. Using a comprehensive data set of averaged closing prices from 2011 to 2014 from the TSX60, an index of 60 large companies traded on the Toronto Stock Exchange, we find strong evidence of liquidity commonality at both market-wide and industry specific levels, persistent after controlling for individual liquidity determinants. Further, we find evidence to indicate that liquidity measures depth, effective spread, and liquidity changes are predictive of volatility changes.

Taking a wider view, we then study common structure breaks in asset returns between foreign exchange and equity markets. We present a modification of a Bayesian online change-point detection procedure to determine economic regime changes between returns of the U.S. Dollar Index and the S&P 500 from 2005-2015. Making use of a nonlinear Gaussian process time series model, we forecast future observations and detect regime changes. Our modified training methodology allows for superior change-point detection and reduced false alarms in volatile time series. We identify common change-points in the U.S. Dollar Index associated with global economic events and find common change-points in the S&P 500. For cross-validation, we also test with returns of gold prices over the same period to compare with the U.S. Dollar Index.

Finally, we will discuss ongoing joint work with a collaboration between the Fields Institute's Centre for Quantitative Modelling (CQAM) and the TMX regarding broker and trading sentiment, as well as limit order book analysis.

Nowcasting Business Trends With Text-Based Indexes

Keiichi Goshima

Bank of Japan, Japan

Recently, many studies have attempted to utilize text data for financial and economic studies.I introduce a more recent survey of methods and utilized data

with focusing on text analysis in finance and economics. Then, I present my work on nowcasting busines trends and forecasting inflation using text data.

I build news-based business cycle indexes from the daily newspaper articles with computational linguistic techniques, and examine its information content in nowcasting business trends and predicting the future inflation in Japan.

Quantifying Total Uncertainty in Physics-Informed Neural Networks for Solving Forward and Inverse Stochastic Problems

Ling Guo

Shanghai Normal University, China

Physics-informed neural networks (PINNs) have recently emerged as an alternative way of solving partial differential equations (PDEs) without the need of building elaborate grids, instead, using a straightforward implementation.

In particular, in addition to the deep neural network (DNN) for the solution, a second DNN is considered that represents the residual of the PDE. The residual is then combined with the mismatch in the given data of the solution in order to formulate the loss function. This framework is effective but is lacking uncertainty quantification of the solution due to the inherent randomness in the data or due to the approximation limitations of the DNN architecture. Here, we propose a new method with the objective of endowing the DNN with uncertainty quantification for both sources of uncertainty, i.e., the parametric uncertainty and the approximation uncertainty.

We first account for the parametric uncertainty when the parameter in the differential equation is represented as a stochastic process. Multiple DNNs are designed to learn the modal functions of the arbitrary polynomial chaos (aPC) expansion of its solution by using stochastic data from sparse sensors. We can then make predictions from new sensor measurements very efficiently with the trained DNNs. Moreover, we employ dropout to correct the over-fitting and also to quantify the uncertainty of DNNs in approximating the modal functions. We then design an active learning strategy based on the dropout uncertainty to place new sensors in the domain in order to improve the predictions of DNNs. Several numerical tests are conducted for both the forward and the inverse problems to quantify the effectiveness of PINNs combined with uncertainty quantification. This NN-aPC new paradigm of physics-informed deep learning with uncertainty quantification can be readily applied to other types of stochastic PDEs in multi-dimensions.

The National Program for Development in Mathematics in Vietnam 2010-2020: An Overview

Lê Minh Hà

Vietnam Institute for Advanced Study in Mathematics (VIASM), Vietnama

I will describe briefly the history of modern mathematics in Vietnam and the ongoing National program for development in Mathematics, concentrating on efforts in promoting applied mathematics.

Uniquenss and Stability for the Recovery of Time-Depenent Source Terms

Guanghui Hu

Beijing Computational Science Research Center, China

This talk is concerned with inverse time-dependent source problems for the Lame and Maxwell systems. In three dimensions, we first show uniqueness and stability for recovering source terms which depend on the time and two spatial variables using partial Dirichlet boundary data. In the second part, we present uniquness to inverse moving source problems for determing the orbit or profile of a moving source modelled by the time-dependent Maxwell's system. This is a joint work with Yavar Kian and Yue Zhao.

Time Evolution of Copulas and Its Applications

Naoyuki Ishimura

Chuo University, Japan

The relation between each risk factors is an important subject for researches. A typical assumption of the independence does not lead to a true estimate of potential risk. Copulas, in this respect, are known to provide a flexible tool for analyzing nonlinear relations among random variables. However, the usual definition of

copulas does not involve the time variable, although real world events proceed with the time.

In this presentation, we review on our recent studies on the time evolution of copulas and its applications. Compared to the dynamic copulas, in our evolution of copulas, copula itself varies with the time according to a diffusion equation. Here we apply our evolution of copulas to the analysis of dependence relation model between exchange rates and focus ourselves on rapidly changing events such that their directions of change are almost stable. The results are that the discrete evolution of copulas approximate fairy well the smoothed transition of empirical copulas from the viewpoint of Kendall's tau.

Issues of Agriculture as an Industry and Fujitsu Challenges to Utilize Artificial Intelligence

Tadashige Iwao

Fujitsu Limited, Japan

Agriculture is an important industry to support society. It is necessary to increase the yield of crops in accordance with the population increases, while number of farmers is decreasing in developed countries such as Japan. Therefore, it is urgent to develop efficient production methods.

Agriculture as an Industry is required to gain higher yield in addition to secure higher quality and lower cost. In order to realize this, it is necessary to adjust the crops to the best condition that can easily been fruited. Production volume is much influenced by the behavior of the inside of each plant, and the internal behavior is greatly affected by their surrounding environment. Generally, in the Agriculture as an Industry, it is desirable to have a way to monitor the condition of many individual crops, predict and control the amount of production to cultivate as a large number of crops as possible.

On the other hand, agronomists are interested in deeper plant physiological studies like genes and photosynthetic mechanism models that still have many unknown issues. It is very difficult to solve the problems and we need strong wisdom of many researchers. That's why researches on production methods have not yet been carried out.

In order to achieve the goal, we started a joint research with Kyushu University to apply Artificial Intelligence to agriculture. We aim to integrate AI to agriculture to achieve "Four Stabilities" such as stable yield, right time to crop, stable price and stable quality. In my presentation, I will explain the approach of Agriculture as an Industry.

Big Data and Multidimensional Analogs of Gelfand-Levitan-Krein Equations

Sergey Kabanikhin

Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of the RAS, Russia

The coefficient inverse problems for hyperbolic equations are considered and investigated. The inverse problem consists of finding unknown coefficients by using additional information, which is given by the measurement of the wave field on the surface of the investigated medium. We use the approach of I. M. Gelfand, B. M. Levitan and M. G. Krein to reduce the nonlinear inverse problems to a sequence of linear integral equations. The main advantage of such approach is that method doesn't involve multiple solution of the direct problem. We present numerical methods based on the fast inversion of the Toeplitz matrix and tensor decomposition approach. We analyse the number of operations and conmpare it with standart methods. The results of the numerical experiments are presented.

Singularity Theory of Mappings and Its Applications

Yutaro Kabata

Kyushu University, Japan

We are interested in applications of singularity theory of mapping. Here a singularity means a singularity of a smooth mapping between real spaces, where the Jacobian of the mapping vanishes. Singularities of mappings appear in many settings (even other than pure mathematics). For instance, let us look at a smooth object (surface), and then we get the apparent contour of it. The apparent contour can be considered as the set of singularities of a projection mapping of the surface, and we can investigate it by singularity theory. It is interesting to ask what kinds of singularities appear or what kinds of conditions give such singularities in some concrete settings. In this talk, we first show some notions and results of classification theory of singularities via the study on the apparent contours. We also introduce the applications of singularity theory of mappings to other areas such as vision science and multiobjective optimization.

Randomized Kaczmarz Method for Linear Inverse Problems

Xiliang Lv

Wuhan University, China

In this talk we will discuss a randomized Kaczmarz method for linear inverse problems. We will explain why randomized Kaczmarz is suitable for linear inverse problem by providing pre-asymptotic analysis and studying the structure of some specific problems. Numerical examples validated our analysis.

Nonparametric Statistical Inference and Density Estimation

Taku Moriyama

Kyushu University, Japan

Observed data always include noise, and statistics offers ways to analyze such noisy data. The noise is often regarded to be "Gaussian", however, such restrictive assumption should be delicately made because it has a great effect on the accuracy of the inference. When the underlying distribution is multi-modal (or asymmetric, skewed, heavy-tailed), fitting a normal distribution to the data is obviously improper. Then, the mean (that means, regression) is not informative for prediction, and we (human beings) need to employ a good strategy. For this purpose it is important that we recognize the feature of the data, and data visualization is effective in some cases. Kernel density estimation is a non-parametric way, which can approximate (almost) any probability density functions. Nonparametric inference do not put model assumptions, and they are highly accurate for large enough data under suitable settings. In this talk, we compare parametric and nonparametric statistical ways, and we introduce some cases that the nonparametric density estimation is worthwhile.

Diversity in Reinforcement Learning and Machine Learning

Takayuki Osogami

IBM Research - Tokyo, Japan

When we make recommendations to a customer, we should recommend products of diverse kinds to increase the probability that at least one of the recommended products is interesting for the customer. In team sports, players should take moves of diverse kinds instead of all players taking the same move to achieve good results as a team. In this talk, we discuss techniques of reinforcement learning and machine learning to take into account such diversity. In reinforcement learning, for example, we seek to estimate a value function, which represents the cumulative reward that can be obtained from each state. We show that multiple agents can learn cooperative and diverse actions by the use of determinant to approximate the value function using determinant.

Discovery of Cancer Driver Gene Sets and Prediction of Anticancer Drug Response with High Throughput Sequencing Data

Pan Qin

Dalian University of Technology, China

Cancer is known to be caused by the accumulation of genetic mutations. The next generation sequencing technology ensures the efficient detection of mutations from whole genome sequence and whole exon sequence. Among these mutations, driver mutations are the somatic mutations responsible for cancer distinguished from randomly occurred passenger mutations. High coverage and mutual exclusivity, being two combinatorial properties of mutations in a collection of driver genes in cancers, have been used to develop mathematical programming models to distinguish driver gene sets. We present a method of identifying driver gene sets by adaptively assigning appropriate weights to the mutual exclusivity for various genes to tune the balance between the coverage and the mutual exclusivity. It embeds the genetic algorithm into the subsampling strategy to obtain the optimization results robust against the uncertainties and noise in the data. The anticancer drug response means that patients are sensitive to the drug or not. However, the drug responses for patient individuals are various. This difference is caused by genetic features, like mutations and RNA expression. The prediction of drug response is crucial for preclinical trial design and precision medicine. We

propose an autoencoder based feature selection method for predicting the drug response. Numerical results are obtained by using biological data to show the feasibility of the proposed methods.

The XVA Issues and Related BSDEs

Jun Sekine

Osaka University, Japan

How to calculate and manage the X-Vaule Adjustment have been important issues for financial institutions after the financial crisis of 2008. Various XVA require careful and "correct" aggregation without double counting, and hence, XVA has now led to the creation of specialized desks in many financial institutions. In this talk, we introduce a general model for XVA valuation, which is inspired by Bichuch et al. (2018), and review theoretical/practical valuation methodologies. Further, we discuss about the no-arbitrage property of x-value adjusted prices. The talk is based on a joint research with Akihiro Tanaka (Sumitomo Mitsui Banking Corporation and Osaka Univ.).

Coefficient Inverse Problems for Parabolic Equations: Application to Medicine and Finance

Maxim Shishlenin

Sobolev Institute of Mathematics of the Siberian Branch of the RAS

We consider two coefficient inverse problems for parabolic equations. The first inverse problem consists on the recovering the leading time-dependent coefficient by known nonlocal additional information. Similar problems arise when drugs diffuse through the patient's skin. For the approximate solution of the nonlinear inverse problems we propose the gradient method of minimization of the cost functional.

The second problem is connected to the financial mathematics. The data is given inside the domain on some curve and it is required to recover coefficients of the parabolic equation. The results of numerical calculations are presented.

Adaptivity of Deep ReLU Network for Learning in Besov Spaces

Taiji Suzuki

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Deep learning has shown high performances in various types of tasks from visual recognition to natural language processing, which indicates superior flexibility and adaptivity of deep learning. To understand this phenomenon theoretically, we develop a new approximation and estimation error analysis of deep learning with the ReLU activation for functions in a Besov space and its variant with mixed smoothness. The Besov space is a considerably general function space including the Holder space and Sobolev space, and especially can capture spatial inhomogeneity of smoothness. Through the analysis in the Besov space, it is shown that deep learning can achieve the minimax optimal rate and outperform any non-adaptive (linear) estimator such as kernel ridge regression, which shows that deep learning has higher adaptivity to the spatial inhomogeneity of the target function than other estimators such as linear ones. In addition to this, it is shown that deep learning can avoid the curse of dimensionality if the target function is in a mixed smooth Besov space. These results support high adaptivity of deep learning and its superior ability as a feature extractor.

Biclustering Multivariate Data for Finding Correlated Data Samples and Dimensions

Shigeo Takahashi

University of Aizu, Japan

Finding correlated data samples and dimensions is one of the promising approaches to understanding important patterns in multivariate data. Manual intervention is commonly required for such analysis while the associated results may excessively depend on the prior knowledge and skills of the analysts. In this talk, we present a novel approach to extracting correlated data as feature blocks by introducing biclustering techniques. Our key idea lies in a mathematical formulation of asymmetric biclustering, which is the combination of ordinary k-means clustering for correlated data samples and spherical k-means for correlated dimensions. After having decomposed the multivariate data matrix into a grid of correlated feature blocks, we also incorporate adaptive data partitioning by identifying possible combinations of such feature blocks that further increase overall

data correlation. We implemented an interactive system for visualizing such decompositions of the data matrix in such a way that it effectively support adaptive decomposition the data matrix through matrix diagrams. We also present several experimental results to demonstrate the feasibility of our proposed approach.

Analytic Solution for Ratchet Guaranteed Minimum Death Benefit Options Under a Variety of Mortality Laws

Eric Ulm

Victoria University of Wellington, New Zealand

We derive a number of analytic results for GMDB ratchet options. Closed form solutions are found for DeMoivre's Law, Constant Force of Mortality, Constant Force of Mortality with an endowment age and constant force of mortality with a cutoff age. We find an infinite series solution for a general mortality laws and we derive the conditions under which this series terminates. We sum this series for at-the-money options under the realistic Makeham's Law of Mortality.

Detecting Changes in Data with Long-Range Dependence

Jonathan Wylie

City University of Hong Kong, HKSAR, China

We consider a family of cumulative-sum change-point estimators for detecting a change in the mean of a correlated sequence. Since cumulative-sum estimators compare differences between empirical means, it seems natural that ergodicity is a minimal assumption for consistent change-point estimation. Surprisingly, we show that change-point estimation can be consistently performed for nonergodic sequences. We determine the rate of convergence for sequences under very general conditions. These conditions allow us to consider a very general class of sequences that includes independent, weakly dependent, strongly dependent, strong mixing and even non-ergodic sequences. In particular, we determine the rate of convergence for sequences in which the correlations decay to zero arbitrarily slowly or even do not decay to zero at all.

Data Modeling in Functional Clothing Design: Forward and Inverse Problems Approaches

Dinghua Xu

Shanghai University of Finance and Economics & Zhejiang Sci-Tech University, China

Textile material design is of paramount important in the study of functional clothing design. The experimental data shows that there are great challenges in Intelligent Manufacturing in Clothing Industry, such as Thermal Comfort Clothing (TCC) and Thermal Protective Clothing (TPC). The experimental Data varies from the data on clothing parameters, environmental situation, human body comfort Index and skin Injury. Therefore the data modelling of functional clothing design will based on physical model of heat and moisture transfer. The advantages of the data modelling may reduce the design cost and experimental risk.

We focus on revealing heat and moisture transfer characteristics in the system of human body-clothing-environment, which directly determine thermal comfort/safety level of human body. Based on the parabolic model of dynamic heat and moisture transfer, we present inverse problems of textile parameters determination (IPTPD), including thickness, thermal conductivity and porosity determination. Moreover, we mathematically formulate a new space-fractional parabolic model of heat transfer within thermal protective clothing under high environmental temperature- humidity, and the corresponding inverse problems of textile material design are put forward. Some numerical algorithms are presented by the regularization approaches. Theoretical study and numerical simulation results validate the formulation of the IPTPD and demonstrate effectiveness of the proposed numerical algorithms.

A Multiscale Radial Basis Function Method for Severely Ill-Posed Problems on Spheres

Min Zhong

Southeast University, China

We propose and analyze a multiscale support vector approach (SVA) algorithm for solving a kind of severely ill-posed problems on spheres. To this end, the algorithm uses Wendland's radial basis functions with different scales and the Vapnik ϵ-intensive loss function to compute a regularized approximation at each step. We discuss the choice strategy for parameter choices and prove the convergence of the

algorithm. Numerical simulations which support the theoretical results will be presented.

Various Barrier Options - a Typical Example of Mathematics Applied in Finance

Songping Zhu

University of Wollongong, Australia

As an important risk management tool, barrier options are often used in modern quantitative finance. In this talk, various barrier options, particularly Parisian/Parasian options, are used as an example to illustrate amazing applications of mathematics in finance and risk management. As a special type of exotic options that are widely used in corporate finance, Parisian/Parasian options have some interesting features that have mathematically posed some challenges in their pricing. In this talk, a series of recent research results in the area of pricing American-style Parisian options is presented with plenty of background information being provided.