FMfl2023 Program at a glance

	Aug. 29	Aug. 30	Aug. 31	Sep. 1
9:00 - 9:30	Registration			
9:30 - 10:00	Opening Kenji Kajiwara Philip Broadbridge Wil Schilders Motoko Kotani			
10:00 - 10:30	①Neil Budko	⑩Amit Singer	⑲Kana Shimizu	㉓Sven Leyffer
chair	W. Schilders	R. Oishi-Tomiyasu	K. Nuida	H. Waki
10:30 - 11:00	②Ichiro Hasuo	⑪Busayamas Pimpunchat	⑳Yusuke Aikawa	㉔Yuko Araki
chair	W. Schilders	S. Taylor	K. Nuida	M. Y. Hirose
11:00 - 11:30				
11:30 - 12:00	③José Alberto Cuminato	⑫Konrad Polthier	㉑Hiroe Tsubaki	㉕Philip Broadbridge
chair	O. Saeki	H. Ochiai	S. Kurata	H. Nguyen
12:00 - 12:30	④Mark McGuinness	⑬Tomohiro Tachi	㉒Masayo Y. Hirose	㉖Kaname Matsue
chair	O. Saeki	H. Ochiai	S. Kurata	H. Nguyen
12:30 - 14:00				
14:00 - 14:30	⑤Yasuaki Hiraoka	⑭Hiroaki Yamada	Poster session	㉗Stephen Taylor
chair	S. Kaji	N. Kamiyama		P. Broadbridge
14:30 - 15:00	⑥Jae-Hun Jung	⑮Satoru Tokuda		㉘Nor Haniza Sarmin
chair	S. Kaji	N. Kamiyama		P. Broadbridge
15:00 - 15:30	⑦Daisuke Sakurai	⑯Yoshikazu Terada		Closing
chair	S. Kaji	N. Kamiyama		Philip Broadbridge
15:30 - 16:00				
16:00 - 16:30	⑧Maria J Esteban	⑰Naoki Hamada		
chair	Y. Fukumoto	Y. Mizoguchi		
16:30 - 17:00	⑨Alfio Quarteroni	⑱Jun Sese		
chair	Y. Fukumoto	Y. Mizoguchi		
17:00 - 17:30				
18:30 -		Banquet		

: Online talk

Presentation Abstract

Usage Guide

Information on speakers is listed in order of presentation number.

(0) Time
(1) **Name**
(2) Affiliation
(3) **Lecture title**
(4) Abstract
(5) Keywords
represents.

①
(0) Aug.29, 10:00 - 10:30
(1) **Neil Budko**
(2) Delft University of Technology
(3) **ECMI: Cooperating, Promoting and Teaching Industrial Mathematics in Europe**
(4) The European Consortium for Mathematics in Industry (ECMI), established in 1987, is actively engaged in promoting the role of mathematics in industry, teaching new generations of applied mathematicians to work directly with industry, and helping the members of academia to acquire European and industrial funding. In this talk the structure and activities of ECMI will be described, including: nodes, study groups, special interest groups, modeling weeks, bi-annual conference, prizes, and publications. Current research directions and initiatives at various ECMI nodes will be presented.

②
(0) Aug.29, 10:30 - 11:00
(1) **Ichiro Hasuo**
(2) National Institute of Informatics
(3) **Proving Safety of Automated Driving Vehicles**
(4) I will introduce our recent work on using mathematical logic to rigorously prove the safety of automated driving vehicles. The main challenge in such formal verification attempts for real-world systems is the absence of target system models. We follow the methodology called RSS (responsibility-sensitive safety, Shalev-Shwartz et al., 2017) that tells what to model (and what not to model) in a both technically and socially sensible way. Our logical formalization and extension of RSS allows us to handle complex driving scenarios in a compositional manner. Overall, the work suggests the potential of mathematical logic as a social infrastructure for establishing trust in novel ICT.

③
(0) Aug.29, 11:30 - 12:00
(1) **José Alberto Cuminato and Débora de Oliveira Medeiros**
(2) Institute of Mathematics and Computer Sciences, University of São Paulo - USP
(3) **A Lagrangian-finite difference scheme for viscoelastic fluid flows**
(4) We present new numerical schemes based on writing the upper-convected time derivative of the polymeric tensor in terms of the Generalized Lie Derivative (GLD) on a Lagrangian framework and then discretizing it by finite differences. The viscoelastic models are rewritten considering the GLD with the method of characteristics. The polymeric tensor derivatives are approximated by methods of first or second order in time, combined with linear, or quadratic, spatial interpolations in order to improve the stability of the scheme, in preparationfor the study of the High Weissenberg Number Problem.
This is a joint work with Cassio Oishi and Hirofumi Notsu.

④
(0) Aug.29, 12:00 - 12:30
(1) **Mark McGuinness**
(2) Victoria University of Wellington
(3) **Real Time Moisture Measurement using Microwaves**
(4) An important factor when delivering bauxite ore to an alumina factory is the moisture content in the shipment. A microwave analyzer can be mounted across a conveyor belt to measure phase shift, attenuation, and ore depth to infer moisture content in real time using a linear calibration.

The moisture content is a important because it affects the weight of the ore, with direct impact on the true value of the ore. Accurate and reliable continuous moisture measurement is important to both buyer and seller.

Our study is informed by data provided to a European Study Group with Industry that was collected from a number of shipments to a factory in Ireland. We use Maxwell's differential equations to develop a four-layer model of microwave propagation that captures the effects of reflections at multiple interfaces between ore and air. These reflections cause interference effects in phase shifts and attenuation as the ore depth varies on the conveyor belt.

Our model explains the strongly nonlinear dependence of attenuation data on ore depth, and improves understanding of and confidence in the real-time measurement of ore moisture content using microwaves.

⑤
(0) Aug.29, 14:00 - 14:30
(1) **Yasuaki Hiraoka**
(2) Kyoto University
(3) **Persistent homology from viewpoints of representation, probability, and application**
(4) Topological data analysis (TDA) has emerged in this century and shed new light on data science. A particularly important tool in TDA is persistent homology, which can provide useful information about "shape of data" in a multi-scale way. Much of the development of theoretical research on persistent homology has been motivated by applications. This talk will survey the progress of persistent homology from the perspective of both mathematical and applied research.

⑥
(0) Aug.29, 14:30 - 15:00
(1) **Jae-Hun Jung**
(2) POSTECH
(3) **Topological data analysis of time-series data**
(4) Time-series data are found in a wide range of industrial applications. We consider topological data analysis (TDA) as an effective method for identifying inherent cyclic structures in the data. We illustrate some applications of TDA to music and periodic signals using the extracted cyclic patterns.

⑦
(0) Aug.29, 15:00 - 15:30
(1) **Daisuke Sakurai**
(2) Kyushu University, JPN
(3) **Maps and Their Topological Singularities in Visualization**
(4) Computation of topology and singularity has become a recognized tool for understanding scalar field data over a volumetric continuum. In the real world, however, volumetric data are rarely scalar, requiring analysis of vector-valued fields. It is thus interesting to consider how computational topology for scalar fields, which are functions, can be generalized for maps. In this talk, the speaker shares his experience on this topic, especially for visualization. Data are treated as PL-maps for the simplicity of topological analysis, and algorithms are studied in a variety of concepts relating to Reeb graphs and Morse theory. Indeed, one key is the generalization of Reeb graphs and the analysis of their structure for understanding data. In particular, the talk sheds lights on how Reeb spaces and singular fibers appear in the context of computation, and recent work on benchmarking multiobjective optimization solvers.

⑧
(0) Aug.29, 16:00 - 16:30
(1) **Maria J ESTEBAN**
(2) Université Paris-Dauphine, FRA
(3) **A new European initiative to facilitate the interaction of industry and academic mathematicians**
(4) In September 2022 was officially launched the OpenDesk of EU-MATHS-IN. In this talk I will present this one-stop-shop for tailor-made solutions for industry, commerce, public administration and startups and comment on its functioning since its launching.

⑨
(0) Aug.29, 16:30 - 17:00
(1) **Alfio Quarteroni**
(2) Politecnico di Milano, Milan, and EPFL, Lausanne, ITA
(3) **Physics-based and data-driven mathematical models for the simulation of the heart function**
(4) This presentation will focus on an integrated numerical model to simulate the cardiac function.
Physics-based models will represent the backbone of our approach, however their synergistic use with data driven models will be addressed as well.
Applications to several problems of clinical relevance will be discussed.

⑩
(0) Aug.30, 10:00 - 10:30
(1) **Amit Singer**
(2) Princeton University
(3) **Computational Mathematics for Cryo-Electron Microscopy**
(4) Single-particle cryo electron microscopy (cryo-EM) is an increasingly popular technique for elucidating the three-dimensional structure of proteins and other biologically significant complexes at near-atomic resolution. It is an imaging method that does not require crystallization and can capture molecules in their native states. In single-particle cryo-EM, the three-dimensional molecular structure needs to be determined from many noisy two-dimensional tomographic projections of individual molecules, whose orientations and positions are unknown. The high level of noise and the unknown pose parameters are two key elements that make reconstruction a challenging computational problem. Even more challenging is the inference of structural variability and flexible motions when the individual molecules being imaged are in different conformational states. The talk will overview the underlying mathematical theory, computational methods, and notable challenges for structure determination by single-particle cryo-EM.

⑪
(0) Aug.30, 10:30 - 11:00
(1) **Busayamas Pimpunchat**
(2) King Mongkut's Institute of Technology Ladkrabang, Thailand
(3) **The role of AI in society and communities for sustainable progress**
(4) The presented research emphasizes the potential of AI to contribute significantly to greater social good. This technology addresses the world's most pressing challenges. A more resilient and sustainable future can be built by using AI as a powerful tool. By focusing on flood protection, agricultural yields, and social security, we showcase the diverse applications of AI in these domains. In the realm of flood protection, AI algorithms are employed to identify high-risk areas, facilitating improved flood protection systems. This approach aids in minimizing casualties and injuries caused by flooding events. AI techniques also play a vital role in forecasting agricultural yields. By leveraging data-driven insights, farmers can make informed decisions regarding planting and harvesting, leading to enhanced food security. Furthermore, our discussion highlights the application of AI in estimating compensation and determining contribution rates for the Social Security Fund. Such analyses enable governments to establish appropriate rates, ensuring the long-term sustainability of social security systems.

⑫
(0) Aug.30, 11:30 - 12:00
(1) **Konrad Polthier**
(2) Free University of Berlin
(3) **Vibrations of Geometric Shapes**
(4) The vibrations of musical strings are well understood by Fourier analysis while the vibrations of geometric shapes exhibit surprising properties triggered by careful choices of differential geometric energies. We will review solved problems and introduce novel approaches with applications in biology, computer graphics and crystallography.

⑬
(0) Aug.30, 12:00 - 12:30
(1) **Tomohiro Tachi**
(2) The University of Tokyo
(3) **Computationally Designing Macroscopic Behaviors of Origami**
(4) Origami, the traditional art of folding sheets of paper, is attracting the attention of scientists and engineers as an approach to obtaining programmable metamaterials with shape-morphing abilities and mechanical properties. To control and design such exotic behaviors of origami, we are developing a novel framework to handle the macroscopic behaviors of origami through computation. The talk shows our recent works on self-organized wrinkling behaviors, conservative systems of origami tessellations, and STEAM collaboration.

⑭
(0) Aug.30, 14:00 - 14:30
(1) **Hiroaki Yamada**
(2) Converging Technologies Laboratory, Fujitsu Ltd.
(3) **Advancing Social Simulation by Fusing with Machine Learning**
(4) Social simulation is a simulation that reproduces various social phenomena. Social simulation has the advantage of visualizing future and past events that are difficult to observe directly and analyzing counterfactual events. In the fields of logistics, traffic management, and pedestrian management, there has been a lot of social simulation research to visualize the whole perspective of large-scale complex social systems and to analyze policies that are difficult to experiment with. In recent years, there has been growing interest in machine learning, such as deep learning, in the social simulation domain, due to the desire to deal with a large amount of accumulated social data and to link social simulation with the real world (digital twin). Specifically, it is expected that machine learning can be helped to build simulation models using large-scale social data and to analyze massive data generated from simulations. In this presentation, we introduce our research which tries to integrate social simulation and machine learning in order to meet recent expectations.

⑮
(0) Aug.30, 14:30 - 15:00
(1) **Satoru Tokuda**
(2) Research Institute for Information Technology, Kyushu University
(3) **Scaling relations between observed data and Occam's razor in Bayesian model selection**
(4) We show how observed data scale Occam's razor in Bayesian model selection, a guiding principle that models should be simple enough to describe the data. This work is motivated by mathematical modelling for understanding physical phenomena.

⑯
(0) Aug.30, 15:00 - 15:30
(1) **Yoshikazu Terada**
(2) Graduate School of Engineering Science, Osaka University / Center for Advanced Integrated Intelligence Research, RIKEN
(3) **A statistical theory of clustering**
(4) With recent advances in computer and measurement technologies, large and complex datasets have become common in various application fields. The importance of unsupervised learning has been recognized. Clustering, one of the most important tasks in unsupervised learning, aims to discover hidden groups for a given set of data points. However, the theoretical properties of clustering methods have received less attention. In this talk, we will discuss the minimal requirements that clustering methods should satisfy from a theoretical standpoint. We will explain the theoretical properties of several clustering methods and present our recent works related to this topic.

⑰
(0) Aug.30, 16:00 - 16:30
(1) **Naoki Hamada**
(2) KLab Inc.
(3) **Two-Parameter Extension of Regularization Path for Elastic Net**
(4) Elastic net is one of the most successful methods in sparse modeling because its two regularization terms achieve sparseness and robustness simultaneously. However, its regularization path varies only one regularization factor while the other is fixed. This talk gives a two-parameter extension of the regularization path and a method for its approximate computation. This is a joint work with Yusuke Mizota, Shunsuke Ichiki and Kenichi Hayashi.

⑱
(0) Aug.30, 16:30 - 17:00
(1) **Jun Sese**
(2) Humanome Lab., Inc.
(3) **Health forecast machine learning model with 25 million measurement data**
(4) We are conducting health measurement research that measures the daily lives of people with IoT devices, analyzes them and returns the results to subjects. Here, we introduce a machine learning method to predict health conditions based on over 25 million data points and questionnaire results.

⑲
(0) Aug.31, 10:00 - 10:30
(1) **Kana Shimizu**
(2) Waseda University
(3) **Secure string search using a succinct data structure**
(4) The secure multi-party computation (SMPC) enables computing a function among mutually untrusted parties. We introduce an efficient SMPC protocol for a database search using a succinct data structure and show the application to genome sequence search.

⑳
(0) Aug.31, 10:30 - 11:00
(1) **Yusuke Aikawa**
(2) The University of Tokyo
(3) **Expander Families for Post-Quantum Cryptography**
(4) The security of public key cryptography is supported by computational hardness of problems derived from mathematics. For example, the integer factoring problem is a basis for the security of RSA cryptography. However, in 1994, Shor proposed an efficient quantum algorithm solving these problems, for example factoring and discrete logarithm problem (DLP). This means that emergence of large-scale quantum computers will break public key cryptography in use today. So, we need cryptography that are resistant to cryptanalysis by quantum computers. Such cryptographic primitives are called post-quantum cryptography, PQC for short. In order to construct PQC, it is necessary to introduce mathematical computational assumptions that are different from factoring and DLP.

In this talk, the speaker will talk about constructing a candidate of PQC from random walks on expander graphs, including our recent results. In particular, isogeny graphs of abelian varieties and Cayley graph expanders will be discussed.

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(0) Aug.31, 11:30 - 12:00

(1) **Hiroe Tsubaki**

(2) The Institute of Statistical Mathematics, Research Organization of Information and Systems

(3) **Statistical Science for Society**

~ Process and Professionals for Progress ~

(4) Statistical science, which was born as a Grammar of Science, generated the process of customer value generation in industry mainly in the field of quality management. After a brief review of its history, I will discuss how these knowledge management processes should be utilized current social issues that cannot be solved without integrating knowledge from diverse fields, how to incorporate new technologies such as statistical machine learning into the processes, and how to foster professionals who possess necessary knowledge of mathematical scientific methods and competencies of utilizing them.

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(0) Aug.31, 12:00 - 12:30

(1) **Masayo Y. Hirose**

(2) Institute of Mathematics for Industry, Kyushu University

(3) **Poverty Mapping in Japan based on Area Level Model Approach using Japanese Official Microdata**

(4) It has been considered a social problem related to poverty in Japan, especially for a decade. To address such a big issue, making a reliable document to understand some poverty situations for small domains may be essential. In this study, we map the poverty rate of a small demographic domain for each prefecture, which was constructed using official Japanese microdata. We also modified one statistical estimating method under the area-level model to analyze the data obtained using a complex sampling design. This is joint work with Dr. Mayumi Oka at the Institute of Statistical Mathematics.

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(0) Sep.1, 10:00 - 10:30

(1) **Sven Leyffer**

(2) Argonne National Laboratory

(3) **Topological Design Problems and Integer Optimization**

(4) Topological design problems arise in many important engineering and scientific applications, such additive manufacturing and the design of cloaking devices. We formulate these problems as massive mixed-integer PDE-constrained optimization (MIPDECO) problems. We show that despite their seemingly hopeless complexity, MIPDECOs can be solved efficiently (at a cost comparable to a single continuous PDE-constrained optimization solve). We discuss two classes of such methods for solving MIPDECOs that do not require exhaustive tree-searches: rounding techniques, and trust-region methods. Surprisingly, both methods converge asymptotically under mesh refinement to a globally optimal integer solution under a convexity assumption. We illustrate these solution techniques with examples from topology optimization.

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(0) Sep.1, 10:30 - 11:00

(1) **Yuko Araki**

(2) Tohoku University

(3) **Statistical modeling of time-varying physical quantities for tactile evaluation of automotive materials**

(4) In the automotive manufacturing industry, there has been significant progress in automating the production process. When it comes to material selection, some companies evaluate multiple materials using a pressure needle, and based on the results, humans choose the materials that provide a comfortable tactile experience. In this study, we developed a statistical model to investigate how the time-varying physical quantities observed on the surface of each material impact the sensory evaluation through touch. Our proposed model predicts a group based on a set of functions, taking into account quantities that vary over time as a function of time. This approach enables a more precise and quantitative assessment of the tactile properties of materials. Additionally, by utilizing the Karhunen-Loeve expansion of the set of time functions, we uncover the waveform characteristics of the physical quantities over time.

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(0) Sep.1, 11:30 - 12:00
(1) **Philip Broadbridge**
(2) La Trobe University, Australia and IMI-Kyushu University, Japan
(3) **Reaction-diffusion models for fish populations with realistic mobility**
(4) Nonlinear reaction-diffusion equations, with Fisher logistic growth and constant diffusion coefficient, have been used in fisheries research to estimate sustainable harvesting rates and critical domain sizes of no-take areas. However, constant diffusivity in a population density corresponds to standard Brownian motion of individuals, with a normal distribution for displacement over a fixed time interval. For available good data sets on mobile fish populations, the distribution is certainly not normal. The data can be fitted with a long-tailed Lévy distribution that corresponds to diffusion by fractional Laplacian. Optimal foraging theory shows that an order-0.5 Lévy process is optimal for sparse populations.
We have developed exact solutions for realistic Fisher-Kolmogorov-Petrovski-Piscounov models with diffusion by fractional Laplacian. These have also been extended to hyperbolic diffusion models with a Cattaneo-type delay between gradient and flux, as an individual will persist with overcrowding for some time before emigrating. It is then shown how to modify critical domain sizes of protected areas.

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(0) Sep.1, 12:00 - 12:30
(1) **Kaname Matsue**
(2) Institute of Mathematics for Industry / International Institute for Carbon-Neutral Energy Research, Kyushu University, JPN
(3) **Nonlinear dynamics of hydrodynamically unstable premixed flames with physicochemical interactions**
(4) Dynamics of hydrodynamically unstable premixed flames are studied. The nonlinear hydrodynamic model and the Sivashinsky equation are considered to extract intrinsic nature of nonlinear flame morphology through numerics and the bifurcation theory. This talk is based on the joint works with Prof. Moshe Matalon (UIUC).

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(0) Sep.1, 14:00 - 14:30
(1) **Stephen Taylor**
(2) University of Auckland
(3) **Dairy Farm Modelling**
(4) Milk production is a major global industry and it is New Zealand's largest export earner.
We use mathematical modelling to analyze common issues faced by dairy farmers in NZ and abroad, including how long cows should be grazing in a particular field before being rotated to another, and the effects of urination and defecation on soil and waterways.

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(0) Sep.1, 14:00 - 14:30
(1) **Nor Haniza Sarmin**
(2) Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia
(3) **DNA Splicing : Emerging Technologies in Recombinant DNA Using Formal Language Theory**
(4) The diversity of mathematical applications in various scientific concepts has led to significant advancements in understanding complex biological processes. One area where this interdisciplinary collaboration thrives is DNA splicing, a basic biological process in manipulating genetic information and simulated by the technique of recombinant DNA molecules that relies on restriction enzymes. This presentation explores the idea of DNA splicing in various concepts. Firstly, the fundamental mathematical framework behind DNA splicing is presented. Also, the interplay between mathematical models and wet lab experiments is shared to validate the theoretical findings. The emergence of DNA splicing in computer science where some computational models such as graphical user interface (GUI) is also discussed. Finally, the graphical approach to studying DNA splicing is presented to emphasize the role of visual representation in comprehending complex biological processes.