

NUS-Tsukuba Joint-Online-Workshop on “Sustainable Management and Data Sciences”

Program & Book of Abstracts

March 14th & 15th, 2021

**Institute of Operations Research and Analytics,
National University of Singapore, Singapore**

**Faculty of Business Sciences,
University of Tsukuba, Tokyo, Japan**

Sponsored by:

**Faculty of Business Sciences, University of Tsukuba, Tokyo, Japan
Grant-in-Aid for Scientific Research (A) /
Challenging Research (Exploratory), JSPS
(Grant No. 20H00285 / 19K22024, PI: Yuji Yamada)**

Organizing committee:

Yuji Yamada	(University of Tsukuba)
Setsuya Kurahashi	(University of Tsukuba)
Naoki Makimoto	(University of Tsukuba)
Yasufumi Saruwatari	(University of Tsukuba)
Jun-ya Gotoh	(Chuo University)
Andrew Lim	(National University of Singapore)

Day1

Sunday, March 14th

Opening address

10:30-10:40 Yuji Yamada

[9:30-9:40 (SGT)] Dean, Faculty of Business Sciences, University of Tsukuba, Japan

■ 1st Session: Statical Modeling and Decision Making / Chair: Yasufumi Saruwatari

10:40-11:30 (JST) Jussi Keppo

[9:40-10:30 (SGT)] Department of Analytics and Operations, Institute of Operations Research and Analytics, NUS, Singapore
 “Learning Manipulation Through Information Dissemination”

11:35-12:10 (JST) Mika Sato-Ilic

[10:35-11:10 (SGT)] Faculty of Engineering, Information and Systems, University of Tsukuba, Japan
 “Complex Statistical Data Modeling”

12:10-12:45 (JST) Koken Ozaki

[11:10-11:45 (SGT)] Faculty of Business Sciences, University of Tsukuba, Japan
 “Bayesian Statistics and Machine Learning for Advanced Adaptive Testing”

12:45-13:45 (JST) [11:45-12:45 (SGT)] **** lunch ****

■ 2nd Session: Data and Optimization with Applications / Chair: Yuji Yamada

13:45-14:35 (JST) Chaitanya Bandi

[12:45-13:35 (SGT)] Department of Analytics and Operations, NUS, Singapore
 “Optimal Staffing and Online Scheduling in Data-rich but Uncertain Environments:
 A Case Study at PGIMER Hospital”

14:40-15:15 (JST) Jun-ya Gotoh

[13:40-14:15 (SGT)] Department of Industrial and Systems Engineering, Chuo University, Japan
 “Fitting Models to Data with Trimmed LASSO Penalties”

15:15-15:35 (JST) [14:15-14:35 (SGT)] **** break ****

■ 3rd Session: Post-Covid Recovery Operations / Chair: Andrew Lim

15:35-16:25 (JST) Chung Piaw Teo

[14:35-15:25 (SGT)] Department of Analytics and Operations, Institute of Operations Research and Analytics, NUS, Singapore
 “Airline Revenue Management: Forecasting and Ancillary Optimization in the Post Covid Era”

16:30-17:05 (JST) Yukio Ohsawa

[15:30-16:05 (SGT)] Systems innovation in engineering, University of Tokyo, Japan
 “Stay with Your Community on Your Way - A Guideline for Living Safely and Sustainably -”

17:05-17:40 (JST) Setsuya Kurahashi

[16:05-16:40 (SGT)] Faculty of Business Sciences, University of Tsukuba, Japan
 “Assessment of the Impact of COVID-19 Infections Considering Risk of Infected People
 Inflow to the Region”

17:40-18:10 (JST) [16:40-17:10 (SGT)] **** Discussion ****

Faculty of Business Sciences, University of Tsukuba, Tokyo, Japan

Day2

Monday, March 15th

■4th Session: Data-driven Optimization and Applications / Chair: Jun-ya Gotoh

10:30-11:20 (JST) Andrew Lim

[9:30-10:20 (SGT)] Department of Analytics and Operations, Department of Finance, Institute of Operations Research and Analytics, NUS, Singapore

“Dynamic Portfolio Choice with Time-varying Covariates and Parameter Uncertainty”

11:25-12:00 (JST) Yuichi Takano

[10:25-11:00 (SGT)] Faculty of Engineering, Information and Systems, University of Tsukuba, Japan

“Best Subset Selection for Linear Regression Models via Mixed-Integer Optimization”

12:00-13:00 (JST) [11:00-12:00 (SGT)] ***** lunch *****

■5th Session: Consumer Behavior and Islamic Finance / Chair: Naoki Makimoto

13:00-13:50 (JST) Leonard Lee

[12:00-12:50 (SGT)] Department of Marketing, NUS, Singapore

“Behavioral Insights in Consumer Research”

13:55-14:30 (JST) Ai Kawamura

[12:55-13:30 (SGT)] Faculty of Business Sciences, University of Tsukuba, Japan

“Comparing Law Making Process by Islamic Finance Dispute Resolution System in the UAE and Malaysia”

14:30-14:40 (JST) [13:30-13:40 (SGT)] ***** break *****

■Closing Session: Robust Optimization and Renewable Energy / Chair: Setsuya Kurahashi

14:40-15:30 (JST) Melvyn Sim

[13:40-14:30 (SGT)] Department of Analytics and Operations, NUS, Singapore

“The Dao of Robustness”

15:35-16:10 (JST) Yuji Yamada

[14:35-15:10 (SGT)] Faculty of Business Sciences, University of Tsukuba, Japan

“Hedging Strategy for Sustainable Solar Power Generation Businesses by Creating Derivatives Market”

Closing address / Chair: Setsuya Kurahashi

16:10-16:20 (JST) Hideo Kigoshi

[15:10-15:20 (SGT)] Vice President and Executive Director for Research, University of Tsukuba, Japan

Book of Abstracts

■ Jussi Keppo

“Learning Manipulation Through Information Dissemination”

[Abstract]

We study optimal manipulation of a Bayesian learner through adaptive provisioning of information. The problem is motivated by settings in which a firm can disseminate possibly biased information at a cost, to influence the public's belief about a hidden parameter related to the firm's payoffs. For example, firms advertise to sell products. We study a sequential optimization model in which the firm dynamically decides on the quantity and content of information sent to the public, aiming to maximize its expected total discounted profits over an infinite horizon. We solve the associated Bayesian dynamic programming equation, and explicitly characterize the optimal manipulation policy in closed-form. The explicit solution allows us to further characterize the evolution of the public's posterior belief under such manipulation over time. We also extend our analysis to consider the public as partially-Bayesian social learners who rely on public reviews to resist manipulation. We show that the public asymptotically learns the truth in this extended setting.

■ Mika Sato-Ilic

“Complex Statistical Data Modeling”

[Abstract]

As the world advances towards a new era of innovative information, complex information processing and interpretation, including AI technology, is necessary to interpret the unprecedentedly complex and massive data observed. This new complex data structure calls for the development of a methodology for innovative data analysis to extract the efficient latent structure of the data. In this talk, as an aspect of statistics and an outline of the development of statistical methods and future challenges for complex data are described within the framework of measuring, quantifying, and modeling data. In this framework, “space” and “scale” play an essential role in analyzing data. From these two perspectives of “space” and “scale”, this presentation will introduce methodologies of data analyses for adapting complex data structures.

■ Koken Ozaki

“Bayesian Statistics and Machine Learning for Advanced Adaptive Testing”

[Abstract]

The importance of human resources strategy is increasing year by year. According to a survey conducted by Ernst & Young ShinNihon LLC in 2015, management's top priority for sustainable management is "human resources strategy."

In Japan, ability measurement tests such as adaptive tests are very often carried out in the recruitment test scene. Adaptive test is a test in which an examinee solves an item(question) on a PC or tablet. And the next item is determined according to the response result (correct or incorrect) of each item. Simply put, if you answer an item correctly, you will be asked to solve a more difficult item, and if you make a mistake, you will be asked to solve an easier item. By conducting an adaptive test, the ability measurement of an examinee can be completed in a short time, so that the examinee can demonstrate his/her true ability, which in turn contributes to proper recruitment of companies. In this study, adaptive testing is advanced by two

methods.

The first is Bayesian statistics. Simulation studies will be shown that when multiple abilities are measured in sequence in an adaptive test, more efficient examinations can be taken by using the correlations between those abilities and by using Bayesian statistics.

The second is machine learning. Adaptive testing enables highly accurate ability measurement with a small number of items, but in some cases, it may output an estimated examinee ability that deviates from the true value. This is unfortunate for the examinee himself/herself, and if the results of this test are used for recruitment, it is also unfortunate for the company. In the second study, a method of detecting which examinee has an outlier ability value by machine learning will be shown.

■ Chaitanya Bandi

“Optimal Staffing and Online Scheduling in Data-rich but Uncertain Environments: A Case Study at PGIMER Hospital”

[Abstract]

In this talk, I will begin by giving an overview of three different problems motivated from our collaboration with PGIMER hospital in India. PGIMER is one of the largest public hospitals in India and was among the first hospitals to be part of the Digital India campaign. The resulting digitization enabled our data-driven study of operations in this hospital. We considered three different but related problems in this hospital: (1) Modeling and calibrating the complex dynamics of patient flows in this hospital; (2) Optimal design of operations and (3) Optimal staffing and scheduling.

In this talk, I will focus on the problem of optimal staffing and scheduling. In particular, I will present our solution approach for the following two problems faced by an Operating-Room (OR) manager: (1) how many ORs to plan to staff on a regular basis, and (2) how to schedule surgery requests that arrive one by one. The former decision is revisited periodically, e.g., quarterly or annually and it determines the cost of regular staff plus overtime. Past work on these problems have either assumed full advance knowledge of the case-length distributions of the entire daily roster of cases, or absolutely no knowledge of future arrivals. Our robust-optimization-based method improves upon both these approaches by leveraging historical data, which are typically only partially informative about future case uncertainty. In particular, we show that algorithms belonging to the class of interval classification algorithms achieve the best *robust competitive ratio*, and develop a tractable approach to calculate the optimal parameters of our proposed algorithm. We implement and test our algorithm on real and synthetic data.

Based on joint work with Diwakar Gupta, and Alexej Prosloupou.

■ Jun-ya Gotoh

“Fitting Models to Data with Trimmed LASSO Penalties”

[Abstract]

In data analysis, fundamental methodologies such as regression and clustering can be enhanced by selecting a subset of covariates, excluding outlying samples, and/or incorporating side information about the underlying structure of a data set. Motivated by the fact that the cardinality constraint on the coefficients of a linear model can be equivalently written by a trimmed lasso penalty function, which is defined as the sum of the largest k components of a vector, we consider a couple of modifications of the methods to fit models to a given data set. In particular, we consider a situation where a batch of data samples consist of outcomes from multiple sources and the analyst knows their (possibly, partial)

relationship. In such situations, we can estimate multiple models by fitting them to the dataset while detecting clusters of the samples. To accomplish such tasks, Hallac, Leskovec, and Boyd (2015) proposed Network Lasso (NL for short). NL often succeeds in forming clusters thanks to the non-smoothness of the l_1 -regularizer employed therein, but there might be limitations because of the convexity of the regularizer. This talk focuses on the cluster structure of NL and develops a non-convex extension, which we call Network Trimmed Lasso (NTL for short). Specifically, we first present a sufficient condition which guarantees the recovery of latent cluster structure of NL on the basis of the result of Sun, Toh, and Yuan (2018) for Convex Clustering, which is a special case of NL for clustering. Second, we extend NL to NTL to incorporate a cardinality constraint, reformulate the non-convex constrained optimization problem into an equivalent continuous unconstrained optimization problem, using the trimmed lasso penalty. Numerical illustrations demonstrate that the non-convex extension provides more clear-cut cluster structure when NL fails to form clusters without incorporating prior knowledge on the associated parameters. This talk is mainly based on joint works with S. Nakayama and S. Yagishita.

■ Chung Piaw Teo

“Airline Revenue Management: Forecasting and Ancillary Optimization in the Post Covid Era”

[Abstract]

The COVID 19 pandemic is ravaging the world and has left a trail of destruction in economic activities around the world. The airline sector is particularly worst hit by this pandemic, as travel bans caused a significant decline in passenger numbers and revenues. More crucially, revenue management practices in the post covid era will have to learn to adapt, as data in the pre-covid era becomes irrelevant. In a recent work, we embed new change point detection techniques into current airline demand forecasting model and show that it has the potential to improve forecast accuracy by several magnitudes, especially in a volatile environment during the pandemic. More importantly, back testing shows that it has the potential to improve forecast accuracy during normal operating conditions. The technique also improves the performance of two stage least square technique, often used to measure the day to departure price elasticity estimates in airline.

If time permits, we will also discuss the challenges of modern fare pricing in airline, where seat and different ancillary services are offered as a bundle (brand) to customers for selection. How do we price and allocate the products to customers to maximise yields? We review a new approach to study this branded fare revenue optimisation problem, combining the classical booking limit methodology and a new convex programming model on bundled product pricing optimization.

■ Yukio Ohsawa

“Stay with Your Community on Your Way - A Guideline for Living Safely and Sustainably -”

[Abstract]

In the social lifestyle "stay with community" proposed by our simulation of infection spread based on a social network model, an individual should suppress the contacts with other people beyond the community of mutual acceptance of intentional contacts. Here we compare the restrictions in such a society with the current urban life based on questionnaire data. The results mean the sustainable methods for managing the risk vary on users and places: The risk of offices and restaurants, as high as drinking places, can be dealt with the control methods such as limits on the number of visits or sparse positioning of tables. Users of supermarkets and trains should sustain their current attitude. We also discuss the mutual care of the interests of others from different organizations in order to enable safe practice of businesses.

■ Setsuya Kurahashi

“Assessment of the Impact of COVID-19 Infections Considering Risk of Infected People Inflow to the Region”

[Abstract]

In this presentation, we propose a new individual-based model and SEIR model to predict new coronavirus infections using mobile statistical information and machine learning, taking into account the risk of influx. The model enables accurate prediction of the number of infected persons in a region. The estimation results in Sapporo City and Tokyo show a high prediction accuracy of 1.2 persons/day. Using this model, we analyze the impact of inflow risk to Sapporo City. The results show that if the influx was restricted after the summer, the infection spread in November could have been reduced to less than half. Besides, we show that comprehensive measures with thorough droplet prevention measures, telework, and event restriction have a greater effect than strengthening the time shortening in restaurants.

■ Andrew Lim

“Dynamic Portfolio Choice with Time-varying Covariates and Parameter Uncertainty”

[Abstract]

Much of data sciences is concerned about decision making with prediction models. In this talk we consider a multiperiod dynamic portfolio choice problem where the underlying “predictive system” for asset returns has observable and hidden covariates, and parameter uncertainty. In this setting, it is well known that the optimal dynamic portfolio can be decomposed into a single period “Markowitz” holding and adjustments called “hedging demands” that manage the inter-temporal risks that come from time-varying covariates and the resolution of parameter uncertainty over time. Hedging demands, however, are impossible to compute not only in this setting but in many simpler ones because they depend on the value function of a dynamic programming problem with an infinite dimensional state space. In this talk, we take an “approximate dynamic programming” approach where the special structure of the portfolio choice problem is used to construct an approximation of the value function that incorporates many features of the application. This leads to a semi-explicit expression of an approximately optimal portfolio that not only turns out to be optimal in certain special cases, but can also be computed more generally using Markov Chain Monte Carlo methods with little extra cost beyond that of sampling from the joint posterior. The structure of the approximate portfolio is intuitive, consisting of the Markowitz term and approximations of the hedging demands in the true optimal. It is also quite different from the solution of the portfolio choice problem with plug-in parameter estimates which ignores parameter uncertainty. Further analysis of the hedging demands gives us insight into how the risks associated with time-varying covariates and parameter uncertainty are managed. (This is joint work with Thaisiri Watwai (Chulalongkorn University)).

■ Yuichi Takano

“Best Subset Selection for Linear Regression Models via Mixed-Integer Optimization”

[Abstract]

Subset selection for regression models has long been recognized as an important task in statistics, and recently it has been actively studied in data mining and machine learning because of the increased amount of data handled. A mixed-integer optimization approach, which has received renewed attention for subset selection, is to formulate subset selection as a

mathematical optimization problem and to solve it using a branch-and-bound method. The greatest advantage of this approach is that the best subset of explanatory variables can be selected with respect to the objective function (i.e., evaluation criteria of regression models) of the optimization problem. We have devised several formulations for simultaneously optimizing a subset of variables and its cardinality in terms of statistical criteria such as Mallows' Cp, adjusted R-squared, information criteria, and cross-validation criterion. In this talk, we explain these mixed-integer optimization formulations for best subset selection in linear regression models. This talk is based on joint work with Ryuhei Miyashiro.

■ Leonard Lee

“Behavioral Insights in Consumer Research”

[Abstract]

In this session, I draw upon a substantial body of work from the consumer psychology and decision-making literature to address several key questions pertaining to how consumers make everyday choices and decisions. Specifically, are consumers more likely to buy or choose when there are more choices, even though they may want to have choices and often seek variety in their purchase decisions? How do consumers evaluate and choose from among the different options available to them? And to what extent are consumers' buying decisions susceptible to contextual factors? In addition to illustrating how consumers make choices and decisions with a variety of psychological phenomena, I highlight three basic principles in consumer decision-making based on prior empirical findings: (1) consumers are cognitive misers; (2) consumers' preferences are often constructed (i.e., context-dependent); and (3) consumers often think in systematic but different ways from those predicted by rational choice theories.

■ Ai Kawamura

“Comparing Law Making Process by Islamic Finance Dispute Resolution System in the UAE and Malaysia”

[Abstract]

This presentation analyzes on how the Islamic finance legal framework was created after it emerged in the two pioneering countries: The United Arab Emirates and Malaysia. In addition, this presentation will be based on political economic literature reviews and field works research done in these two countries.

Islamic finance emerged as an alternative finance. The aim for such alternative finance started in order to tackle social and economical injustice occurring in the Islamic world. Especially, economical issues related to poverty alleviation and development. Theoretical discussion on creating an Islamic economic has been taking place since the 1940s. This developed into the discussion on establishing alternative Islamic economical system and lead to the establishment of the Islamic financial market. After the first commercial Islamic bank was established in the United Arab Emirates, Islamic finance expanded rapidly and created a global market. Nowadays, Islamic finance became one of the financial schemes that is utilized in international organizations for sustainable development projects to tackle global issues.

After the birth of the Islamic finance, there were some issues related to the legal system as the conventional finance existed before Islamic finance emerged. This issue appeared clearly in civil dispute cases which lead to academic discussions on who to create an Islamic dispute resolution system for Islamic finance. In addition, the uneven Islamization in the global financial market occurred due to diversified political, historical and cultural background by creating plural legal system in the Islamic world. For political and economical reasons, the global Islamic financial market was able to sustain its grow with diversified approach by governments. This presentation will focus on how such emerging market sustained its development by comparing

two pioneer countries law making process and their political economic backgrounds. In addition, this presentation will also cover how regulations are created for new financial technologies.

■ Melvyn Sim

“The Dao of Robustness”

[Abstract]

We present a model for optimization under uncertainty called robustness optimization that favors solutions for which the model's constraint would be the most robust or least fragile under uncertainty. The decision maker does not have to size the uncertainty set, but specifies an acceptable target, or loss of optimality compared to the baseline model, as a tradeoff for the model's ability to withstand greater uncertainty. We axiomatize the decision criterion associated with robustness optimization, termed as the fragility measure, which is a class of Brown and Sim (2009) satisficing measure, and it satisfies the properties of monotonicity, positive homogeneity, subadditivity, pro-robustness, and anti-fragility. We present a suite of practicable robustness optimization models for prescriptive analytics including linear, adaptive linear, data-driven adaptive linear, combinatorial and dynamic optimization problems. Similar to robust optimization, we show that robustness optimization via minimizing the fragility measure can also be done in a tractable way. We also provide numerical studies on static, adaptive, and data-driven adaptive problems and show that the solutions to the robustness optimization models can withstand greater impact of uncertainty compared to the corresponding robust optimization models without increasing the cost or incurring additional computational effort. This is a joint work with Zhuoyu Long and Minglong Zhou.

■ Yuji Yamada

“Hedging Strategy for Sustainable Solar Power Generation Businesses by Creating Derivatives Market”

[Abstract]

Solar power has been paid much attention recently as clean and sustainable energy resources, and many countries have installed substantial solar power capacity into power networks to provide an alternative to traditional fossil-fuel thermal power generation. However, due to the rapid introduction of solar power and other renewable electricity generations, there is a growing impact of weather and climate changes on electricity markets. For example, solar photovoltaic (PV) power outputs largely depend on uncertain weather conditions and are difficult to know exact volumes in advance for selling the electricity delivery contract between certain time periods of next day through the power exchange market. In addition, the amount of PV output has a strong effect on wholesale electricity prices nowadays, leading to simultaneous fluctuations of both price and volume for PV power generators. This fact may cause a significant risk or loss in solar PV businesses, and an effective tool involving derivative contracts is required to reduce such risks.

The objective of this work is to propose a hedging methodology of price and volume for solar PV output using energy and weather derivatives simultaneously. Our approach is to apply a prediction method based on nonparametric techniques for constructing optimal payoff functions of derivatives or optimal portfolios given derivative contracts for weather indices (e.g., solar radiation and temperature), energy prices (e.g., natural gas and oil) and electricity prices. Empirical data analysis of the Japan Electric Power Exchange (JEPX) demonstrates the significant hedging effect and supports the versatility of the proposed modeling approach.

This presentation is based on joint work with Takuji Matsumoto,

<https://www.sciencedirect.com/science/article/pii/S0140988321000062>.

Faculty of Business Sciences, University of Tsukuba, Tokyo, Japan

Keywords: cross hedge, electricity markets, energy risk, non-parametric regression, minimum variance hedge, weather derivatives

JEL classification: L94, G19