2022 - 2023

Research Organization of Information and Systems

The Institute of Statistical Mathematics

CONTENTS

Message from Director-General

Since our founding on June 5, 1944, the Institute of Statistical Mathematics (ISM) has been dedicated to statistical theories and their applications to elucidate and design behaviors and other phenomena of interest. We express our sincerest gratitude to the many industry, government, and academia stakeholders who have supported our statistical and mathematical science research for almost 80 years. The ISM faculty and staff remain committed to our mission, engaging in new research projects, and providing academic career development opportunities.

Today, the world seeks to identify an ideal form of a data-driven society, and Japan is in great need of data scientists with excellent problem-solving and goal-achieving capabilities. In fiscal year (FY) 2021, ISM received funding for five years from the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) to implement "The Project for Training Experts in Statistical Sciences." Under this project, we launched the Center for Training Professors in Statistics in January 2022 as a teaching platform similar to ISM's School of Statistical Thinking, which has been home to various levels of statistical scientists. The new center offers two-year faculty development programs to empower junior and mid-career members of the 21 academic institutions participating in the project. These member institutions have formed a consortium to jointly develop and implement a master's-level statistical education program. The junior and mid-career faculty members who complete the two-year program will lead their institutions' career development ecosystem, where graduate students will receive world-leading statistical education and training.

Two additional five-year projects proposed by ISM were also approved by MEXT in FY 2021. One is the "Creation of data infrastructure for data-driven polymer materials research" project, which was approved under the Program for Promoting Research on the Supercomputer Fugaku. This project is represented by ISM's Data Science Center for Creative Design and Manufacturing. The other is the "New developments in space-time earthquake forecasting and monitoring: from long-term to real-time" project, which is represented by ISM's Risk Analysis Research Center. This research plan was approved under the Seismology TowArd Research innovation with data of Earthquake Project (STAR-E Project). We have spent a long time implementing the Network of Excellence (NOE) Project, an inter-institutional effort to advance the theoretical foundations of data science and to build and activate the relevant research networks. These activities have opened the door to new concepts, methodologies, and applied research opportunities. Such advancements demonstrate the practical utility of statistical and mathematical sciences.

With regard to the novel coronavirus disease 2019 (COVID-19), we launched the COVID-19 Response Project in FY 2020, which addresses statistical and mathematical methods to reduce the risks of COVID-19 infection. Since the COVID-19 pandemic continues with no end in sight, ISM's activities involving overseas scientists and in-person interactions have been severely disrupted. Under these circumstances, we make the best available choices utilizing the experience we gained in virtual research meetings and other contingency measures.

ISM's Fourth Medium-Term Plan has been in effect since April 2022. This plan guides ISM's future research and educational orientations. This plan will not only ensure that the research outputs of ISM inform and benefit society but also that ISM researchers are well equipped with the competencies to advance the frontiers of basic science and apply advanced knowledge to practical contexts. We cordially ask for your continued support and cooperation.

Hiroe Tsubaki
Director-General
The Institute of Statistical Mathematics

Basic Research

Department of Statistical Modeling

The Department of Statistical Modeling works on structural modeling of physical phenomena related to numerous factors, and conducts research on model-based statistical inference methodologies. By means of model-based prediction and control, modeling of complex systems, and data assimilation, the department aims to contribute to the development of modeling intelligence in many fields.

Prediction and Control Group

The Prediction and Control Group works on the development and evaluation of statistical models, which function effectively in terms of prediction and control of phenomena, decision making, and scientific discoveries. These efforts involve data analysis and modeling related to phenomena that vary across time and space.

Complex System Modeling Group

The Complex System Modeling Group conducts studies aimed at discovering the structures of complex systems, such as nonlinear systems and hierarchical networks, through statistical modeling. For these purposes, the group also considers Monte Carlo simulations, discrete mathematics, and computer science.

Data Assimilation Group

The Data Assimilation Group works on the development of data assimilation techniques, which are procedures aimed at combining information derived from large amounts of observations and a numerical simulation model. By developing computational algorithms and high-performance parallel computing systems, the group aims to build a next-generation simulation model that can predict the future in real time.

Department of Statistical Data Science

The Department of Statistical Data Science conducts research on data design methods aimed at managing uncertainty and incompleteness of information, quantitative methods for evidence-based practice, and related data analysis methods. Moreover, the department investigates methods for inferring the latent structures in target phenomena from observation data.

Survey Science Group

The Survey Science Group promotes research on the design of statistical surveys, development of statistical analysis methods on survey data, privacy protection in official statistics, and their applications. By exploring complex phenomena in various fields, the group also aims to contribute to practical applications in academia and policy-making through social surveys.

Metric Science Group

The Metric Science Group conducts research aimed at identifying and evaluating statistical evidence through quantification of phenomena that have not been measured thus far, as well as efficient information extraction from large databases. The group investigates related methods and develops methods for analyzing the collected data. By working on applied research in various fields of real science, the group aims to advance practical, applied, statistical mathematical research based on evidence.

Structure Exploration Group

The Structure Exploration Group conducts research on statistical science aimed at inferring the latent “structure” behind various target phenomena in biology, physics, and social science, based on observational data. The group focuses on machine learning, Bayesian reasoning, experimental design methods, and spatial-temporal analysis methods to investigate micro/meso/macroscopic and spatial-temporal dynamic structures in target phenomena.

Department of Statistical Inference and Mathematics

The Department of Statistical Inference and Mathematics carries out research into general statistical theory, statistical learning theory, optimization, and algorithms for statistical inference.

Mathematical Statistics Group

The Mathematical Statistics Group is concerned with aspects of statistical inference theory, modeling of uncertain phenomena, stochastic processes and their application to inference, probability and distribution theory, and the related mathematics.

Learning and Inference Group

The Learning and Inference Group develops statistical methodologies to describe the stochastic structure of data mathematically and clarify the potential and the limitations of the data theoretically.

Mathematical Optimization Group

The Mathematical Optimization Group focuses on mathematical theory and practical applications of optimization and computational algorithms together with underlying numerical or functional analysis and discrete mathematics.

NOE-type Research

Risk Analysis Research Center

Risk Analysis Research Center is pursuing a scientific approach to managing uncertainties and risks in society, which have increased with the growing globalization of society and economy. Our research projects are mainly seismology, finance, resources, environmentology, database development, risk mathematics, and spatiotemporal modeling. The Center also manages a network organization for risk analysis to facilitate research collaboration across different organizations with the common goal of creating a safe and resilient society.

Research Center for Statistical Machine Learning

Machine learning is a research field associated with autonomous systems that can learn their behavior from data. This field is based on both the statistical science concerning inference from data and computer science concerning efficient algorithms. It can be applied to broad disciplines ranging engineering and information science to natural science, such as robotics and brain sciences. Our research center aims at supporting the academic community of this field, as well as producing influential research through various joint projects.

Data Science Center for Creative Design and Manufacturing

We aim to foster new scientific methods for innovative design and manufacturing. Various fields in manufacturing are now facing a revolutionary period. Population reduction and globalization are bringing dramatic changes in the industrial structure in Japan. Countries around the world has actively developed their growth strategies utilizing data science as a driving force. We have accumulated state-of-the-art technologies in data science here. We are devoted to foster and practice advanced methods in data science for design and manufacturing.

Research Center for Medical and Health Data Science

Research Center for Medical and Health Data Science aims to facilitate statistical data science research that covers medical studies, drug developments, health care, and public health. Our research projects involve fundamental mathematics and computational science for medical applications, applied methodology for basic, clinical and social medicine, and modern technology such as artificial intelligence, machine learning, and big data analyses. Furthermore, our research center aims at constructing a research network of the academic community of this field, as well as offering advanced statistical education programs.

Professional Development

School of Statistical Thinking

The mission of the School of Statistical Thinking is to plan and implement various programs for statistical thinking, from extension courses to a professional development program. The researchers affiliated with the school are often involved with specific data analysis projects, which help them to gain hands-on knowledge of data science. We expect such an experienced researcher will play an active role as a number-cruncher, as a modeler, or as a project coordinator.

Center for Training Professors in Statistics

The Center has established the nationwide consortium of universities and promotes the Project for Training Experts in Statistical Sciences to address the critical shortage of professors in statistics, which form the core of data science. Over the next 5 years, the Center will develop at least 30 university professors in statistics, who will train statistics experts at member universities of the consortium. The Center aims to establish a positive cycle of professional development.

Research Support

Center for Engineering and Technical Support

The Center for Engineering and Technical Support assists academics and their collaborators in many ways: managing computer systems and networks, editing and publishing journals, maintaining the library, and managing tutorial programs.

- **Computing Facilities Unit** The Computing Facilities Unit is in charge of managing computer facilities and scientific software.
- **Computer Networking Unit** The Computer Networking Unit is responsible for computer networking and its infrastructure, and network security.
- **Information Resources Unit** The Information Resources Unit is responsible for maintaining a library and an electronic repository, and is in charge of planning statistical tutorial programs open to the public.
- **Media Development Unit** The Media Development Unit is in charge of publishing and editing of research results and PR brochures.

Data Science in Seismology and Geodesy

■ Data science in seismology and geodesy

In seismology and geodesy, continuous data obtained by a wide variety of instruments are accumulated. Since the temporal and spatial granularity of seismic and geodetic data is becoming finer and finer with the development of measuring techniques, the volume of data is a serious issue. In recent years, many research projects have been launched worldwide to analyze such massive data and to obtain seismic and geodetic knowledge by utilizing new data-science technologies in addition to conventional ones. Here, I would like to introduce two of the projects in which I participate.

■ Earthquake detection by deep learning

Detecting earthquakes in the vast amount of continuous waveform records is the first step in seismology. Deep learning is one of the de facto standard data analysis methods, and earthquake detection using deep learning has been successful and greatly outperformed existing detection methods. However, most of the researches have utilized only waveform data at a single observation station. In addition to seismic signals, local environmental noises near the ground are contained in the observed waveforms, and thus there is a potential limitation in preventing false positives by using only a single observation point. We proposed a method for automated earthquake detection by using convolutional neural networks for continuous data at multiple stations. We applied the proposed method to the Metropolitan Seismic Observation network (MeSO-net), and succeeded in suppressing the false detection rate and capturing very weak earthquake signals overlooked by humans (Figure 1).

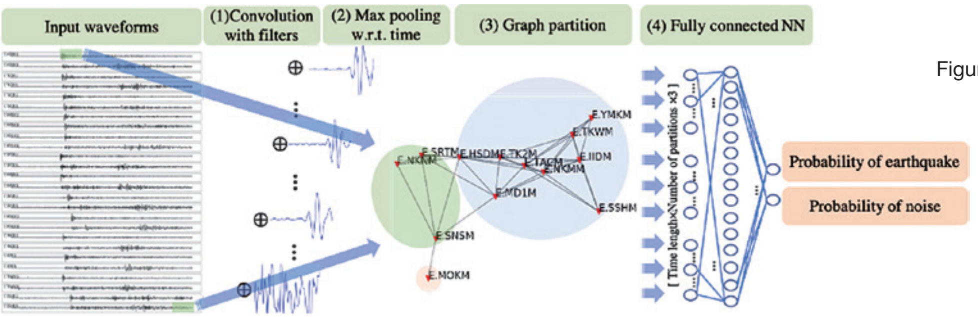


Figure 1: Automated earthquake detection by convolutional neural network using continuous waveform records at multiple observation stations (Yano et al., JGR Solid Earth, 2021).

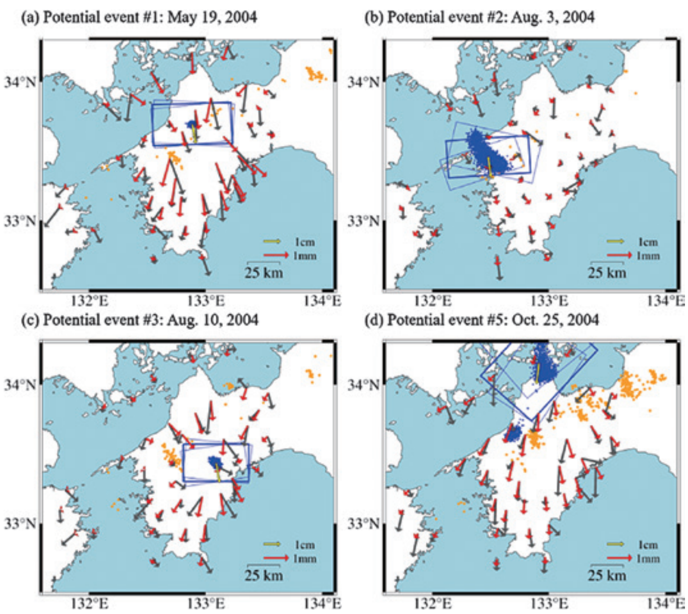


Figure 2: Inversion results of potential slow slip events detected by the proposed method (Yano and Kano, ESSOAr).

■ Slow slip detection by sparse modeling

The phenomenon of "slow slip event," in which a fault ruptures over a long period (from days to years) and releases strain energy without emitting seismic waves, has been attracting attention in seismology and geodesy. This phenomenon has been found in tectonic zones worldwide, and provides a clue to understanding the surrounding stress environment. Slow slip event often does not lead to clear crustal deformation that can be visually picked. So, developing an automatic detection method with high detection accuracy is necessary.

We have developed an automatic detection method of slow slip events from GPS data using "sparse modeling" and "combined p-value method." By applying the developed method to data in western Shikoku, we found new 12 events in about two years (Figure 2).

Keisuke Yano

Risk Evaluation for a Specific Predator Species for a Specific Prey Population

■ Prey-predator system

For a prey-predator system which is more easily investigated, the predator or the prey? More concretely, which is more easily estimable, the proportion of a specific prey species in food resource of a predator species, or the proportion of a specific predator species in mortality of a prey population? The answer is the latter. The former is available, for example, investigating stomach contents, chasing individuals, and so on, whereas for the latter, we should chase hundreds of preys from the birth to death, which is nearly impossible.

■ Risk evaluation for predator control

Occasionally, predators were excluded to protect endangered preys, or introduced to reduce harmful preys. In order to evaluate the risk for these, we need to know the contribution of that predator species in the mortality of preys.

■ Autotomy: evidence of predation

As is well-known, a lizard cut the tail to escape from a predator and the tail is regenerating (autotomy). An individual with a regenerating tail should provide information on the predator's contribution in the prey mortality.

Conducting experiments in a laboratory, we may know the proportions of three fates of a prey when attacked by a predator, consumed, escape by autotomy and escape without autotomy. Conducting a capture-mark-recapture survey, we may find an individual with an intact tail when released and with a regenerating tail when recaptured. The number of such individuals multiplied by the ratio between consumed and escape with autotomy in the experiment should give us an estimate of mortality by a specific predator. Because recapture data provides us an estimate of the mortality (Fig. 1), their differences corresponds to the contribution of the specific predator species to the mortality of the preys.

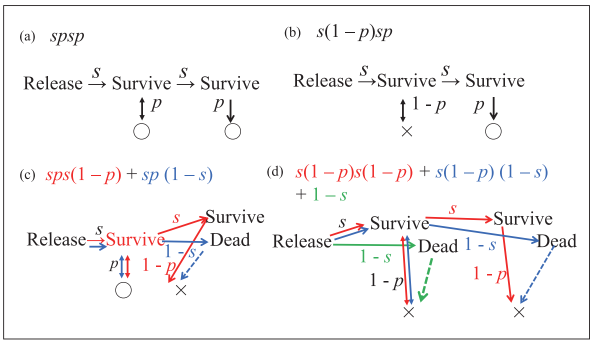


Figure 1: Let s be the survival probability and p the recapture probability. If recapture censuses were done twice, there are four patterns (in which ○ indicates success in recapture and × failure). The probability that we obtain each pattern can be derived as below (likelihood). From these equations, we may estimate the survival and the recapture probabilities.

■ Snail-snake system in Okinawa

Such a study was carried out for a specific snail species and a specific snake species in which the snail may escape from the snake's attack by autotomy. Integrating the experiment, a capture-mark-recapture survey and a hierarchical Bayesian model, the encounter rate to the snake species per month was estimated as 0.033, and the proportion of the snake species in the mortality until maturation (it is about 1.5 year) as about 40% (Fig. 2).

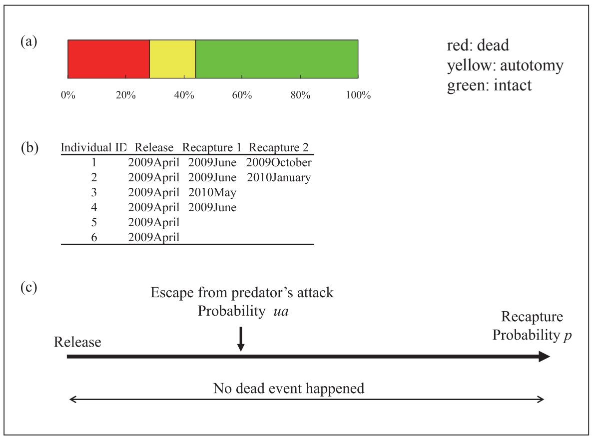


Figure 2: (a) An example of the proportions of the three fates when a snail was attacked by a snake. The real proportions are more complicated because the fates depend on attributes of snails.
(b) A part of the recapture records.
(c) Let u be the encounter rate to a predator, a the probability of escape by autotomy, and p the recapture probability. If an individual with a regenerating tail is recaptured, its probability is not a simple product of uap, but the probability that the prey survived (=did not meet any mortality event) must be multiplied.

■ Statistical model, field works and experiments for risk evaluation

There are variety of prey-predator systems on a globe. If field works, experiments and statistical models are adequately integrated to capture the characteristics of the system, we will be able to obtain estimates about the risk of controlling the predators.

Kenichiro Shimatani

Assessment of Significance of Gravitational Wave Signals

■ What is the gravitational wave?

In 1915, Albert Einstein published the paper on the general theory of relativity, which describes gravity as differential geometry of spacetime. The theory is based on a nonlinear partial differential equation for metric. Since small strain of a spacetime follows a linear wave equation, Einstein predicted existence of the gravitational wave, which is produced by mass acceleration and propagates at the speed of light. The existence was certain, because decay of an orbit of a binary star system can be explained by loss of energy by the gravitational wave radiation. Nevertheless, direct observation of the gravitational wave had been difficult, because strain of space time is extremely small: it is typically smaller than 10-20 when we observe gravitational waves produced by astronomical phenomena. Observation of the gravitational wave has several importance, including demonstration of cutting-age measurement technology, establishment of astronomical observation device other than electromagnetic waves, and testing of theories of gravity.

■ Assessment of significance of gravitational wave signals

In September 2015, the gravitational wave telescope LIGO in the United States, consists of two detectors, firstly detected a gravitational wave signal. The gravitational wave was produced by merger of black hole binary and was named the GW150914. Since a gravitational wave produced by merger of a binary star system is well described by the theory of general relativity, we fit wave forms computed by the theory to the observed wave and use a test statistic constructed by using the likelihood ratio (Figure). Significance of a gravitational wave signal is represented by the return period; the GW150914 is once in 0.2 million years if it was a noise. Here, the estimation under the noise assumption is done by shifting in time of the time series obtained by the two detectors. The posterior probability is also used. If a candidate of a gravitational wave signal fulfils criteria for the return period and the posterior probability, the candidate is considered a signal. Dozens of candidates have already been found, and the assessment of the significances is an issue. The gravitational wave telescope KAGRA is constructed in Japan, and the observation is in preparation (Photo).

■ Estimation of the false discovery rate

Assessment of significance when we have multiple signal candidates is a typical issue in data analysis. The false discovery rate, formally introduced by Benjamini and Hochberg in 1995 (expected proportion of noises in events called signal) is frequently used. The distribution of the detection statistic is unknown, but we can estimate p-values. Using the fact that p-vales of noises are uniformly distributed, we proposed a method to estimate the false discovery rate if we call a candidate a signal. Compared with estimation of the posterior probability, the proposed method is free from distributional assumption on the detection statistic and computationally cheap. Candidates with high significance are significant under any criteria, but others are not. This is a collaboration with Drs. Hirotaka Yuzurihara and Hideyuki Tagoshi from ICRR, The University of Tokyo, and supported by the ISM Cooperative Research Program. The details are published in the open access journal, Progress of Theoretical and Experimental Physics, Volume 2021, Number 12.

Shuhei Mano

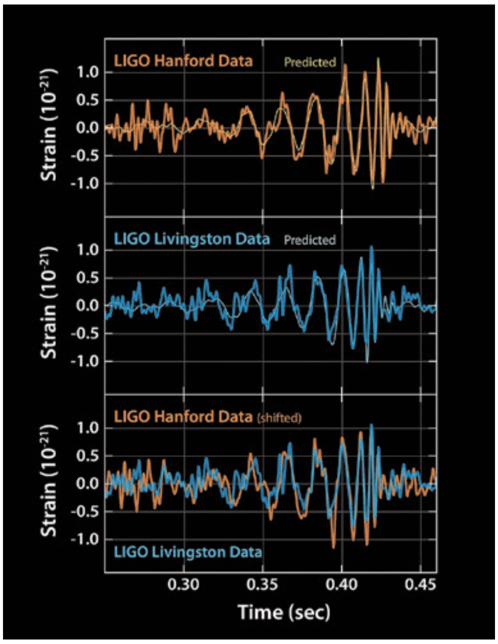


Figure: The wave form of the gravitational wave GW150914 (Courtesy Caltech/MIT/LIGO Laboratory).

Photo: A duct for laser of the gravitational wave telescope KAGRA (Photo courtesy: KAGRA Observatory, ICRR, The University of Tokyo).

Efficient Method for Estimating Causal Structures

■ Causal Discovery

Suppose that among many variables, there is a causal structure such that a change in A causes changes in B and C, a change in B causes a change in D, and so on. The problem is to identify this causal structure from the data. The well-known correlation structure alone cannot identify such a causal structure because the direction of influence is unknown. However, if we assume some structure behind the data, we can identify the causal structure from the data. Using this idea, there is a research topic called causal search, in which causal structures are identified from data.

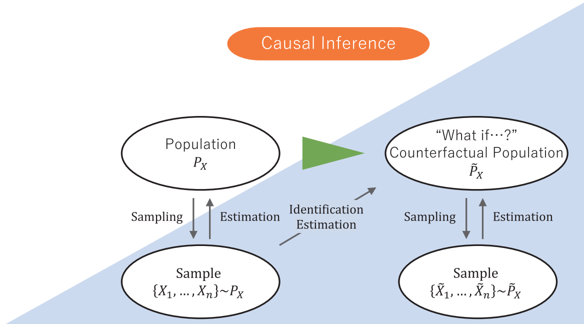


Figure 1: Causal Inference.

■ Linear Non-Gaussian Acyclic Model (LiNGAM)

One of the most famous methods in causal discovery is a method that enables causal structure identification by assuming acyclicity and noise non-normality under linear structural equation models. This method is based on the idea of independent component analysis, and is named Linear Non-Gaussian Acyclic Model (LiNGAM).

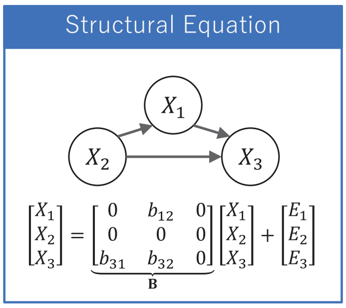


Figure 2: Acyclic Linear Structural Equation.

■ LiNGAM with sparse structure

We have studied an efficient method for estimating the causal structure in LiNGAM under the assumption that the regression parameters of the linear structural equation model are sparse. When the linear structural equation is acyclic, half of the regression parameters of the linear structural equation are zero. Therefore, it is natural to assume a sparse structure. Also, in high-dimensional data, it is natural to assume that the regression parameters are sparse, as in LASSO. Therefore, we have considered taking a sparse estimation approach to LiNGAM.

■ Penalized likelihood method

LiNGAM makes good use of the ideas of independent component analysis. The parameter estimation is based on maximization of the non-Gaussian likelihood used in independent component analysis. If we add a sparsity penalty to the likelihood and consider a penalized likelihood maximization, the sparse estimation of LiNGAM seems to be possible. Such a study has already been done. However, in past studies, the orthogonalization, which is important in independent component analysis, was not well incorporated in the penalized likelihood maximization. In addition, if we simply incorporate not only orthogonalization but also sparse penalty at the same time, it is difficult to achieve a sparse structure sufficiently because they are not compatible. In this study, we have solved this problem by using the alternating direction multiplier method and relaxation of the parameter structure, which enables efficient sparse structure identification.

■ Numerical experiments

We compared our method with many other methods by numerical experiments. In addition to the standard ICA-LiNGAM and DirectLiNGAM, we also compared our method with Zheng+ (2018, GOLEM) and Ng+ (2020, NOTEARS), which were recently published in NeurIPS. The good performance of the proposed method was confirmed.

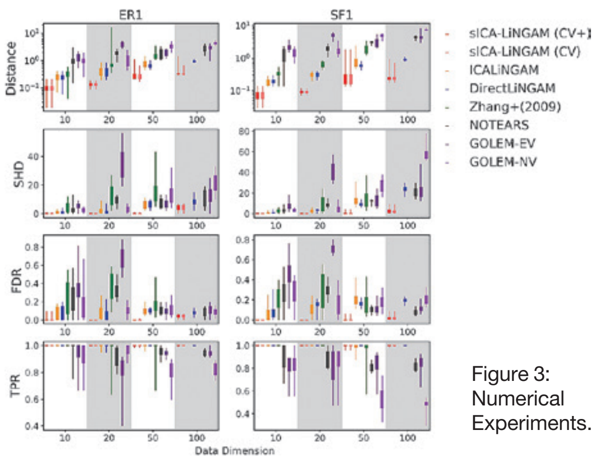


Figure 3: Numerical Experiments.

This work is summarized in the following paper.

References: Harada, K. and Fujisawa, H. (2021). Sparse Estimation of Linear Non-Gaussian Acyclic Model for Causal Discovery. Neurocomputing, Vol. 459, 223-233.

Hironori Fujisawa

Creation of Polymer Properties Database Using Automated Molecular Dynamics Simulation

■ Exploration of polymeric materials with innovative properties

Polymeric materials, such as plastics, are widely used because of their lightness, ease of processing, and high viscoelasticity. On the other hand, the parameter space for material design is vast, so there is a need to establish an efficient material exploration method for further functionalization. The aim of the project is to discover new polymeric materials with innovative properties. Our group is participating in a research program of the Japan Science and Technology Agency (JST) for Nano-enabled Thermal Control, which started in 2019. In addition, in 2021, the Program for Promoting Research on the Supercomputer Fugaku "Creation of Data Infrastructure to Transform Data-Driven Polymer Materials Research" was accepted.

■ Machine learning technologies for automated molecular design

We applied a machine learning algorithm to PoLyInfo to design polymers with high thermal conductivity. For amorphous polymers measured at around room temperatures, only 28 samples were recorded at the database. To overcome the difficulty of the limited data, we first trained machine learning models using the dataset of other related thermophysical properties where sufficient data were available, and then these pretrained models were finetuned with the small dataset of thermal conductivity. This is a machine learning technique called transfer learning. By solving the inverse problem of the resulting model, we found and synthesized new polymers that reached a thermal conductivity of 0.41 W/mK.

■ Lack of open data for data-driven research

The amount of data in materials research is much less than in other applied fields of data science. There are three main reasons for this: (1) the high cost of data production; (2) the difficulty of creating common data due to the diversity of demand; and (3) the importance of the prevention of information leakage to competitors. These factors have hindered the development of open databases. In particular, for polymers, there is no database that can be used in data-driven research, other than the PoLyInfo database mentioned above.

■ Creation of polymer property database with automated molecular dynamics simulation

We are developing RadonPy, an automated high-throughput calculation system using molecular dynamics (MD) simulations for polymer properties. Currently, we are developing a polymer properties database using RadonPy. Our ultimate goal is to build a database that covers a broad array of polymeric properties for more than 100,000 polymers. Once this goal is achieved, we will be able to observe the joint distribution of multiple properties in the vast material space. For example, we aim to comprehensively identify polymer structures distributed at around the Pareto boundaries between multiple properties. Furthermore, in the process of data accumulation, unique materials that can overcome the Pareto boundary may be discovered. We will accomplish this mission as a joint research project under industry-academia partnerships.

Yoshihiro Hayashi

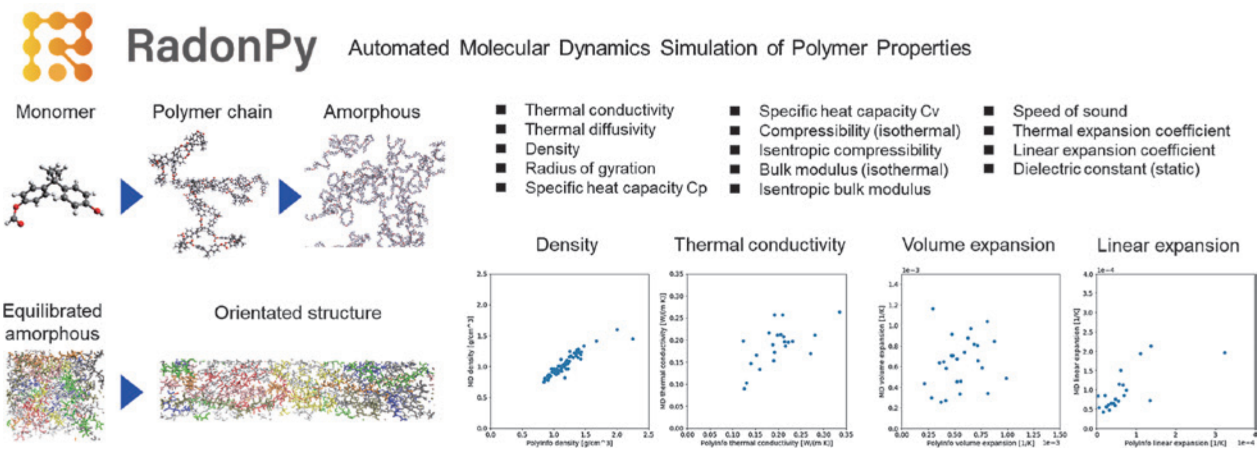


Figure: Automated calculation of polymer properties using molecular dynamics simulation.

Search for New Quasicrystals Using Machine Learning

■ Accelerating the discovery of new quasicrystals based on data science

Quasicrystals are a class of materials that do not have the translational symmetry of ordinary periodic crystals, but have a high degree of order in their atomic arrangement. The first quasicrystal was discovered by Schechtman in 1984. Over the next 35 years, more than 100 types of quasicrystals were found, and quasicrystals were placed as the third class of solids along with ordinary crystals and amorphous. However, the pace of the discovery has slowed significantly in recent years. We are participating in the Grant-in-Aid for Scientific Research on Innovative Areas, “Hypermaterials: Innovation of Materials Science in Hyperspace”), which started in 2019 (Prof. Ryuji Tamura, Tokyo University of Science). We will accelerate the discovery of new quasicrystals by introducing machine learning techniques to the field.

■ Prediction of chemical compositions to form quasicrystals

We tackled the problem of predicting quasicrystals using a simple workflow of supervised learning. The input variable of the model is the chemical composition. The output variables represent class labels indicating “quasicrystals”, “approximant crystals”, and “others” including ordinary periodic crystals. As training data, we used the chemical compositions of quasicrystals, approximants, and ordinary crystals that have been discovered so far. We evaluated the predictability of machine learning models for the three-class classification task. The predicted quasicrystalline phases were compared with known experimental phase diagrams, and the precision and recall of the phase prediction reached 0.793 and 0.714, respectively. We aim to use this model to narrow down the candidate compositions that form quasicrystals and approximants.

■ Discovery of the laws of physics

Furthermore, by extracting the input-output rules inherent in the black-box model of machine learning, we have uncovered rule-of-thumbs on the formation of quasicrystalline phases. These rules are expressed in five equations for the van der Waals radius of consistent elements and the itinerant valence electron concentration. These conditions provide design guidelines for the search for new quasicrystals. This may open the door to a better understanding of the stability of quasicrystals, a central issue in condensed matter physics.

■ Towards discovery of innovative quasicrystals

With this work, we have taken the first step toward realizing quasicrystal discovery through data science. We are now using our model in the synthetization of new quasicrystals. During nearly 35 years after the discovery of the first quasicrystal, little is known about the formation mechanism of quasicrystals. Data science may make a significant contribution to solving this unsolved issue in quasicrystal research.

Chang Liu

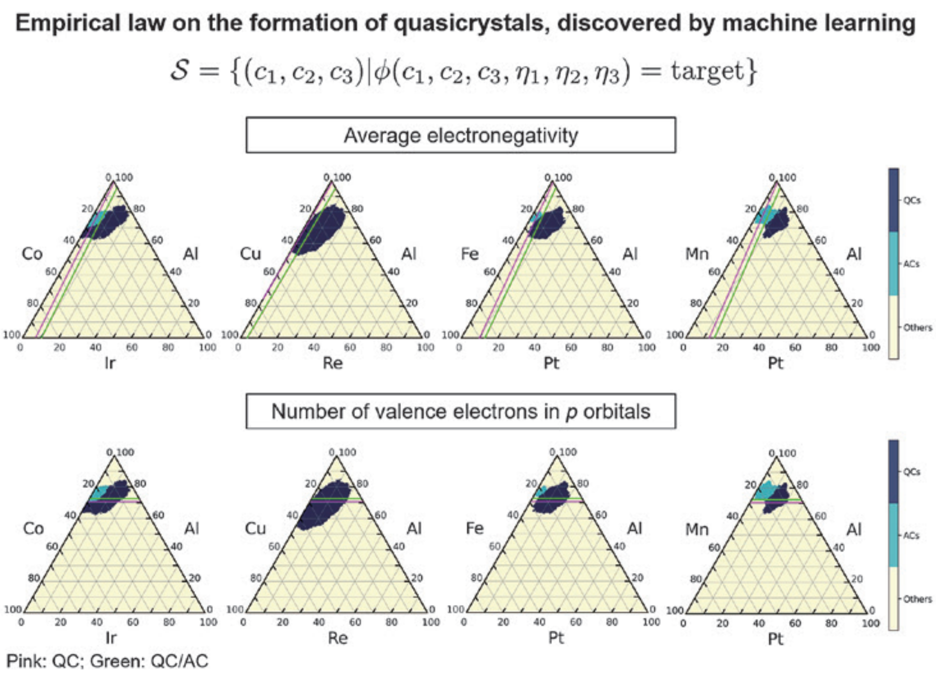


Figure:
Formation rules on quasicrystalline phases that were discovered by machine learning.

Pursuing the Advancement of Medical and Health Data Science

■ Medical and health data science and the center's mission

In recent years, expectations regarding data science have been growing in various fields, including medical and health sciences. These days, the application of deep learning and other cutting-edge AI technologies to the analysis of molecular/medical big data is widely expected to sharply accelerate the elucidation of biological and disease mechanisms, the development of medical technologies, including drug discovery, and the realization of precision medicine. In the meantime, we should not forget the critical role of obtaining solid evidence on medical technology from high-quality small data derived through careful study design and statistical inference. While it is considered that expectations regarding medical and health data science will continue to grow, the framework of data science has yet to be established to fully meet such expectations; hence there is a big gap to be filled. That is to say, the enhancement of education and research in medical and health data science is our great challenge for the future.

The Research Center for Medical and Health Data Science was established in April 2018 based on research and researcher education in data science and on the network of Japanese and foreign researchers that the Institute of Statistical Mathematics has established over many years. The Center's mission is to promote projects that enhance education and research in medical and health data science in Japan. Although the Center has been in existence for only three years, it has been involved in a variety of educational and research activities thus far.

e-learning website

Symposium

■ Educational and research activities

In the area of education, the Center has been promoting the development of various educational programs, such as systematic education courses on theories and methods of statistical mathematics, biostatistics, theoretical epidemiology, and machine learning, topics that form the basis of medical and health data science. In addition, the Center has focused on open lectures and on-the-job-training, as well as e-learning materials to be shared with the research community.

In the research sector, the Center has been actively working on a variety of projects, such as those involving statistical methodologies pertaining to advances in medical technology and healthcare, as well as research in public health and social medicine. Additionally, the Center is involved in big data analysis using cutting-edge machine learning and AI algorithms, and is performing studies on foundational mathematics and computer technologies.

■ Medical and Health Data Science Research Network

All of the above projects are linked with the activities of the newly launched "Medical and Health Data Science Research Network." This unique network comprises 94 organizations (as of January 2022), including related academic societies, universities, and research institutions in all parts of Japan, as well as hospitals and companies. The substantial advancement of medical and health data science depends on the organic collaboration of researchers in the fields of statistical mathematics and information science and those in the fields of medical and health science. The Center intends to make every possible effort to play an important part in bridging these fields.

Shigeyuki Matsui

A Confidence Interval Robust to Publication Bias

■ Meta-analysis in medical research

Meta-analysis is statistical analysis in which statistical results from some studies with a common purpose are combined to obtain an overall result with higher evidence. Typical examples of meta-analysis in medical research are found in clinical trials to verify effects of new drugs and epidemiological studies to explore causes of some diseases. For instance, in randomized clinical trials where a new drug and an existing drug are compared, it is possible to obtain an overall result to support the effect of the new drug, even if each trial does not necessarily support it.

■ Publication bias

In meta-analysis, the data from each study tends to be biased since it can be obtained only from published sources. For example, statistically significant results tend to be published in clinical trials and epidemiological studies with two-group comparison, and therefore the result of meta-analysis should be also statistically significant if such published results are combined. This sort of bias is called publication bias. Figure 1 shows results of clinical trials to verify that some drug prevents premature birth. The horizontal and vertical axes show estimates of log-odds ratios and reciprocals of their standard errors from the trials. Since the standard errors are larger and the results do not tend to be statistically significant in the bottom, the skewed plot implies that there exists publication bias. This type of plot is called a funnel plot, which is often used to check existence of publication bias.

■ Robust confidence interval

In meta-analysis, there are two types of statistical models called fixed-effects model and random-effects model, depending on whether we take into account the heterogeneity between studies. Although the random-effects model is more flexible, it tends to be more affected by publication bias. We proposed to use the fixed-effects model even if there exists some heterogeneity and constructed a confidence interval which is robust to publication bias, based on the fixed-effects model with appropriate statistical adjustment (Henmi and Copas, 2010). Figure 2 shows simulation results of coverage probabilities of some confidence intervals in the presence of some publication bias. The horizontal and vertical axes show the number of studies and the coverage probabilities, respectively. The white circles indicate the coverage probabilities of our proposal and tell us that our proposal keeps higher coverage probabilities than others. Our method is implemented in the R-package called 'metafor' for meta-analysis (as a function 'hc') and is widely used in practice. An improved version has been proposed recently for the case where very few studies are included in meta-analysis (Henmi, Hattori and Friede, 2021).

Masayuki Henmi

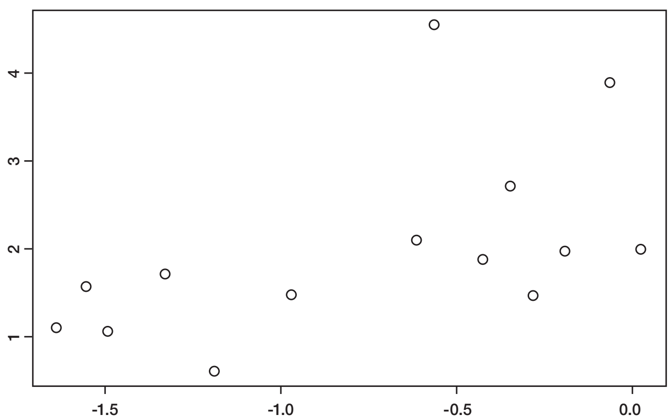


Figure 1: Funnel plot of clinical trials.

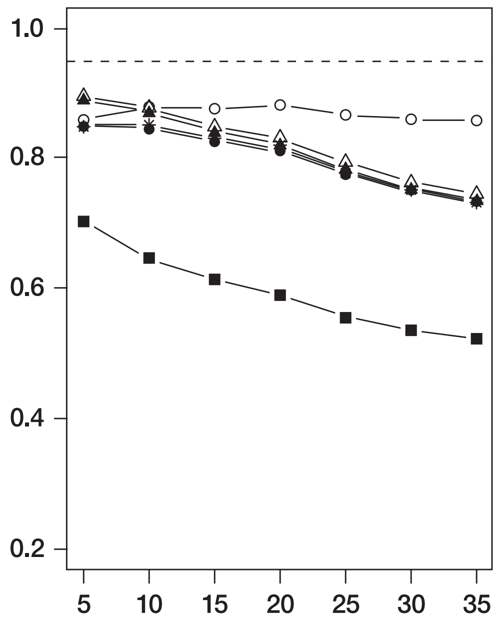


Figure 2: Coverage probabilities of some confidence intervals.

Relativistic Gaussian Mixture Model

■ Relativistic effects: Particles travel slower than the speed of light

It has been known that the Gaussian mixture model is useful for analyzing “non” relativistic plasma. When analyzing relativistic plasma, on the other hand, it is physically unreasonable to adopt a Gaussian distribution as a component distribution of a mixture model. This is because while the speed of plasma particles should be slower than that of light due to the relativistic effects, Gaussian distributions permit particles traveling faster than light. We need to take into account the relativistic effects in the component distribution of the mixture model.

■ Relativistic effects on Gaussian distribution

We have developed a mixture model composed of distribution that is obtained by applying Lorentz transformation to the plasma energy represented by the Gaussian distribution, which is known as the relativistic Maxwell distribution or the Jüttner-Synge distribution. Here, we call the component distribution the relativistic Gaussian distribution. First, we summarize the basic characteristics of the relativistic Gaussian distribution (Table). The table includes the normalization constants when the bulk velocity is non-zero, which has not been derived before. We also derived simple equations that are satisfied by the maximum likelihood estimators of the parameters of the relativistic Gaussian distribution (bulk velocity and temperature).

Random variable	$\boldsymbol{u} \in \mathbb{R}^3$
Parameters	$\boldsymbol{\beta} \in \mathbb{R}^3, \lvert\boldsymbol{\beta}\rvert < 1$ (bulk velocity) $\Theta \in \mathbb{R}, \Theta > 0$ (temperature)
PDF (Lorentz factor) (Normalizing constant)	$\frac{1}{Z}\exp\left[-\gamma\left(\sqrt{1+\lvert\boldsymbol{u}\rvert^2}-\boldsymbol{\beta}'\boldsymbol{u}\right)\Theta^{-1}\right]$ $\gamma = \frac{1}{\sqrt{1-\lvert\boldsymbol{\beta}\rvert^2}}$ $Z = 4\pi\Theta\gamma K_2(\Theta^{-1})$
Mode	$\gamma\boldsymbol{\beta}$
Non-central moment (first order)	$\gamma\boldsymbol{\beta}\frac{K_3(\Theta^{-1})}{K_2(\Theta^{-1})}$
Non-central moment (second order)	$\gamma^2\boldsymbol{\beta}\boldsymbol{\beta}'\frac{K_4(\Theta^{-1})}{K_2(\Theta^{-1})} + \Theta\mathbf{I}\frac{K_3(\Theta^{-1})}{K_2(\Theta^{-1})}$

Table: Relativistic Gaussian distribution.

■ Relativistic Gaussian mixture model

We then proposed a relativistic Gaussian mixture model represented by the weighted sum of the relativistic Gaussian distributions, and developed an EM algorithm for estimating the parameters (mixing proportion, bulk velocity and temperature of each component distribution). In particular, the M-step of the EM algorithm we derived equations whose solution is guaranteed to maximize the conditional expectation of the log-likelihood of the complete data. To initialize the parameters for the EM algorithm, we divide data into groups whose number corresponds to that of the components, and in each group we use maximum-likelihood estimates or estimates by the method of moments.

■ Application

We apply a two-component R-MMM to a distribution function by a particle-in-cell (PIC) simulation of relativistic pair plasma, and separate the simulated distribution function into two components (Figure). We find that one component has a large bulk velocity while the other is almost stagnant, and that the two components have almost the same temperatures, which is also consistent to the initial temperature of the PIC simulation. Based on the parameters, we can infer large-scale plasma environments such shocks and discontinuities.

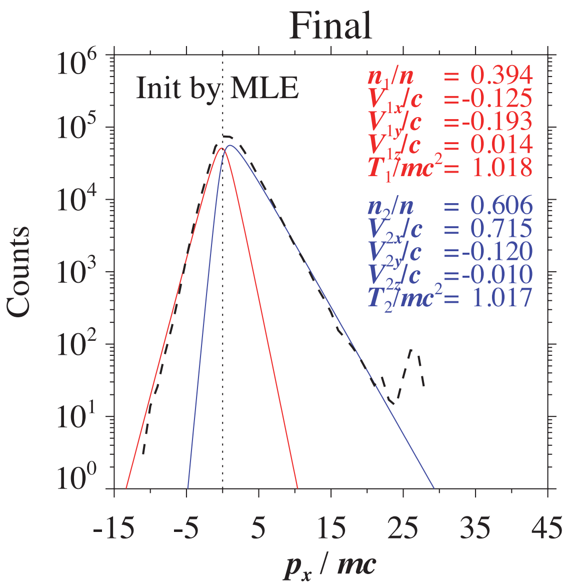


Figure: Application of a two-component relativistic Gaussian mixture model.

References: Genta Ueno and Seiji Zenitani, “Relativistic Maxwellian mixture model”, Physics of Plasmas 28, 122106 (2021) https://doi.org/10.1063/5.0059126

Genta Ueno

Introduction of the “Japanese National Character Study” Project

■ What is the Japanese National Character Survey?

The Social Survey Research Group of the Institute of Statistical Mathematics has conducted the Japanese National Character Survey (hereafter simply “National Character Survey”) once every five years since 1953, and its 14th nationwide survey was carried out in the fall of 2018. This survey has been conducted repeatedly using basically the same survey method and content, and regarded as a representative example of “repeated social surveys” in Japan. It has been widely used in research and education, as well as in the mass media, to describe changes in values and attitudes in Japanese people of the postwar period.

The objectives of the National Character Survey are (1) to clarify the views and attitudes of the Japanese people and their changes through the survey results, (2) to research new statistical survey methods that can respond to future social changes through conducting the real-life survey, and (3) to develop better statistical methods for analyzing the survey data.

■ Long-term changes in Japanese opinion — major trends

Here is a typical example that captures changes in attitudes over time. There are items that show a major trend in which “traditional views” favored by older generations have receded and newer views have gained support as time has passed (the # symbol below indicates the item number). For example, in the item “#4.10 Adopt a child” the proportion of respondents who answered “No” increased when asked whether it is necessary to adopt other people’s children to keep the family line when they have no children (Figure 1). This means that opinions about the traditional family system have been replaced by new opinions over the 65 years since the end of World War II.

■ Recent trends in Japanese opinion — stability and fluctuation

Some items have been considered relatively stable in their results throughout time. For example, the Japanese tendency to “prefer humanistic answers” has been considered relatively stable. However, in recent years, there seems to be a slight decline in this humanistic preference. “#5.6 Types of boss preferred” (Figure 2) asks respondents to choose between “a manager who makes unreasonable requests at work but also looks after you” (humane) and “a manager who does not make unreasonable requests at work but never does anything for you personally” (dry). In the latest 14th nationwide survey, support for the humane manager was 74%, the lowest ever, and support for the dry manager was 22%, the highest ever.

■ Future challenges

Because of its long history, the project itself has some problems that could be considered a kind of exhaustion. For example, the response rate has been declining in recent years, and some items have seen little change in results. If we change the content of survey items or survey methods, it will be difficult to distinguish whether the Japanese people’s opinions have really changed or whether they have changed only apparently due to changes in items or methods. The challenge for our group is how to refine the survey methodology and capture new trends in Japanese opinion within the limitations of a repeated survey.

Tadahiko Maeda

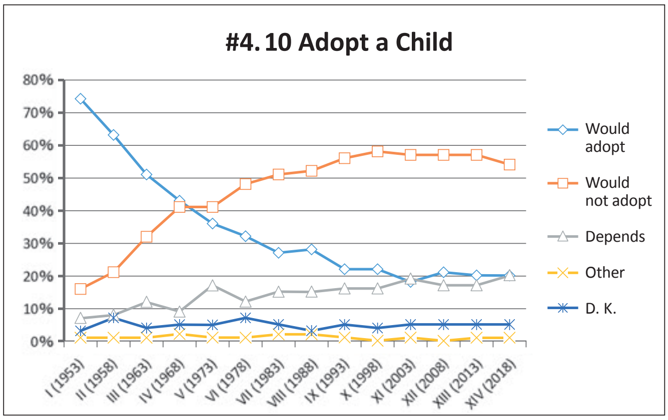


Figure 1: Increased opinion that the maintenance of the traditional family system (when there are no children, even someone else’s children should be adopted to keep the family line) is unnecessary.

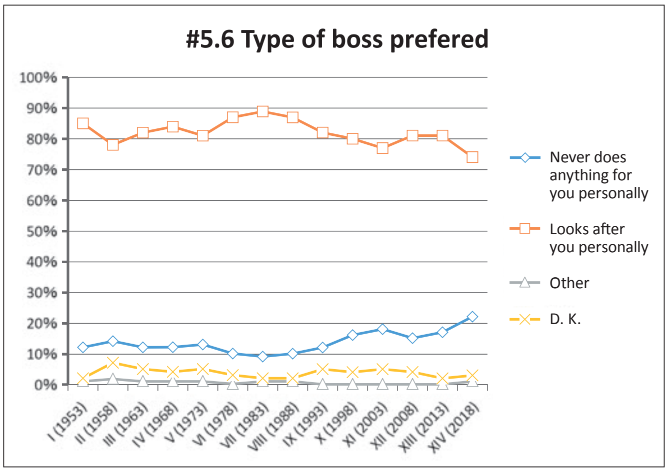


Figure 2: The dry boss is gaining some support recently, whereas the humane boss has long been preferred.

Building a Framework for Advancing Strategic Research and Pursuing a New Approach to Collaborative Research

■ Research and Educational Activities as a Biaxial Structure

The Institute of Statistical Mathematics (ISM) pursues research and education in the own biaxial structure; one is structured by three basic research departments and the other is by four NOE-type research centers and two organizations for professional development. By its nature, the basic research departments cut across and link various disciplines, with the goal of developing tools for interdisciplinary research. The field of statistical and mathematical sciences must itself evolve to meet the changing needs of society and the data environment, and is therefore constantly evolving as a field of study. At the same time, there are approaches and directions that have remained unchanged as the field evolves. There are three basic research departments: Statistical Modeling, Statistical Data Science, and Statistical Inference and Mathematics. Almost all tenured research staff at ISM are assigned in principle to one of these basic research departments. These departments engage in cutting edge research aimed at developing methodologies for rational prediction and decision making, based on data and existing knowledge. We regularly assess whether our research system is functioning effectively from the viewpoints of research trends and prospects in statistical and mathematical sciences.

On the other hand, NOE-type research centers and organizations for professional development (along the vertical axis) are staffed by permanent researchers within ISM, project professors/researchers (post-doctoral researchers), and visiting professors and researchers. There are four NOE-type research centers: the Risk Analysis Research Center, the Research Center for Statistical Machine Learning, the Data Science Center for Creative Design and Manufacturing, and the Research Center for Medical and Health Data Science. These centers conduct research activities at the interface of statistical and mathematical sciences and individual scientific disciplines to find solutions to urgent social problems. In addition, two organizations are committed to professional development. The School of Statistical Thinking, which was established in 2011, is the base for the Project for Fostering and Promoting Statistical Thinking and provides various programs. The Center for Training Professors in Statistics was established on January 1, 2022 to promote the Project for Training Experts in Statistical Sciences. This center also trains statistics professors and experts in statistical sciences, primarily through graduate school education. For more details, please see each project's webpage.

■ NOE Project

In accordance with the second mid-term plan of the Research Organization of Information and Systems

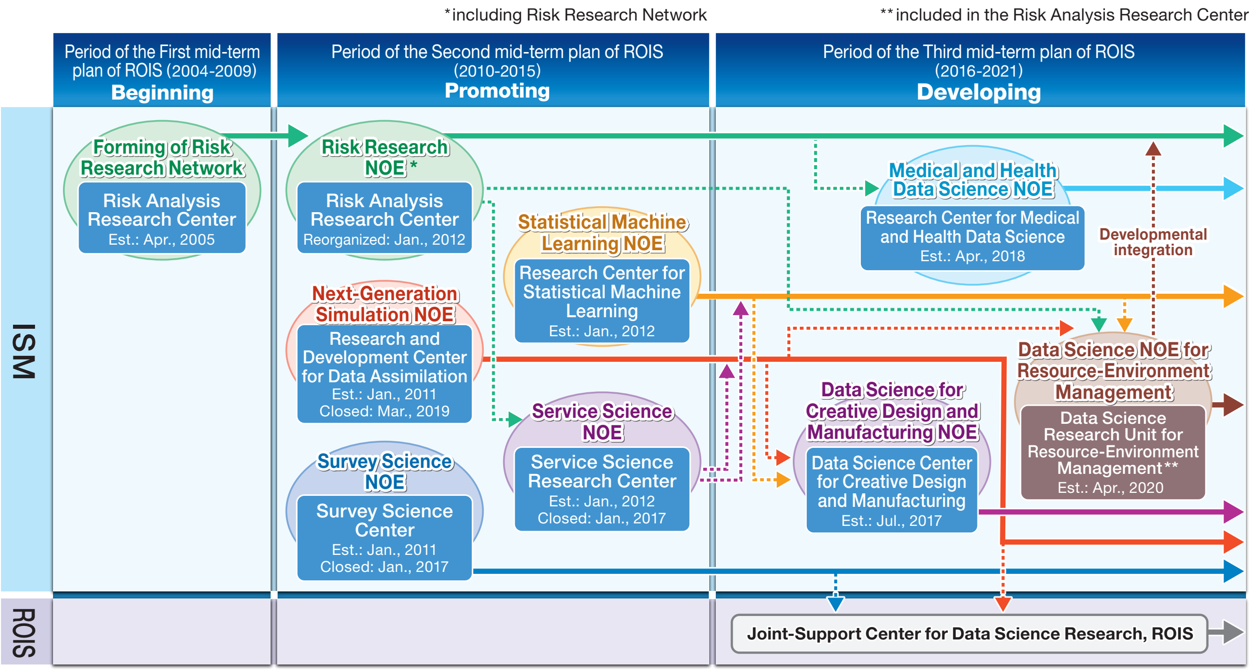


Fig. 1: Brief history of NOE Project (dotted lines mean history or transformation in each NOE).

(ROIS, ISM's parent organization), ISM had set as a goal the establishment of NOE in statistical mathematics. Initially, ISM established NOE in Risk Research, Next-Generation Simulation, Survey Science, Statistical Machine Learning, and Service Science. Over the next few years, however, ISM reorganized NOE domains or NOE-type research centers considering the needs of each community as well as modern society as a whole (Fig.1).

To fulfill the goal of establishing new scientific methodologies in a knowledge-based society, in which the importance of knowledge goes beyond merely solving individual problems, the NOE activity is being systematically pursued under the unified guidelines formulated by Managing Committee of the NOE Project. We also commission experts from the industrial, academic, and government sectors to be members of the Advisory Board of NOE Project, and their advice helps us to promote the project much more effectively.

After completing the reorganization, which began in FY 2016, the 3rd Advisory Board Meeting of NOE Project was held on December 17, 2019. All six members of the board attended the meeting. They represented each NOE domain and engaged in discussion with core members of the project at ISM. The meeting provided an opportunity to collect valuable opinions about our future plans. The Advisory Board was restructured in FY 2021, and it consists of experts in each NOE domain, including newly appointed members (Fig. 2).

Each year, the number of Memoranda of Understanding (MOUs) with research organizations within Japan and overseas, which are conducted by NOE-type research centers, is increasing. In particular, academic exchanges encompassing multiple NOE domains provide significant opportunities to integrate different research fields and create new ones. ISM provides flexibility for research and contributes to society. Consequently, ISM's general research in statistical and mathematical sciences is highly demanded by various research fields in both the humanities and sciences. Recent reorganizations at ISM have deepened and promoted the NOE Project.

In the fourth mid-term plan for six years of ROIS, which began in April 2022 (and continues until March 2028), ISM set the following goals: (1) to promote the development of cutting-edge mathematical techniques and industry-government-academia collaborations, (2) reorganize NOE-type research centers so that they are goal oriented and classified by both methodology type and domain type, and (3) enhance relations with other research organizations and increase NOE-type MOUs.

ISM is continuously expanding and developing this NOE project with the aim of establishing new scientific methodologies ("Fourth Paradigm: Data Science"), creating new research disciplines, and developing new styles of joint research. For up-to-date information, please visit the website. We truly appreciate your understanding and support for this project.

https://www.ism.ac.jp/noe/project/en/

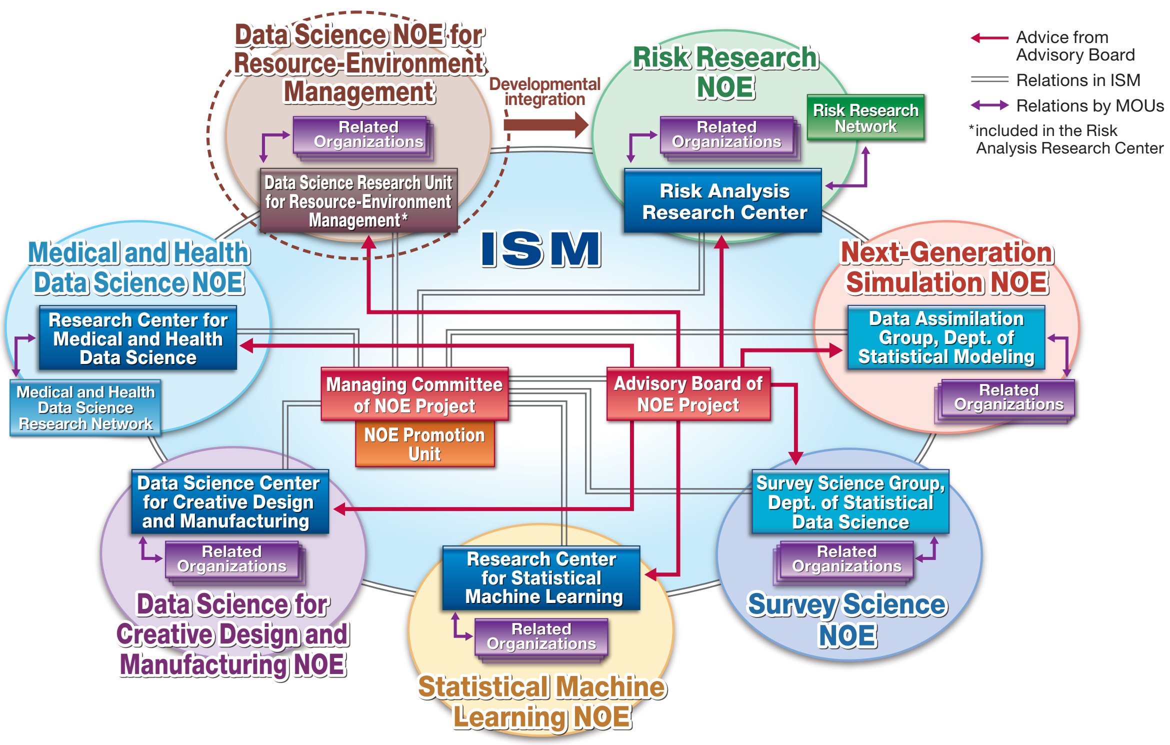


Fig. 2: Relationship diagram of NOE Project.

Project for Fostering and Promoting Statistical Thinking

Rapid development of information and communication technology has led to the explosion of data. Now surrounded by “Big Data”, everybody is expected to “think statistically”. More than ever, there is a need for data scientists who can handle such big data and are able to extract useful knowledge from it. Meanwhile, Japanese higher education is exhibiting a deplorable lack of production capacity in terms of data scientists. This can be accounted for by the fact that, until quite recently, no academic institution other than ISM had a Ph. D. course in statistics and the small number of statisticians in academia are isolated from each other, being scattered over various disciplines. Hoping to gain a little traction on this problem, ISM established the School of Statistical Thinking, into which we integrated all of our educational resources. In FY 2016, ISM established the Managing Committee of School of Statistical Thinking, inviting contributions from outside experts, and in FY 2017 we launched the Leading DAT program by adopting the suggestions by the committee. In FY 2020, we launched online courses. The following are the principal projects.

Research Collaboration Startup

The Institute had already been providing a consultation service for statistical science, but along with the launch of the School of Statistical Thinking in November 2011, this service was reorganized as a research collaboration startup. This program, being one of the projects to foster and promote statistical thinking, is mainly aimed at supporting applied scientists and other non-experts. Expert statisticians affiliated with the Institute give them advice on statistical modeling, data analysis, and research. Some cases have developed into official research collaborations, which are our primary duty as an inter-university research institute. The Institute accepts around 25 cases annually, some of which benefit society in diverse ways.

Data Science Research Plaza

Researchers funded by private-sector firms can maintain a desk and phone in the School of Statistical Thinking. This program is subject to fees, and the contract can be renewed annually. A faculty mentor gives advice to the accepted funded researcher so that he or she can freely attend various events, such as seminars, workshops, conferences, and extension courses. After learning the expertise of the ISM research staff, participants in this program are invited to take advantage of paid consultations and funded research collaboration.

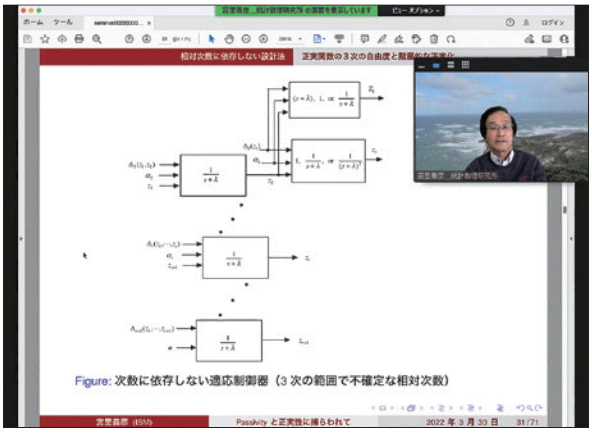
Open-type Professional Development Program

This is a spin-out program from ISM cooperative research projects. Establishing a goal is an indispensable element of the proposal of a cooperative research project. On the other hand, such goal setting is irrelevant for a summer school program, study session, or retreat. Since the launch of the School of Statistical Thinking, organizers of such group-oriented study programs can apply to the Open-type Professional Development Program. There are two categories under this program: one is ‘workshop’ and the other is ‘intensive training for young researchers’. For FY 2021, eight workshops have been accepted after review.

Statistical Mathematics Seminar Series

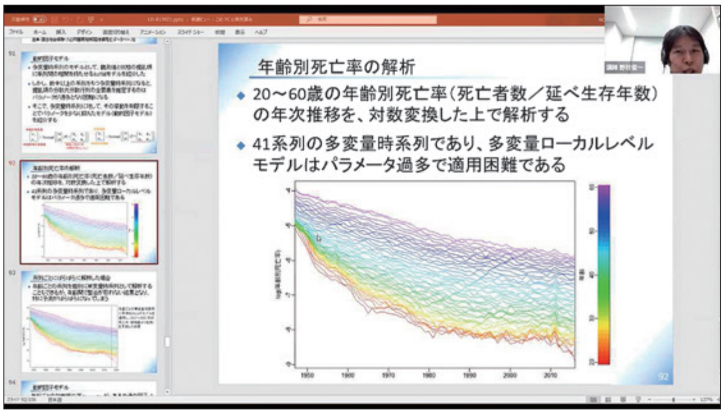
The Institute holds weekly seminar series on statistical mathematics every Wednesday. The seminars are led by in-house and external lecturers to showcase their latest studies. These lectures are currently held online due to COVID-19. To view the seminar schedule and learn more about the program, please visit the Institute of Statistical Mathematics website.

https://www.ism.ac.jp/index_e.html



Leading DAT

In FY 2017, the School of Statistical Thinking launched a program called "Leading DAT" aimed at training data scientists with the knowledge and skills in statistical mathematics required by modern society. In FY 2021, we held three Leading DAT lectures online, entitled "L-A. Introductory Data Science", "L-B1. An Introduction to Statistical Modeling" and "L-B2. Machine Learning and Modern Methodologies in Data Science". Around half of the attendants of L-B1 and L-B2 enroll the Leading DAT Training Course, in which we grant certificates to participants who have fulfilled the course requirements, including attendance in L-B1 and L-B2 lectures and submission of reports. A total of 21 people have been granted the certificate of completion.



Online lecture (L-B1)

Tutorial Courses

The education program at ISM dates back to 1944, the year of founding. The Ministry of Education installed a training center within ISM to foster technicians in numerical computation. After the World War II, this training center was relaunched in 1947 to develop pollsters and census takers. It helped to cultivate professionals in the field of statistical surveys, while a growing number of entries from business and industry coming for various types of training were also observed.

Now the tutorial courses are operated by the School of Statistical Thinking, which was established in 2011.

In FY 2021, 6 lectures and one course (including Leading DAT) were held and the number of participants was 664. The total numbers of lectures and courses held from 1969 to March, 2022 were 392 and 5 respectively, with a total of 28,884 participants. These lectures covered a wide range of fields from basic to applied statistics. The schedule of tutorial courses can be found on the website of the Institute of Statistical Mathematics.

https://www.ism.ac.jp/lectures/kouza.html

Research Cooperation

International Cooperation

Associated Foreign Research Institutes

Organization name	Address	Conclusion date
The Statistical Research Division of the U.S. Bureau of the Census	USA (Washington)	July 27, 1988
Stichting Mathematisch Centrum	The Kingdom of the Netherlands (Amsterdam)	May 10, 1989
Institute for Statistics and Econometrics, Humboldt University of Berlin	Germany (Berlin)	December 8, 2004
The Steklov Mathematical Institute	Russia (Moscow)	August 9, 2005
Central South University	China (Changsha)	November 18, 2005
Soongsil University	The Republic of Korea (Seoul)	April 27, 2006
University of Warwick	The United Kingdom (Coventry)	January 16, 2007
Indian Statistical Institute	India (Kolkata)	October 11, 2007
Institute of Statistical Science, Academia Sinica	Taiwan (Taipei)	June 19, 2008
Department of Empirical Inference, Max Planck Institute for Biological Cybernetics	Germany (Tubingen)	August 11, 2010
Department of Communication Systems, SINTEF Information and Communication Technology	Norway (Trondheim)	January 30, 2012
University College London	The United Kingdom (London)	February 16, 2012
Department of Electronics and Telecommunications, Norwegian University of Science and Technology	Norway (Trondheim)	May 22, 2012
Department of Probability and Mathematical Statistics, Charles University in Prague	Czech Republic (Prague)	October 10, 2012
Department of Ecoinformatics, Biometrics and Forest Growth of the Georg-August University of Goettingen	Germany (Goettingen)	October 18, 2012
Korean Statistical Society (KSS)	The Republic of Korea (Seoul)	July 9, 2013
Toyota Technological Institute at Chicago	USA (Chicago)	February 10, 2014
Australian National University	Australia (Canberra)	May 15, 2014
RiskLab ETH Zurich	Switzerland (Zurich)	February 7, 2015
Institut de Recherche en Composants logiciel et matériel pour l'Information et la Communication Avancee	France (Paris)	February 9, 2015
Centre de Rechereche en Informatique, Signal et Automatique de Lille	France (Paris)	February 12, 2015
University College London Big Data Institute	The United Kingdom (London)	February 26, 2015
The Institute of Forestry, Pokhara of Tribhuvan University	Nepal (Pokhara)	March 6, 2015
The Institute of Forest and Wildlife Research and Development of the Forestry Administration of Cambodia	Cambodia (Phnom Penh)	March 6, 2015
The Chancellor masters and Scholars of the University of Oxford	The United Kingdom (Oxford)	March 10, 2015
Forest Inventory and Planning Institute of Vietnam	Vietnam (Hanoi)	June 2, 2015
Zuse Institute Berlin	Germany (Berlin)	June 20, 2016
The University of Porto	Portugal (Porto)	June 22, 2016
National University of Laos	Laos (Vientiane)	March 15, 2017
Institute of Geophysics China Earthquake Administration	China (Beijing)	April 28, 2017
Hong Kong Baptist University	Hong Kong (Kowloon Tong)	August 28, 2017
University of Malaya	Malaysia (Kuala Lumpur)	September 18, 2017
Unversidade de Évola	Portugal (Evola)	November 30, 2017
Universität Ulm	Germany (Ulm)	December 8, 2017
The Korean Association for Survey Research	The Republic of Korea (Seoul)	February 14, 2018
The Jean Golding Institute for data-intensive research, University of Bristol	The United Kingdom (Bristol)	January 15, 2019
Survey Research Center, Sungkyunkwan University	The Republic of Korea (Seoul)	February 25, 2019
University of Lampung	Indonesia (Lampung)	March 6, 2019
Department of Earth and Space Sciences, Southern University of Science and Technology	China (Shenzhen Shi)	March 25, 2019
Université Bretagne Sud	France (Lorient)	March 29, 2019
North Carolina State University	USA (Raleigh)	November 13, 2019
National University of Singapore Konrad-Zuse-Zentrum für Informationstechnik Berlin	Singapore Germany (Berlin)	February 25, 2020

Associated Foreign Research Institutes

Organization name	Address	Conclusion date
Singapore-ETH Centre	Singapore	March 18, 2020
Department of Actuarial Studies and Business Analytics, Macquarie University	Australia (Sydney)	December 21, 2020
EURECOM	France (Sophia Antipolis)	August 25, 2021
The University of Texas at Dallas,School of Economic, Political and Policy Sciences	USA (Dallas)	March 11, 2022

* There are two more agreements concluded.

Research Collaboration

ISM performs many activities for collaborating with researchers in the various fields of statistical science, from the individual level to the national level. The ISM cooperative research program regularly performs research activities to provide the research resources of ISM to researchers at universities or research institutes in order to advance their academic research. Available research resources include books, journals, supercomputers, some commercial statistical software packages, as well as statistical packages developed by ISM, and also the researchers in ISM themselves, who have abundant professional knowledge and experience in statistical science and data analysis. The ISM cooperative research program provides not only research support funds but also opportunities for the various researchers in many fields who require statistical knowledge to make use of the resources available at ISM. ISM's aim is to be a place for interaction and fusion among researchers inside and outside of ISM, and to contribute to multidisciplinary development of both the theory and the application of statistical science.

Number of Activities

Year	2016	2017	2018	2019	2020	2021
Number of Activities	187	161	166	178	145	143

Fields of Research Collaboration

Research collaboration is classified by research field as follows. Applicants can use the table below to find the most appropriate type of project.

ISM Fields

Number	Fields
a	Prediction and Control Group
b	Complex System Modeling Group
c	Data Assimilation Group
d	Survey Science Group
e	Metric Science Group
f	Structure Exploration Group
g	Mathematical Statistics Group
h	Learning and Inference Group
i	Mathematical Optimization Group
j	Others

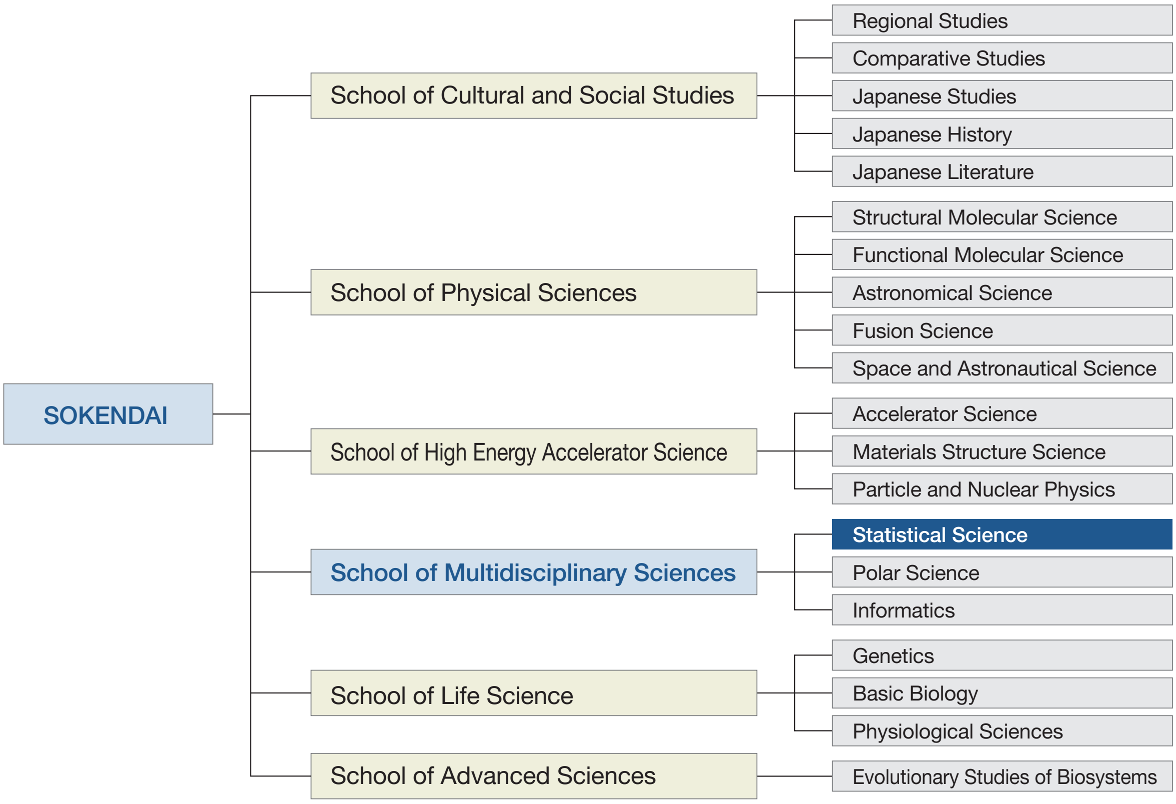
Major Research Fields

Number	Fields	Major Research Domains
1	Statistical mathematics	Mathematical theory of statistics, optimization, etc.
2	Information science	Algorithms, use of computer in statistics, etc.
3	Biological science	Medicine, pharmacy, epidemiology, genetics, etc.
4	Physical science	Space, planet, earth, polar region, materials, etc.
5	Engineering	Mechanics, electronics, control, chemistry, architecture, etc.
6	Human science	Philosophy, art, psychology, education, history, geography, culture, language, etc.
7	Social science	Economics, law, politics, society, management, official statistics, population, etc.
8	Environmental science	Environmental statistics, environmentrics, agricultural statistics, statistical meteorology, land economics, landscape management, forest management, etc.
9	Others	Other research fields

Graduate School Program

Organization

The Institute of Statistical Mathematics is one of the platforms of SOKENDAI (The Graduate University for Advanced Studies; the headquarters in Hayama, Kanagawa), which was opened in October 1988 to offer graduate education. Since its opening, the Institute has included the Department of Statistical Science and, since April 1989, has accepted students for education and research in doctoral programs. In 2006, the Institute adopted a five-year system, offering either a five-year education and research program, or a three-year education and research program starting from the third year of study.



Outline of Education and Research

The Department of Statistical Science, which is based on the Institute of Statistical Mathematics (ISM) serving as its underlying platform, aims to cultivate individuals who possess creative research skills to contribute to solving various important intricately-intertwined problems. To this end, the Department conducts education and research related to the basis, mathematics and applications of data collection designs, modeling, inference and prediction, and equip students with the ability to extract information and knowledge from the real world based on the effective use of data.

Field of Education and Research	Contents
Statistical Modeling	We provide education and research focused on dynamic modeling such as spatial and space-time modeling, graphical modeling of temporally and/or spatially inter-related complex phenomena, and intelligent information processing. We also provide education and research on statistical inference based on various models, methods of calculation for inference, and evaluation of models based on data.
Statistical Data Science	We provide education and research on data design, investigation and analytical methods to cope with the uncertainty and incompleteness of information, as well as on computational statistics.
Statistical Inference and Mathematics	We provide education and research on the theory of statistics and related basic mathematics, statistical learning theory to extract information from data by automated learning and inference techniques; as well as theory and applications of optimization and computation algorithms which serve as the basis for computational inference.

Features of Education and Research

- The Department of Statistical Science is one of the few comprehensive doctoral programs in statistical science in Japan, and has accepted students from a wide range of academic fields. Education and research in all aspects of statistical science is conducted by faculty members specializing in a variety of fields, from theory to application.
- The Institute of Statistical Mathematics, the platform for the course, is equipped with a world-class super computer, high-speed 3D graphic computers and simulators to generate physical random numbers, as well as a variety of software, including original statistical software developed by the Institute.
- The Institute of Statistical Mathematics has an extensive library covering a wide variety of journals and books on statistical and mathematical sciences.
- The Institute of Statistical Mathematics, as a joint research institute, frequently holds research meetings and seminars presented by visiting professors and researchers from Japan and abroad. Students are encouraged to participate in these seminars and interact with the presenters.
- Students have the opportunity to participate in different research projects through collaborations with other universities and research institutes.

Course Requirements and Type of Degree Granted

- Requirements to complete the doctoral course are as follows:
  Completion of at least 40 credits, including the required ones, by a student in the five-year program, or completion of at least 10 credits by a three-year doctorate student who previously completed a Master's course; meeting all the criteria set by the thesis committee of the Institute; and successfully completing the examination.
- On completion of the course, either a Doctorate in Statistical Science or, if the thesis deals mainly with an inter-disciplinary field related to statistical science, a Doctorate of Philosophy is awarded.
- The required number of years of study will be flexible if a student demonstrates outstanding research results.

Number of Students (As of April 1, 2022)

■ 5-year doctoral course:Quota,2

Year of enrollment	2018	2019	2021	2022
Number of students	1	1	1	1

■ 3-year doctoral course:Quota,3

Year of enrollment	2016	2017	2018	2019	2020	2021	2022
Number of students	1 ①	1 ①	5 ⑤	9 ⑦	6 ③	5 ③	2 ②

* The figures in circles indicate those who are employed by other organizations.

University Background of Students

National and public universities

• Hokkaido University (5) • Tohoku University (5) • Fukushima University (1) • University of Tsukuba (7) • Saitama University (1) • Chiba University (1) • Ochanomizu University (1) • National Graduate Institute for Policy Studies (1) • Tokyo Medical and Dental University (1) • Tokyo University of Marine Science and Technology (1) • Tokyo Gakugei University (2) • Tokyo Institute of Technology (6) • The University of Tokyo (24) • Tokyo Metropolitan University (1) • Tokyo University of Agriculture and Technology (1) • Hitotsubashi University (6) • Shizuoka University (1) • Kanazawa University (1) • Japan Advanced Institute of Science and Technology (1) • Nagoya University (4) • Toyohashi University of Technology (2) • Kyoto University (8) • Osaka City University (1) • Osaka University (3) • Nara Institute of Science and Technology (1) • Okayama University (2) • Shimane University (3) • Kyushu University (4) • Oita University (1) • The University of Electro-Communications (1)

University Background of Students

Private universities

• Aoyama Gakuin University (1) • Kitasato University (1) • Keio University (8) • International Christian University (1) • Shibaura Institute of Technology (1) • Sophia University (1) • Chuo University (9) • Tokyo University of Science (7) • Toyo University (1) • Japan Women's University (1) • Nihon University (2) • Hosei University (7) • Waseda University (9) • Nanzan University (1) • Osaka Electro-Communication University (1) • Kansai University (1) • Kyoto Sangyo University (1) • Ritsumeikan University (1) • Okayama University of Science (1) • Kurume University (1)

Foreign universities

• Aston University (1) • University of California, Irvine (1) • California State University, Long Beach (1) • University of Campinas (1) • University of Colorado Boulder (2) • University of Dhaka (2) • University of Hawaii (1) • Jahangirnagar University (2) • University of Malaya (1) • Northeast Normal University (1) • Ohio University (2) • University of Rajshahi (2) • Stanford University (1) • The University of Nottingham (1) • Zhejiang University (1) • Institute of Applied Mathematics, AMSS, CAS (1) • University of Science and Technology of China (1) • Center for Analysis and Prediction, China Seismological Bureau (1) • Northeastern University (1) • The Hong Kong University of Science and Technology (1) • China University of Geosciences (1)

Degrees Awarded

Year	2015	2016	2017	2018	2019	2020	2021
Doctor of Philosophy	5	7	5	5	5	4	7

Alumni

National and public universities, and public organizations

• Obihiro University of Agriculture and Veterinary Medicine • University of Tsukuba • University of Hyogo • The University of Tokyo • The University of Electro-Communications • Saitama University • Nagoya University • Kyushu University • Kyushu Institute of Technology • University of the Ryukyus • The Institute of Statistical Mathematics • Tohoku University • Yokohama National University • Hokkaido University • Tokyo Institute of Technology • Hiroshima University • Oita University of Nursing and Health Sciences • JAXA's Engineering Digital Innovation Center • Kyoto University • Nara Institute of Science and Technology • Bank of Japan • Japan Broadcasting Corporation • Railway Technical Research Institute • Statistical Information Institute for Consulting and Analysis • Government Pension Investment Fund • Public School • RIKEN • Statistics Bureau of Japan • Pharmaceuticals and Medical Devices Agency (PMDA)

Private universities

• Sapporo Gakuin University • Tokyo Health Care University • Meiji University • Doshisha University • Josai University • Nihon University • Komazawa University • Aichi University of Technology • Tokyo University of Information Sciences • Shibaura Institute of Technology • Rikkyo University • Waseda University • Keio University • Tokyo Medical University

Foreign universities

• Jahangirnagar University • Victoria University • Massey University • University of Otaga • Statistics New Zealand • University of Rajshahi • University of California, Los Angeles • Asia-Pacific Center for Security Studies Department • Central South University • Hong Kong Baptist University • University of South Carolina • The University of Warwick

Private companies, etc.

• Hitachi, Ltd. Central Research Laboratory • NTT Communication Science Laboratories • Seiwa Kikaku • NLI Research Institute • Mizuho Trust and Banking • Nomura Securities Co., Ltd. • ATR Computational Neuroscience Laboratories • Toyota Motor Corporation, Higashi-Fuji Technical Center • Schlumberger Limited • Macquarie Securities, Japan • Non-Life Insurance Rating Organization of Japan • Barclays Global Investors • Open Technologies Corporation • Yamaha Corporation • Goldman Sachs Asset Management L.P. • CLC bio Japan, Inc. • MUFG Bank, Ltd. • Pfizer Japan Inc. • Doctoral Institute for Evidence Based Policy • Sony Corporation • NTTIT Corporation • Sompo Japan Insurance Inc. • Qualicaps Co.,Ltd. • Bridgestone Corporation • Brain Pad Inc. • Sumitomo Chemical Co.,Ltd. • PricewaterhouseCoopers Aarata • Mitsubishi Tanabe Pharma Corporation • Daiichi Sankyo Co.,Ltd. • Shizuoka Cancer Center • CPC Clinical Trial Hospital, Medipolis Medical Research Institute • CRD Association • Japan Society for the Promotion of Science • Tokyo Electric Power Company Holdings, Inc. • Asahi Kasei Corporation • Honda R&D Co.,Ltd. • Yokogawa Electric Corporation • Kao Corporation • Advanced Smart Mobility Co., Ltd. • NEC Corporation • Janssen Pharmaceutical K.K. • Taisho Pharmaceutical Holdings • Otsuka Pharmaceutical Co., Ltd. • Kyowa Kirin Co., Ltd. • KOSÉ Corporation • Novartispharma K.K.

Facilities and Equipment

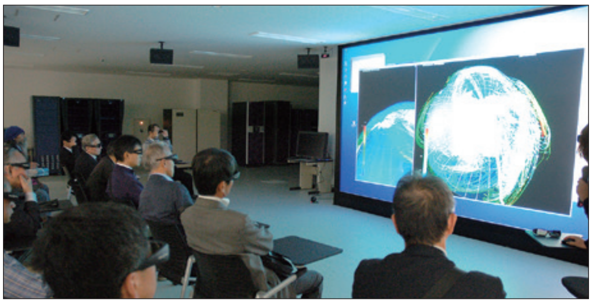
Computational Resources (As of April 1, 2022)

ISM is operating a supercomputer system, the Supercomputer System for Statistical Science, which is suitable for analyzing large-scale datasets. The Supercomputer System for Statistical Science, an HPE SGI 8600 system, has been operated since October 2018. The system is a distributed-memory parallel computer that has total theoretical peak performance of 1.49 PFLOPS. The system is liquid cooled and consists of 384 computing nodes. Each node has two CPU chips (Intel Xeon GOLD 6154) with 18 cores and has 384 GB memory. The system includes hardware random number generator. For visual representation of research results, ISM has a 200-inch wide screen and a projector capable of showing 3D movies in 4K resolution in the historical computers exhibit room.

In March 2021, we introduced the Communal Cloud Computing System to provide a computing environment that is easy for each user to use and customize. This system is equipped with 64 computing nodes (HPE ProLiant DL385 Gen 10 Plus; total theoretical computing performance of 154.0 TFLOPS), and each node has two 32-core CPUs (AMD EPYC 7452), 1 TB of main memory, and an SSD with 20 TB of usable capacity.

In the main office building, the primary local area network (LAN) consists of an Ethernet network using 10GBase-SR for the main trunk and 1000Base-T for branches. The personal computers in researchers' offices and the supercomputer system are all connected to this network. A wireless LAN system is also available in the immediate area of the building occupied by ISM. These LAN systems enable distributed processing and allow computing resources and statistical data to be used effectively. Comprehensive network security methods have been implemented, such as a firewall system, anti-virus software, and an intrusion prevention system. To encourage joint research with researchers both in Japan and abroad, as well as the exchange of e-mails, the network is connected to the Internet through SINET6 (100Gbps).

Supercomputer System for Statistical Science (HPE SGI 8600)



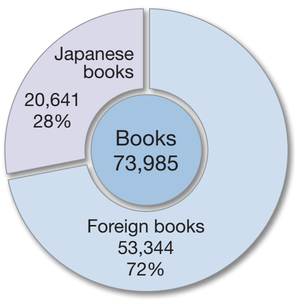
200-inch wide screen showing 3D movies in 4K resolution

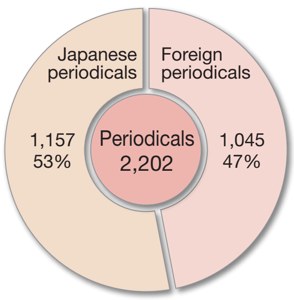
Library and Materials (As of April 1, 2022)

We have a large number of major Japanese/foreign journals covering a wide variety of fields including statistics, mathematics, computer science and informatics. In addition, we also have a large library consisting of books on humanities, social science, biology, medical science, science and engineering.

Besides contributed to Japanese and foreign publications, we also have a collection of journals that we publish ourselves: Annals of the Institute of Statistical Mathematics (English; Springer), Proceedings of the Institute of Statistical Mathematics (Japanese), ISM Survey Research Report (Statistical Researches mainly related to the Japanese National Character), Computer Science Monographs, Cooperative Research Reports (for collaborative research projects), Research Memorandum, ISM Reports on Statistical Computing, and ISM Report on Research and Education.

All materials are properly catalogued and can be searched from the web in order to meet the needs of researchers working in a wide of fields. We also accept photocopy requests.





Finance and Buildings

Administration Subsidy and Others (2021)

Type	Personnel expenses	Non-personnel expenses	Total
Expenditure	675,641	975,623	1,651,264

Unit: 1,000JPY

Accepted External Funds (2021)

Type	Items	Income
Joint research	19	29,898
Joint research division	2	21,700
Subcontracted research, Trustee business	24	509,860
Contract researchers	1	284
Academic consulting	5	4,789
Contribution for scholarship	3	1,580
Total	54	568,111

Unit: 1,000JPY

Grants-in-Aid for Scientific Research "KAKENHI" (2021)

Research Category	Items	Amount Granted
Grant-in-Aid for Scientific Research on Innovative Areas	3	24,050
Grant-in-Aid for Transformative Research Areas (A)	—	—
Grant-in-Aid for Transformative Research Areas (B)	1	9,880
Grant-in-Aid for Scientific Research (S)	—	—
Grant-in-Aid for Scientific Research (A)	5	39,780
Grant-in-Aid for Scientific Research (B)	7	25,870
Grant-in-Aid for Scientific Research (C)	17	17,810
Grant-in-Aid for Challenging Research (Exploratory)	2	2,860
Grant-in-Aid for Challenging Research (Pioneering)	1	9,100
Grant-in-Aid for Early-Career Scientists	14	17,550
Grant-in-Aid for Forming an Independent Foundation	1	1,820
Grant-in-Aid for Research Activity Start-up	—	—
Grant-in-Aid for JSPS Fellows	1	780
Total	52	149,500

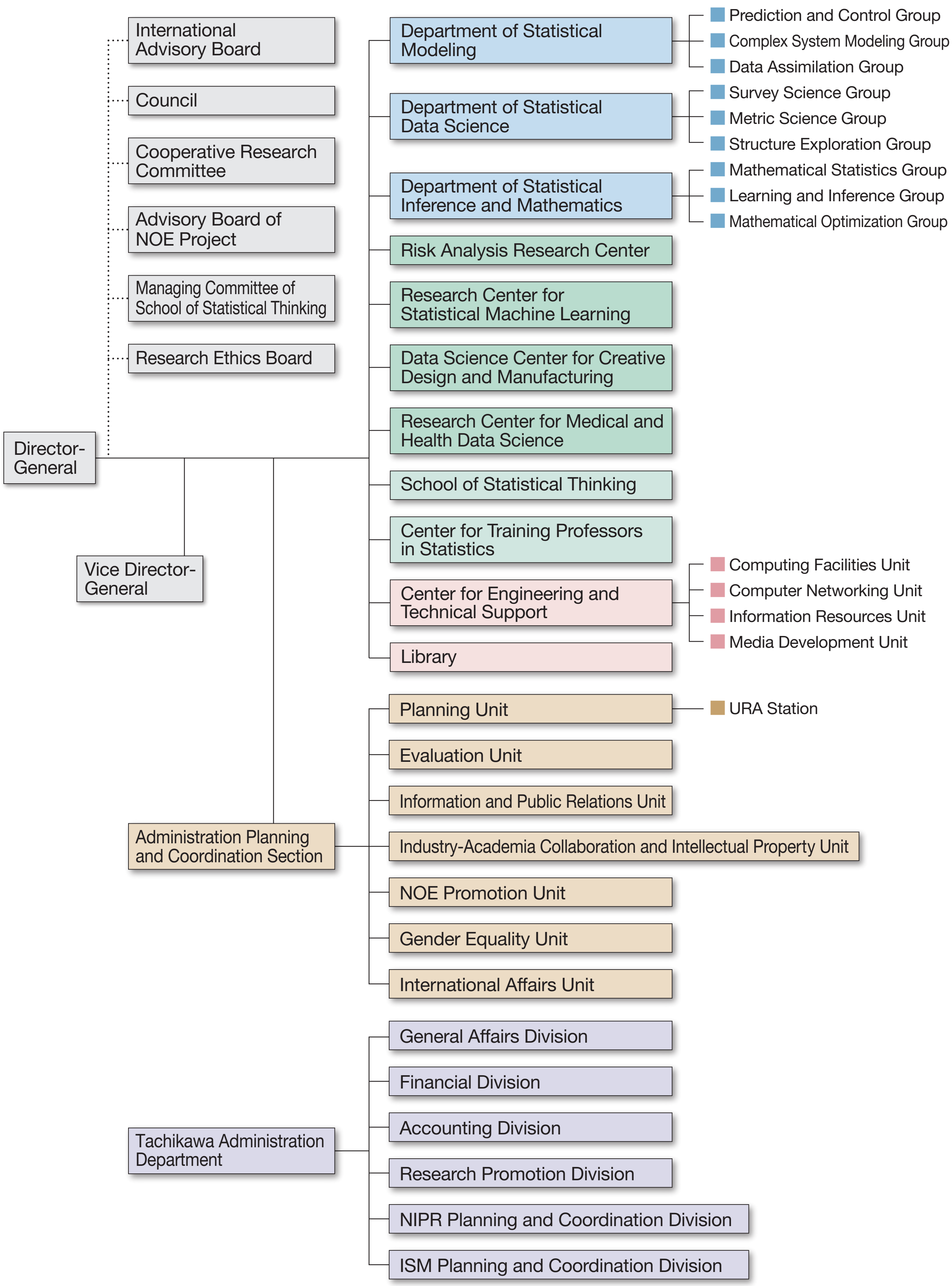
Unit: 1,000JPY

Site and Buildings (As of April 1, 2022)

Site Area	62,450m^2
Area for Buildings (total)	16,209m^2

Organization

Organization Diagram (As of April 1, 2022)



Number of Staff (As of April 1, 2022)

Type	Director-General	Professor	Associate Professor	Assistant Professor	Administrative Staff	Technical Staff	Total
Director-General	1						1
Department of Statistical Modeling		5	6				11
Department of Statistical Data Science		5	6	3			14
Department of Statistical Inference and Mathematics		7	8				15
School of Statistical Thinking				5			5
Center for Engineering and Technical Support						10	10
Administration Planning and Coordination Section					1		1
Tachikawa Administration Department					(37)		(37)
Total	1	17	20	8	1(37)	10	57(37)

( ) Total number of staff of Tachikawa Administration Department.

The number under Technical Staff at the Center for Engineering and Technical Support include two staff members who retired because of age and are reemployed in a different position.

Staff (As of August 1, 2022)

Director-General	Hiroe TSUBAKI	Vice Director-General	Yoshinori KAWASAKI	Vice Director-General	Satoshi YAMASHITA

Department of Statistical Modeling

Director Tomoko MATSUI

Prediction and Control Group

Prof.	Yoshinori KAWASAKI	Prof.	Atsushi YOSHIMOTO	Assoc. Prof.	Fumikazu MIWAKEICHI
Assoc. Prof.	Jiancang ZHUANG	Assoc. Prof.	Yumi TAKIZAWA		

Complex System Modeling Group

Prof.	Tomoko MATSUI	Prof.	Yukito IBA	Prof.	Hideitsu HINO
Assoc. Prof.	Shinsuke KOYAMA	Assoc. Prof.	Kengo KAMATANI		

Data Assimilation Group

Prof.	Genta UENO	Project. Prof.	Shigeru FUJITA	Assoc. Prof.	Shinya NAKANO
Project Researcher	Yusaku OHKUBO	Visiting Prof.	Masako KAMIYAMA	Visiting Prof.	Toshikazu KITANO
Visiting Prof.	Tadahiko SATO	Visiting Prof.	Kazuyuki NAKAMURA	Visiting Prof.	Tomoyuki HIGUCHI
Visiting Assoc. Prof.	Hiroshi KATO	Visiting Assoc. Prof.	Masaya SAITO	Visiting Assoc. Prof.	Hiromichi NAGAO
Visiting Assoc. Prof.	Shunichi NOMURA	Visiting Assoc. Prof.	Yosuke FUJII	Visiting Assoc. Prof.	Takashi YAMAMOTO

Department of Statistical Data Science

Director Kazuhiro MINAMI

Survey Science Group

Prof.	Kazuhiro MINAMI	Assoc. Prof.	Tadahiko MAEDA	Assoc. Prof.	Yoo Sung PARK
Project Assoc. Prof.	Naoko KATO	Project Assist. Prof.	Kiyohisa SHIBAI	Project Assist. Prof.	Le Duc ANH
Visiting Prof.	Takatoshi IMADA	Visiting Prof.	Toru KIKKAWA	Visiting Prof.	Yoshimichi SATO
Visiting Prof.	Wataru MATSUMOTO	Visiting Prof.	Kazufumi MANABE	Visiting Assoc. Prof.	Yusuke INAGAKI
Visiting Assoc. Prof.	Koken OZAKI	Visiting Assoc. Prof.	Taisuke FUJITA		

Metric Science Group

Prof.	Satoshi YAMASHITA	Prof.	Koji KANEFUJI	Prof.	Shigeyuki MATSUI
Assoc. Prof.	Ikuko FUNATOGAWA	Assoc. Prof.	Hisashi NOMA	Assist. Prof.	Nobuo SHIMIZU

Staff

Department of Statistical Data Science / Metric Science Group

Project Researcher	Hiroka HAMADA	Project Researcher	Yasuhiro TANAKA		

Structure Exploration Group

Prof.	Ryo YOSHIDA	Assoc. Prof.	Jun ADACHI	Assoc. Prof.	Kenichiro SHIMATANI
Assoc. Prof.	Stephen WU	Assist. Prof.	Daisuke MURAKAMI	Assist. Prof.	Yoshihiro HAYASHI

Department of Statistical Inference and Mathematics

Director Satoshi ITO

Mathematical Statistics Group

Prof.	Satoshi KURIKI	Prof.	Yoshiyuki NINOMIYA	Prof.	Shuhei MANO
Assoc. Prof.	Shogo KATO	Assoc. Prof.	Takaaki SHIMURA	Assoc. Prof.	Keisuke YANO
Visiting Prof.	Akimichi TAKEMURA				

Learning and Inference Group

Prof.	Kenji FUKUMIZU	Prof.	Hironori FUJISAWA	Assoc. Prof.	Daichi MOCHIHASHI
Assoc. Prof.	Masayuki HENMI	Assoc. Prof.	Ayaka SAKATA		

Mathematical Optimization Group

Prof.	Satoshi ITO	Prof.	Shiro IKEDA	Assoc. Prof.	Mirai TANAKA
Assoc. Prof.	Bruno FIGUEIRA LOURENÇO				

Risk Analysis Research Center

Director Satoshi YAMASHITA　Vice Director Shogo KATO

Prof.	Satoshi YAMASHITA	Prof.	Satoshi KURIKI	Prof.	Koji KANEFUJI
Prof.	Tomoko MATSUI	Prof.	Atsushi YOSHIMOTO	Prof.	Yoshinori KAWASAKI
Prof.	Yoshiyuki NINOMIYA	Prof.	Kazuhiro MINAMI	Prof.	Shuhei MANO
Assoc. Prof.	Kengo KAMATANI	Assoc. Prof.	Keisuke YANO	Assoc. Prof.	Masayuki HENMI
Assoc. Prof.	Jiancang ZHUANG	Assoc. Prof.	Kenichiro SHIMATANI	Assoc. Prof.	Shogo KATO
Assoc. Prof.	Yumi TAKIZAWA	Assoc. Prof.	Takaaki SHIMURA	Assoc. Prof.	Stephen WU
Assoc. Prof.	Ikuko FUNATOGAWA	Project Assoc. Prof.	Masayuki KUMON	Project Assoc. Prof.	Yuuki RIKIMARU
Project Assoc. Prof.	Takao KUMAZAWA	Assist. Prof.	Daisuke MURAKAMI	Project Assist. Prof.	Xiong ZIYAO
Project Assist. Prof.	Tran Duc VU	Project Assist. Prof.	Shingo OBATA	Project Assist. Prof.	Tadashi NAKANISHI
Project Researcher	Atsushi FUKAZAWA	Project Researcher	Yosihiko OGATA	Project Researcher	Petrillo GIUSEPPE
Visiting Prof.	Masakazu ANDO	Visiting Prof.	Shinsuke ITO	Visiting Prof.	Masao UEKI
Visiting Prof.	Tadashi ONO	Visiting Prof.	Takashi KAMEYA	Visiting Prof.	Aitaro KATO
Visiting Prof.	Naoki SAKAI	Visiting Prof.	Yo SHEENA	Visiting Prof.	Yasutaka SHIMIZU
Visiting Prof.	Kiyomi SHIRAKAWA	Visiting Prof.	Kazuyuki SUZUKI	Visiting Prof.	Rinya TAKAHASHI
Visiting Prof.	Isao TAKABE	Visiting Prof.	Satoshi TAKIZAWA	Visiting Prof.	Hideatsu TSUKAHARA
Visiting Prof.	Hiroshi TSUDA	Visiting Prof.	Tetsuji TONDA	Visiting Prof.	Shunji HASHIMOTO
Visiting Prof.	Hisayuki HARA	Visiting Prof.	Masaaki FUKASAWA	Visiting Prof.	Satoshi FUJII
Visiting Prof.	Toshihiro HORIGUCHI	Visiting Prof.	Toshio HONDA	Visiting Prof.	Hiroshi MATSUZOE
Visiting Prof.	Mihoko MINAMI	Visiting Prof.	Sadaaki MIYAMOTO	Visiting Prof.	Hitoshi MOTOYAMA
Visiting Prof.	Hirokazu YANAGIHARA	Visiting Prof.	Yoshiki YAMAGATA	Visiting Prof.	Nakahiro YOSHIDA
Visiting Prof.	Yasushi YOSHIDA	Visiting Prof.	Takaaki YOSHINO	Visiting Prof.	Toshinao YOSHIBA
Visiting Prof.	Tetsuya IWASA	Visiting Prof.	Katsutoshi NAGASHIMA	Visiting Prof.	Hiroaki NAGAFUJI
Visiting Assoc. Prof.	Takaki IWATA	Visiting Assoc. Prof.	Bogdan Dumitru ENESCU	Visiting Assoc. Prof.	Yukihiko OKADA
Visiting Assoc. Prof.	Teppei OGIHARA	Visiting Assoc. Prof.	Kenichi KAMO	Visiting Assoc. Prof.	Takafumi KUBOTA
Visiting Assoc. Prof.	Yuta KOIKE	Visiting Assoc. Prof.	Masashi KONOSHIMA	Visiting Assoc. Prof.	Noriyoshi SAKUMA
Visiting Assoc. Prof.	Seisho SATO	Visiting Assoc. Prof.	Junichi TAKAHASHI	Visiting Assoc. Prof.	Dou XIAOLING
Visiting Assoc. Prof.	Koyomi NAKAZAWA	Visiting Assoc. Prof	Kazuyoshi NANJO	Visiting Assoc. Prof.	Shunichi NOMURA
Visiting Assoc. Prof.	Keisuke FUKUI				

Research Center for Statistical Machine Learning

Director Kenji FUKUMIZU　Vice Director Tomoko MATSUI

Prof.	Kenji FUKUMIZU	Prof.	Tomoko MATSUI	Prof.	Yukito IBA
Prof.	Satoshi ITO	Prof.	Shiro IKEDA	Prof.	Satoshi KURIKI
Prof.	Shuhei MANO	Prof.	Hironori FUJISAWA	Prof.	Kazuhiro MINAMI
Prof.	Hideitsu HINO	Assoc. Prof.	Daichi MOCHIHASHI	Assoc. Prof.	Shinsuke KOYAMA
Assoc. Prof.	Ayaka SAKATA	Assoc. Prof.	Mirai TANAKA	Assist. Prof.	Daisuke MURAKAMI
Assist. Prof.	Kohei HATTORI	Assist. Prof.	Masato SHIRASAKI	Project Assist. Prof.	Yoichi MOTOTAKE
Project Assist. Prof.	Toshimitsu ARITAKE	Project Assist. Prof.	Kotaro SAKAMOTO	Project Assist. Prof.	Hideto NAKASHIMA
Project Researcher	Zheng NING	Visiting. Prof.	Masataka GOTO	Visiting. Prof.	Arthur GRETTON
Visiting Prof.	Konstantin MARKOV	Visiting Assoc. Prof.	Masaaki IMAIZUMI	Visiting Assoc. Prof.	Shuichi KAWANO
Visiting Assoc. Prof.	Kei KOBAYASHI	Visiting Assoc. Prof.	Sayaka SHIOTA	Visiting Assoc. Prof.	Tsutomu TAKEUCHI
Visiting Assoc. Prof.	Makoto YAMADA	Visiting Assoc. Prof.	Eiji MOTOHASHI	Visiting Assoc. Prof.	João Pedro Pedroso

Data Science Center for Creative Design and Manufacturing

Director Ryo YOSHIDA　Vice Director Hironori FUJISAWA

Prof.	Ryo YOSHIDA	Prof.	Hironori FUJISAWA	Prof.	Kenji FUKUMIZU
Prof.	Hideitsu HINO	Assoc. Prof.	Shinya NAKANO	Assoc. Prof.	Stephen WU
Assist. Prof.	Yoshihiro HAYASHI	Project Assist. Prof.	Liu CHANG	Project Assist. Prof.	Yuta AOKI
Project Researcher	Aiko TAKAHASHI	Project Researcher	Yoh NOGUCHI	Project Researcher	Hironao YAMADA
Project Researcher	Minoru KUSABA	Visiting. Prof.	Junichiro SHIOMI	Visiting. Prof.	Junko MORIKAWA
Visiting Assoc. Prof.	Masaaki TAKADA				

Research Center for Medical and Health Data Science

Director Shigeyuki MATSUI　Vice Director Hisashi NOMA

Prof.	Satoshi YAMASHITA	Prof.	Shigeyuki MATSUI	Project Prof.	Shinto EGUCHI
Assoc. Prof.	Hisashi NOMA	Assoc. Prof.	Masayuki HENMI	Assoc. Prof.	Fumikazu MIWAKEICHI
Project Assoc. Prof.	Mayumi OKA	Visiting. Prof.	Manabu AKAZAWA	Visiting Prof.	Yoichi M. ITO
Visiting. Prof.	Senichiro KIKUCHI	Visiting. Prof.	Ken KIYONO	Visiting. Prof.	Atsushi GOTO
Visiting Prof.	Tosiya SATO	Visiting. Prof.	Kunihiko TAKAHASHI	Visiting. Prof.	Masataka TAGURI
Visiting Prof.	Hisateru TACHIMORI	Visiting Prof.	Satoshi TERAMUKAI	Visiting Prof.	Nobuaki NISHIYAMA
Visiting. Prof.	Satoshi HATTORI	Visiting Prof.	Michiko WATANABE	Visiting Assoc. Prof.	Chieko ISHIGURO
Visiting Assoc. Prof.	Takeshi EMURA	Visiting Assoc. Prof.	Ryoichi KIMURA	Visiting Assoc. Prof.	Yasunori SATO
Visiting Assoc. Prof.	Kazushi MARUO	Visiting Assoc. Prof.	Shonosuke SUGASAWA	Visiting Assoc. Prof.	Kengo NAGASHIMA

School of Statistical Thinking

Director Satoshi KURIKI　Vice Director Yukito IBA

Prof.	Yoshinori KAWASAKI	Prof.	Yukito IBA	Prof.	Satoshi KURIKI
Prof.	Hironori FUJISAWA	Prof.	Kazuhiro MINAMI	Prof.	Yoshiyuki NINOMIYA
Prof.	Hideitsu HINO	Prof.	Shiro IKEDA	Project Prof.	Hiroko NAKANISHI
Assoc. Prof.	Kenichiro SHIMATANI	Assoc. Prof.	Masayuki HENMI	Assoc. Prof.	Keisuke YANO
Assoc. Prof.	Ayaka SAKATA	Assist. Prof.	Akifumi OKUNO	Assist. Prof.	Kohei HATTORI
Assist. Prof.	Masato SHIRASAKI	Assist. Prof.	Kei NOBA	Assist. Prof.	Ryota YUASA
Project Assist. Prof.	Kazuhei KIKUCHI	Project Researcher	Yusaku OHKUBO	Visiting Prof.	Masayuki YOKOYAMA
Visiting Assoc. Prof.	Osamu KOMORI	Visiting Assoc. Prof.	Kei TAKAHASHI		

Center for Training Professors in Statistics

Director Masato CHINO

Prof.	Yoshinori KAWASAKI	Prof.	Satoshi YAMASHITA	Project Prof.	Masato CHINO

Staff

Center for Training Professors in Statistics

Project Prof.	Hiroko NAKANISHI	Project Prof.	Kazuo MUROTA	Project Prof.	Manabu IWASAKI
Project Prof.	Yasunori SAWAMURA	Project Prof.	Naoto KUNITOMO	Project Prof.	Hideki ORIGASA
Project Prof.	Naoki KAMIYA	Project Prof.	Masakazu JIMBO	Project Prof.	Masahiro MIZUTA
Project Prof.	Kunio TANABE	Project Assoc. Prof.	Masayoshi TAKAYANAGI	Assist. Prof.	Ryota YUASA

Center for Engineering and Technical Support

Director Genta UENO Vice Director Kazuhiro MINAMI

Deputy Manager Kazuhiro NAKAMURA

Unit Leader of Computing Facilities Unit	Mitsuru HAYASAKA	Unit Leader of Computer Networking Unit	Kazuhiro NAKAMURA
Unit Leader of Information Resources Unit	Noriaki MIYAZONO	Unit Leader of Media Development Unit	Akiko NAGASHIMA

Library

Head Genta UENO

Administration Planning and Coordination Section

Chief Director Hiroe TSUBAKI

Director of Planning Unit	Yoshinori KAWASAKI	Director of Evaluation Unit	Yoshinori KAWASAKI
Vice Director of Evaluation Unit	Yoshihiko MIYASATO	Director of Information and Public Relations Unit	Satoshi YAMASHITA
Vice Director of Information and Public Relations Unit	Yoshihiko MIYASATO	Director of Intellectual Property Unit	Satoshi YAMASHITA
Director of NOE Promotion Unit	Satoshi YAMASHITA	Director of Gender Equality Unit	Yoshinori KAWASAKI
		Director of International Affairs Unit	Hiroe TSUBAKI

URA Station

Kozo KITAMURA	Motoi OKAMOTO	Keisuke HONDA

Tachikawa Administration Department

General Manager Hikaru SASAGAWA

General Affairs Division

Manager Mitsuo HAMADA Deputy Manager Hisayuki IGARASHI

Deputy Manager

Specialist	Yoshihiro YAMADA	Head, General Affairs Team	Ayako NARITA
Head, Personnel Team	Akiharu MIYAGI	Head, Labor Management Team	Keiko SHIMIZU
Head, Graduate School Team			

Financial Division

Manager Takashi BAN Deputy Manager Hiroaki ARAI

Head, General Affairs and Audit Team	Hiroaki ARAI	Head, Budget and Account Settlement Team (NIPR)	Takeshi KUWAHARA
Head, Budget and Account Settlement Team (ISM)	Akiko MAEKAWA	Head, Assets Management and Acceptance Team	Taku SASAKI

Accounting Division

Manager Koji SAKAMOTO Deputy Manager

Specialist	Hiroshi TAKAGI	Specialist	Junichi NAKATA
Specialist	Kana KATO	Head, Accounting Team	Hitoshi HIRAYAMA
Head, Contract Team (NIPR)	Yumiko OKAWA	Head, Contract Team (ISM)	Yuji HIRONAKA
Head, Facilities Team	Takuya SAITO		

Staff

Tachikawa Administration Department

Research Promotion Division

Manager	Masakazu ICHIKAWA	Deputy Manager	Hiromi OBAMA
Head, Research Promotion Team	Yusuke KASAKAWA	Head, Cooperative Research Team	Isao SAKUMA

NIPR Planning and Coordination Division

Manager	Tsuyoshi ABE	Deputy Manager	Hiroyasu KUMAGAI
Head, NIPR Planning and Coordination Team			

ISM Planning and Coordination Division

Manager	Mitsuo HAMADA	Deputy Manager	Hisayuki IGARASHI
Head, ISM Planning and Coordination Team	Ayako NARITA		

International Advisory Board (As of April 1, 2022)

Song Xi CHEN	University Chair Professor, Peking University
Arthur GRETTON	Professor, University College London
Juan Carlos JIMÉNEZ-SOBRINO	Professor, Departamento de Matemática Interdisciplinaria, Instituto de Cibernética, Matemática y Física
Jibum KIM	Professor, Sungkyunkwan University
Gareth W. PETERS	Chair Professor of Actuarial Science, Chair Professor of Statistics for Risk and Insurance, Department of Statistics and Applied Probability, University of California Santa Barbara
Evgeny SPODAREV	Professor, Ulm University

Council of The Institute of Statistical Mathematics (As of April 1, 2022)

Keiko TAKAHASHI	Senior Researcher (Professor), Global Consolidated Research Institute for Science Wisdom, Comprehensive Research Organization, Waseda University
Hiroshi MARUYAMA	PFN Fellow, Preferred Networks, Inc.
Satoru IGUCHI	Professor, National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Fumiyasu KOMAKI	Professor, Graduate School of Information Science and Technology, The University of Tokyo
You SHIINA	Professor, Dean of Faculty of Data Science, Shiga University
Hiroshi SAIGO	Professor, Faculty of Political Science and Economics, Waseda University
Yasuhiro OMORI	Professor, Faculty of Economics, University of Tokyo
Kikuo MAEKAWA	Professor, Spoken Language Division, Director, Center for Corpus Development National Institute for Japanese Language and Linguistics
Hideki ASOH	Adjunct Researcher, Artificial Intelligence Research Center, Department of Information Technology and Human Factors, National Institute of Advanced Industrial Science and Technology
Mihoko MINAMI	Professor, Department of Mathematics, Faculty of Science and Technology, Keio University
Yoshinori KAWASAKI	Professor (Vice Director-General, ISM)
Satoshi YAMASHITA	Professor (Vice Director-General, ISM)
Tomoko MATSUI	Professor (Director of Department of Statistical Modeling, ISM)
Kazuhiro MINAMI	Professor (Director of Department of Statistical Data Science, ISM)
Satoshi ITO	Professor (Director of Department of Mathematical Analysis and Statistical Inference, ISM)
Genta UENO	Professor (Director of Center for Engineering and Technical Support, ISM)
Satoshi KURIKI	Professor (Director of School of Statistical Thinking, ISM)
Kenji FUKUMIZU	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)
Hironori FUJISAWA	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)

Cooperative Research Committee (As of April 1, 2022)

Toshikazu KITANO	Professor, Department of Architecture, Civil Engineering and Industrial Management Engineering, Nagoya Institute of Technology
Shido SAI	Professor, Department of Economics, Faculty of Economics, Okayama Shoka University
Takashi SEO	Professor, Department of Applied Mathematics, Faculty of Science Division I, Tokyo University of Science

Cooperative Research Committee

Nagatomo NAKAMURA	Professor, Faculty of Economics and Business Administration, Sapporo Gakuin University
Hiroki MASUDA	Professor, Department of Mathematical Sciences, Faculty of Mathematics, Kyushu University
Tomoko MATSUI	Professor (Director of Department of Statistical Modeling, ISM)
Kenichiro SHIMATANI	Associate Professor (Department of Statistical Data Science, ISM)
Masayuki HENMI	Associate Professor (Department of Statistical Inference and Mathematics, ISM)
Hiroko NAKANISHI	Project Professor (Center for Training Professors in Statistics, ISM)

Advisory Board of NOE Project (As of April 1, 2022)

Satoshi ITOH	Chief Coordinator, Foundation for Computational Science
Naonori UEDA	Deputy Director, RIKEN Center for Advanced Intelligence Project (AIP)
Yasushi OKADA	President, The Japan Pharmaceutical Manufacturers Association
Masafumi KAMACHI	Director, Ocean Eyes Co., Ltd.
Yoshimichi SATO	Dean and Professor, Department of Humanities, Kyoto University of Advanced Science
Yutaka SOEJIMA	Director-General, Institute for Monetary and Economic Studies, Bank of Japan
Yoshiki YAMAGATA	Professor, Graduate School of System Design and Management, Keio University

Managing Committee of School of Statistical Thinking (As of April 1, 2022)

Ken KUROKAWA	Vice Director/Professor, National Institute of Genetics
Manabu KOBAYASHI	Professor, Center for Data Science, Waseda University
Yoshiyuki TAKEUCHI	Associate Professor, Graduate School of Economics, Osaka University
Yoshihiko NISHINO	Director, Advanced Analytics & AI Innovation Division, SAS Institute Japan, Ltd.
Jinfang WANG	Professor/Dean, School of Data Science, Yokohama City University
Satoshi KURIKI	Director (School of Statistical Thinking, ISM)
Yukito IBA	Vice Director (School of Statistical Thinking, ISM)
Yoshinori KAWASAKI	Professor (Vice Director-General, ISM)
Hiroko NAKANISHI	Project Professor (Center for Training Professors in Statistics, ISM)

Research Ethics Board (As of April 1, 2022)

Specialist on epidemiology and social research	Masayuki KANAI	Professor, School of Human Sciences, Senshu University
Specialist on epidemiology and social research	Keiko SATO	Associate Professor, Department of Health Informatics Graduate School of Medicine & School of Public Health, Kyoto University
Specialist in the field of ethics and law	Hitomi NAKAYAMA	Lawyer, Kasumigaseki-Sogo Law Offices
Specialist in the field of ethics and law	Hiroe TSUBAKI	Director-General, The Institute of Statistical Mathematics
Person in citizen's position	Yutaka KURIKI	Director, Social welfare corporation Kunitachi nursery school
Research education staff of ISM	Tadahiko MAEDA	Associate Professor (Department of Data Science, ISM)
Research education staff of ISM	Yoo Sung PARK	Associate Professor (Department of Data Science, ISM)
Research education staff of ISM	Hisashi NOMA	Associate Professor (Department of Data Science, ISM)

Professor Emeritus (As of April 1, 2022)

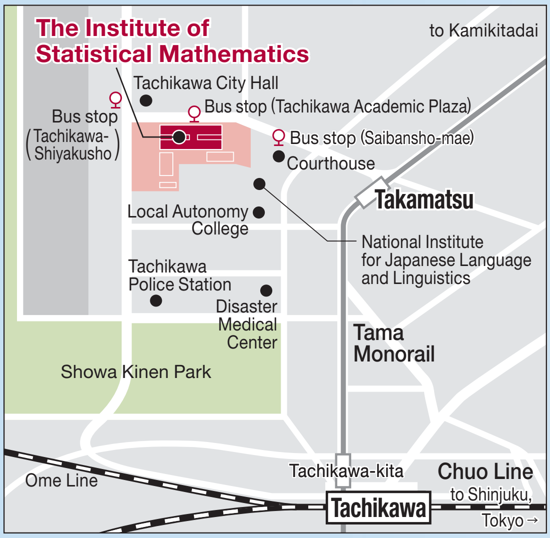
Sigeki NISIHIRA	Tatsuzo SUZUKI	Giitiro SUZUKI	Ryoichi SHIMIZU
Noboru OHSUMI	Masakatsu MURAKAMI	Kunio TANABE	Tadashi MATSUNAWA
Masami HASEGAWA	Yoshiyuki SAKAMOTO	Takemi YANAGIMOTO	Yoshiaki ITOH
Yasumasa BABA	Katsuomi HIRANO	Masaharu TANEMURA	Makio ISHIGURO
Yosihiko OGATA	Hiroe TSUBAKI	Genshiro KITAGAWA	Nobuhisa KASHIWAGI
Takashi NAKAMURA	Yoshiyasu TAMURA	Tomoyuki HIGUCHI	Junji NAKANO
Ryozo YOSHINO	Shinto EGUCHI	Yoshihiko MIYASATO	

History

1944	June	Based on a proposal submitted at an academic study conference in December 1943, the organization was founded as an institute under the direct control of the Ministry of Education. This proposal aimed to provide supervision for studies looking into the mathematical principles of probability and their application, and was also intended to facilitate, unify and promote the publication of research results.
1947	April	The affiliated statistical specialists' school was opened.
	May	The Institute was divided into the 1st Research Dept. (fundamental theories), the 2nd Research Dept. (statistical theories for the natural sciences), and the 3rd Research Dept. (statistical theories for the social sciences).
1949	June	The Institute was placed under the control of the Ministry of Education because of the enforcement of the Ministry of Education Establishment Law.
1955	September	Reorganized into the 1st Research Dept. (fundamental theories), the 2nd Research Dept. (natural and social science theories), and the 3rd Research Dept. (operations research, statistical analysis theories). The laboratory system, comprising 9 laboratories and the research guidance promotion room, was adopted.
1969	October	A new office building was constructed in Minato Ward.
1971	April	The 4th Research Dept. (informatics theories) was instituted.
1973	April	The 5th Research Dept. (prediction and control theories) was instituted.
1975	October	The 6th Research Dept. (statistical theories of human behavior) was instituted.
1979	November	The Information Research Building was constructed.
1985	April	Repositioned as a National Inter-University Research Institute due to the regulation change. The new mission includes providing facilities and skills to other universities, in addition to conducting cutting-edge research on statistical mathematics. Accordingly, the institute was reorganized into four basic research departments (Fundamental Statistical Theory, Statistical Methodology, Prediction & Control, and Interdisciplinary Statistics) and two strategic centers (Statistical Data Analysis Center and Statistical Education & Information Center). The Statistical Technical Training Center was terminated.
1988	October	The Dept. of Statistical Science was instituted in the School of Mathematical and Physical Science, part of the Graduate University for Advanced Studies (SOKENDAI).
1989	June	The Institute was reorganized as an Inter-University Research Institute based on the National School Establishment Law.
1993	April	The Planning Coordination Chief System was instituted.
1997	April	The affiliated Statistical Data Analysis Center was reorganized into the Center for Development of Statistical Computing, and the Statistical Education and Information Center was reorganized into the Center for Information on Statistical Sciences.
2003	September	The Prediction and Knowledge Discovery Research Center was instituted.
2004	April	The Institute was reorganized into the Institute of Statistical Mathematics, part of the Research Organization of Information and Systems of the Inter-University Research Institute based on the National University Corporation Law. The Planning Coordination Chief System was abolished and the position of Vice Director-General was instituted instead. The Dept. of Statistical Science in the School of Mathematical and Physical Science, SOKENDAI, was reorganized. In addition, the Dept. of Statistical Science and the School of Multidisciplinary Sciences were instituted.
2005	April	The research organization was reorganized into three research departments (the Department of Statistical Modeling, the Department of Data Science, and the Department of Mathematical Analysis and Statistical Inference). The affiliated Center for Development of Statistical Computing, the Center for Information on Statistical Sciences, and the Engineering and Technical Services Section were integrated into the Center for Engineering and Technical Support. The Risk Analysis Research Center was instituted.
2006	April	The Administration Planning Coordination Unit was instituted.
2008	April	The Research Innovation Center was instituted. The Administration Planning and Coordination Unit was reorganized into the Administration Planning and Coordination Section (hereafter APCS), within which the Intellectual Property Unit, the Evaluation Unit and the Information and Public Relations Unit were instituted.
2009	January	The Planning Unit was instituted within APCS.
	October	The Institute was moved to 10-3 Midori-cho, Tachikawa, Tokyo.

2010	June	Officially opened the Akaike Guest House.
	July	Reorganized the Administration Office to create the NIPR/ISM Joint Administration Office and launch the General Service Center. The NOE Forwarding Unit (now we call “NOE Promotion Unit”) was instituted within APCS.
2011	January	Research and Development Center for Data Assimilation was instituted. Survey Science Center was instituted.
2012	January	Research Center for Statistical Machine Learning, Service Science Research Center and School of Statistical Thinking were instituted.
2014	July	The URA Station was instituted within the Planning Unit.
	December	The Office of Female Researcher Development was instituted within the Planning Unit.
2017	January	Survey Science Center and Service Science Research Center were closed.
	July	Data Science Center for Creative Design and Manufacturing was instituted.
	December	The International Affairs Unit were instituted, and the Gender Equality Unit, which had been within the Planning Unit, reorganized within APCS. The Intellectual Property Unit was reorganized as the Industry-Academia Collaboration and Intellectual Property Unit within APCS.
2018	April	Research Center for Medical and Health Data Science was instituted. The NIPR/ISM Joint Administration Office was reorganized as the Tachikawa Administration Department of the Research Organization of Information and Systems (ROIS).
2019	March	Research and Development Center for Data Assimilation was closed.
2021	April	ISM Planning and Coordination Division was instituted within Tachikawa Administration Department.
2022	January	Center for Training Professors in Statistics was instituted.

The Institute of Statistical Mathematics



Access to the ISM

◎ Tachikawa Bus
— Tachikawa Academic Plaza bus stop
— 5 min walk from Saibansho-mae or Tachikawa-Shiyakusho bus stop

◎ Tama Monorail
—10 min walk from Takamatsu Sta.

◎ JR Chuo Line
—25 min walk from Tachikawa Sta.

Research Organization of Information and Systems
The Institute of Statistical Mathematics
10-3 Midori-cho, Tachikawa, Tokyo 190-8562, Japan
Tel: +81-(0)50-5533-8500　Fax: +81-(0)42-527-9302
https://www.ism.ac.jp/