Research Organization of Information and Systems

The Institute of Statistical Mathematics

2017-2018

ISM

CONTENTS

Message from Director-General

The information criterion known as Akaike Information Criterion (AIC) — proposed by the late Dr. Hirotugu Akaike, the 8th Director-General of The Institute of Statistical Mathematics, for the purpose of comparing statistical models — not only had a major impact on the field of statistics itself but also succeeded in establishing a certain style of research, aspiring to achieve intellectual gains through perpetual improvement of models, within a wide range of research disciplines. The 1974 paper, published in IEEE Australia Council (IEEE-AC), that introduced the philosophy of AIC provided a clear demonstration of its efficacy to the entire community, and to this day, over 40 years after its publication, the number of citations of this paper continues to grow each year. This shows that the full magnitude of achievements in statistical mathematics research can only be assessed with the benefit of many years (about 20 to 30 years) of hindsight, and that the influence of those achievements remains relevant long into the future. Indeed, citations to the paper in Web of Science (WoS) and Scopus, the two primary databases for journal papers, peaked in 2015. Perhaps this is because one typical way to use AIC is in selecting (explanatory) variables, and this has begun to be replaced by the modern techniques of sparse modeling and deep learning. Indeed, today, nearly half a century after the birth of AIC, I have a feeling that a new era has come to statistical mathematics.

It is at this turning point that I assume my final term as Director-General (a two-year term spanning FY2017 and FY2018). During my final term, I hope to strengthen three areas in particular: our research capabilities, our professional development facilities, and our collaboration with society. With operating support funds steadily shrinking year by year, and with increasing priority placed on developing and expanding the Corporation's headquarters operations, it has become difficult to establish independent employment plans for our Institute itself. However, the imperatives of bringing together outstanding personnel to lead the research community, while simultaneously producing a steady stream of personnel capable of shouldering the challenges of the future, remains the most critical mission of us, as an Inter-University Research Institute. Thus, we will proceed with aggressive personnel recruiting; moreover, by reforming our core research organizations, we will establish a new organizational structure that abounds in the diversity and flexibility required to meet the needs of future generations. Indeed, the reform trajectory on which we have embarked has already had noticeable consequences: this fiscal year, we have employed five young assistant professors, and the share of full-time instructional positions occupied by women has grown from 4% to 18%, a significant improvement, during my tenure as Director-General.

Improving our professional development facilities is among the highest priority obligations that we owe to society at large. Within this fiscal year, the six national universities will each establish a center to promote education throughout the university basing the particular center related to mathematics and data science. In Japan, for many years it was the case that, aside from our Institute, no organization existed for the systematic study of statistics and other data sciences; we are extremely gratified that centers will be established to advance this important area of professional development. Whereas the six university centers address training at all levels, from intern-level trainees to independent practitioners, our Institute will develop professionals with the much advanced skills needed to lead their own project teams. As part of this initiative, at the end of the previous fiscal year, we signed the contract with the Center for Advanced Intelligence Project (AIP), RIKEN including offering rapid-study courses and developing educational materials for machine learning. In the area of industrial cooperation, we have continued to devote energy to several initiatives; including improving the Research Collaboration Start-up as a single unified consultation portal and setting up the Data Science Research Plaza, at which employed researchers belonging to private industrial companies can sit down to learn or conduct research. We hope to develop our cooperation with private sectors in ways that remain clearly visible to the outside world, including offering courses linking institutions at the organizational level and calling for relatively large-scale collaborative research projects with the private sector.

It was in April 2011, just after the Great East Japan Earthquake, that the Director-General's baton was passed on to me from former Director-General Dr. Genshiro Kitagawa. In a time of great societal chaos and unrest, the fact that I, despite my inexperience, managed somehow to withstand the pressure of great expectations and respond to the needs of this position is due entirely to the advice and guidance that I received from my wise mentors, the strong support of the entire staff, and the assistance of the broader research communities. Going forward, I am committed to making the Institute an even better place, and one that makes even more valuable contributions to society, and I look forward to receiving your advice and guidance in this process.

Tomoyuki Higuchi
Director-General
The Institute of Statistical Mathematics

Basic Research

Department of Statistical Modeling

The Department of Statistical Modeling works on the structural modeling of physical phenomenon related to numerous factors, and it conducts research on model-based statistical inference methodologies. By means of the modeling of spatially and/or temporally varying phenomena, complex systems, and latent structures, the department aims to contribute to the development of cross-field modeling intelligence.

■ Spatial and Time Series Modeling Group

The Spatial and Time Series Modeling Group works on the development and evaluation of statistical models, which function effectively in terms of predicting phenomena or scientific discoveries, through data analysis and modeling related to space-time-varying phenomena.

■ Complex System Modeling Group

The Complex System Modeling Group conducts studies in order to discover the structures of complex systems, such as nonlinear systems and hierarchical networks, through statistical modeling.

■ Latent Structure Modeling Group

The Latent Structure Modeling Group works on the modeling of variable factors as latent structures existing behind various dynamic phenomena in the real world. It also conducts research on methodologies for inference computation associated with structures on the basis of data related to phenomena.

Department of Data Science

The aim of the Department of Data Science is to contribute to the development of natural and social sciences by conducting research into the methodology of designing statistical data collection systems, measuring and analyzing complex phenomena for evidence-based sciences, and performing exploratory multivariate data analyses.

■ Survey Science Group

The Survey Science Group focuses on research toward designing statistical data collection systems and developing the related data analysis methods in a variety of survey and experimental environments.

■ Metric Science Group

The Metric Science Group studies methods for measuring and analyzing complex phenomena to extract statistical evidence behind them in the various fields of science.

■ Structure Exploration Group

The Structure Exploration Group advances statistical and mathematical research by applying or developing exploratory multivariate data analyses to clarify latent structures of real phenomena in various fields of both natural and social sciences.

Department of Mathematical Analysis and Statistical Inference

The Department of Mathematical Analysis and Statistical Inference 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.

■ Computational Inference Group

The Computational Inference Group studies mathematical methodologies in the research fields of numerical analysis, optimization, discrete mathematics, and control and systems theory for computation-based statistical inference, as well as their applications.

NOE-type Research

Risk Analysis Research Center

The Risk Analysis Research Center is pursuing a scientific approach to 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, medical-health science, database development and risk mathematics. The Center also manages a network organization for risk analysis with the goal of contributing to creating a safe and resilient society.

Research and Development Center for Data Assimilation

Research and Development Center for Data Assimilation aims to construct simulation models that can predict the future and to design effective observation systems by means of “data assimilation”, which is a fundamental technology integrating numerical simulations and observational data.

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 motivate advanced technologies in the field of data science, and foster scientific methodologies for creative design and manufacturing. Population reduction and globalization are bringing dramatic change in the industrial structure, resulting in a rapid lost of our global predominance in the manufacturing industry. Furthermore, countries around the world has actively launched new data science programs for the next generation design and manufacturing. Following the global trend is no longer an effective way to survive in the intensive power game around the world. We have to develop innovative thinking, for which data science can provide the essential tools. We have accumulated state-of-the-art data science technologies here, for instance, machine learning, optimization theory, Bayesian inference, materials informatics, etc. We are devoted to foster innovative methods for design and manufacturing through industry-academia collaboration. This is the mission of this center.

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.

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 manage extension courses.

Computing Facilities Unit

The Computing Facilities Unit is in charge of managing computer facilities, scientific software, networking 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 education courses open to the public.

Media Development Unit

The Media Development Unit is in charge of publishing and editing of research results and PR brochures.

How to Predict Future Population of Wild Animals?

Fundamental problem

The importance of conservation of engaged species is currently widely recognized. By the way, how can we answer to the following question?

For bird species A, an adult female lays one egg every year. It takes 3 years until a nestling grows to an adult with 60% yearly mortality. The mortality of adults decreases to 5%. Is this species growing or declining?

For species B, an adult female lays 3 eggs. It needs 5 years until a nestling becomes an adult with 25% mortality. The adult mortality increases to 75%. Compared with species A, is species B growing more rapidly or declining?

In order to increase the population, which is more effective, increase the survival of nestlings or that of adults?

Transition matrix model

It is not easy to imagine the future of these populations. The Markov transition matrix model greatly helps us solve these issues.

First, we illustratively draw a life history of the species (Fig. 1).

Second, based on the survival rates, we produce the matrix shown in the right in Fig. 2. Third, from the information on eggs, we produce the matrices shown in the left in Fig. 2.

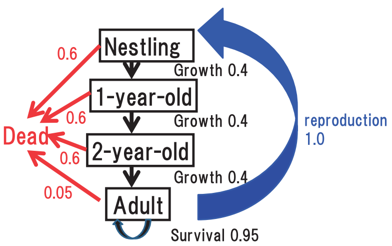


Figure 1: The illustrative formulation of life history.

(a)

Reproduction (Nestling, 1-year, 2-year, Adult) × Survival/Growth (Nestling, 1-year, 2-year, Adult)

$$\begin{array}{l} \text{Nestling} \\ \text{1-year} \\ \text{2-year} \\ \text{Adult} \end{array} \begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0.4 & 0 & 0 & 0 \\ 0 & 0.4 & 0 & 0 \\ 0 & 0 & 0.4 & 0.95 \end{pmatrix}$$

(b)

Reproduction (Nestling, 1, 2, 3, 4, Adult) × Survival/Growth (Nestling, 1-year, 2-year, 3-year, 4-year, Adult)

$$\begin{array}{l} \text{Nestling} \\ \text{1-year} \\ \text{2-year} \\ \text{3-year} \\ \text{4-year} \\ \text{Adult} \end{array} \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 3 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0.75 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.75 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.75 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.75 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.75 & 0.25 \end{pmatrix}$$

Figure 2: Transition matrix models for (a) bird A and (b) bird B.

Finally, taking the product of the two matrix and calculating the eigenvalue of that matrix. It is known that the eigenvalue expresses the growth rate of that population.

In the case of the above examples, growth rates are 1.012 and 0.99 for species A and B, respectively. Therefore, we can predict that species A will be growing of 1.2% every year, while species B is declining of 1%.

Estimation from data

In order to apply this mathematical model, we need estimates of survival and numbers of eggs. For the latter, we may count them in bird's nests. For the former, deploying a ring to indentify each individual is commonly done. If we check whether that individual is present every year, we can estimate the survival probability. Note that it needs at least 2 times censuses. If an individual is not observed in the next census, there is no way to distinguish whether that individual died or we just failed to find it (Fig. 3b). Continuing 2 or more times, we will obtain data like Fig. 3c, then we are sure that this individual was living and we failed to find it in that census. Combining a suitable statistical model, we can obtain estimates about mortality.

An advanced technique such as sensitivity analysis allows us to know which is more effective, increasing survival of nestling or adults.

Field survey, mathematics and statistical model

Combining field surveys, mathematics and statistical modeling, we can search better risk management for engaged species.

Kenichiro Shimatani

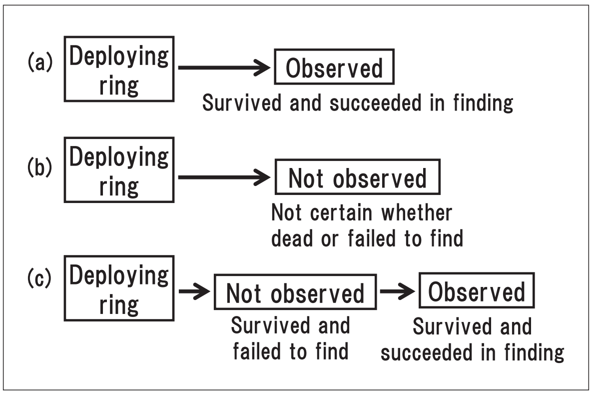


Figure 3: The concept for estimating survival from mark-recapture data.

Study in Activity of Neuron and Neural System, and Its Application

In order to scientifically capture the risks of social and natural phenomena, it is necessary to grasp the object as a system and model it appropriately. The neural system is taken up as an example of complicated, various, and huge systems in our study. Then the modeling of activity of a neuron and systematization of neural systems by synchronization are studied along with the applications.

Activity of neurons and systematization of neural group by synchronization

Based on the relation between an individual (a single neuron) and a group (a neural group), We aim to clarify the mechanism of neural system by analyzing the electrophysical dynamics with a viewpoint on the relationship between individuals (neurons) and the group (neural system).

(1) Mechanism of electro-chemical activation of a single neuron

A neuron generates electric potentials of a pulse or a plateau when its dendrite receives electric and chemical stimulations as the input, and then the generated signals are transmitted to the axon terminals for electrical potential or chemical secretion to stimulate the next cells (neurons or other tissues). This response is an active operation that consumes energy and works as an amplifier or an oscillator. It is impossible to realize with the conventional passive circuit models which consists of the elements of capacitors and resistors.

In this study, the neuron is modeled by three terminal active elements separated by liquid junctions (Fig. 1), and formulated by the equivalent circuit defined by closed loop gain G and feedback ratio β. This research was awarded as the Best Paper at International Conference on Neurology held in July 2012.

(2) Synchronization and systematization of neuron set by mutual injection

It is clarified that the neuron operates as a pulse oscillator from the basic study in neural activity described in (1), then the mechanism of synchronous operation of the neuron group is also clarified. It is known that the group of neurons oscillates at an average period when the neurons are injected of the output each other, even if each neuron has an individual period. From this analysis, we have formulated electrophysically and formally that the nervous system is a synchronization system realized by mutual injection of neuron output.

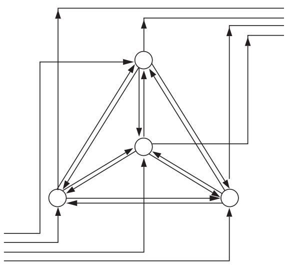


Figure 2:
Synchronization of neural group by mutual injection.

Estimation of liquid level of fuel by microwave measurement

Natural gas is expected to expand the effective usage because carbon dioxide emissions per burning calorie are less than petroleum. However, in the transport of liquefied natural gas (LNG), the measurement is really tough problem by conventional schemes because of the extremely small reflection.

In our study, highly accurate measurements are possible by using not only reflected waves on the liquid surface but also transmitted waves that pass through both liquid media and air. And the relative information of known objects as a reference position are also used effectively in the location estimation in neural systems of living animals.

This method was applied for the patent in 2013, and exhibited at Innovation Japan held in Tokyo Big Sight in September, 2014.

Yumi Takizawa

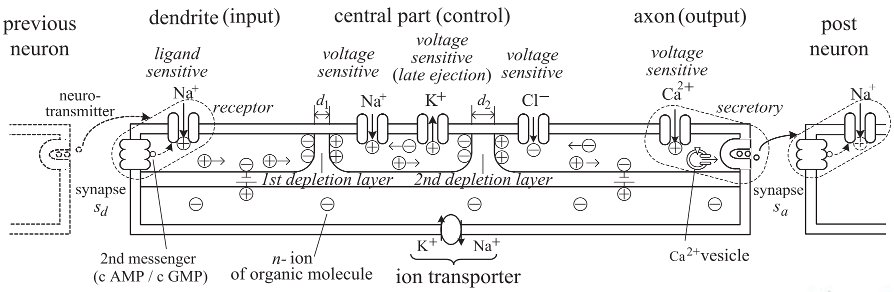


Figure 1: Model of an active neuron.

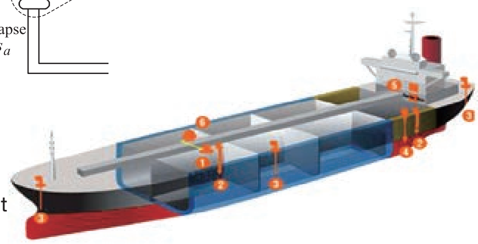


Figure 3:
Liquid level measurement by microwave.

Hardware Random Number Generation with Physical Phenomena

■ Random number

Random number is defined a sequence of random variables. An example is a sequence of binary random variables with equal probability. We can get this random numbers form a result of finite number of honest coin tossing.

■ Random number generator

Methods to generate sequence of random variable are called random number generators. The sequence generated by an algorithm on the computer is called pseudo random number. The most popular pseudo random numbers have uniform distribution on [0, 1). There are linear congruential method, M-sequence, Mersenne Twister and so on. These random numbers are not true random number. The random number sequence generated by a physical phenomenon is called physical random number and can seem to be true random number. The most popular phenomenon which is used for a hardware random number generator is thermal noise of electronic circuit. Recently chaos phenomenon of semiconductor laser or magnetoresistive element is used.

■ Development of hardware random number generator in our institute

We introduced FACOM128 which is the first commercial computer system of Japan in 1956. We used hardware random generator whose noise source was radioactivity. In 1963, 1971, 1989 we introduced hardware random number generator whose noise sources are thermal noise of diodes and noise signal is digitized by using comparators. Fig.1 is a component of hardware random number generator which was developed in 1989. Generation speed is 1.5 MB/s by using 8 boards in parallel. In 1998 we changed generation method. A/D converters are used for digitizing analogue signal. Fig.2 is the generation board which was developed in 1999 whose speed is 25MB/s. Speed of the latest board is faster than 640MB/s. These hardware random number generators were certified as historical computer equipment by Information Processing Society of Japan in March 2016.

■ Use of random numbers

Random numbers are used for Monte Carlo method, bootstrap and so on. Large-scale computations are necessary to large-scale problems. Parallel computations must be conducted. We, however, cannot accept results free from care, since it is too difficult to confirm whether two random sequences have correlation or not. On the other hand we can use random numbers generated by hardware random number generator for parallel computing at ease. Users can download random numbers from our portal site http://random.ism.ac.jp/.

Yoshiyasu Tamura

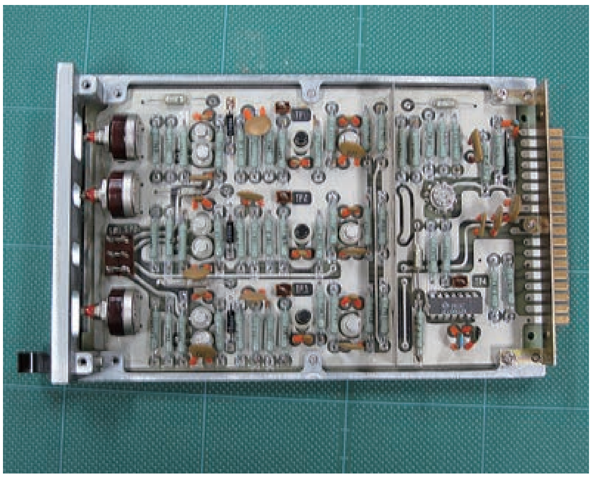


Figure 1: Component of hardware random number generator for Hitachi's computer M680H.
(1989, Generation speed is 1.5MB/s)

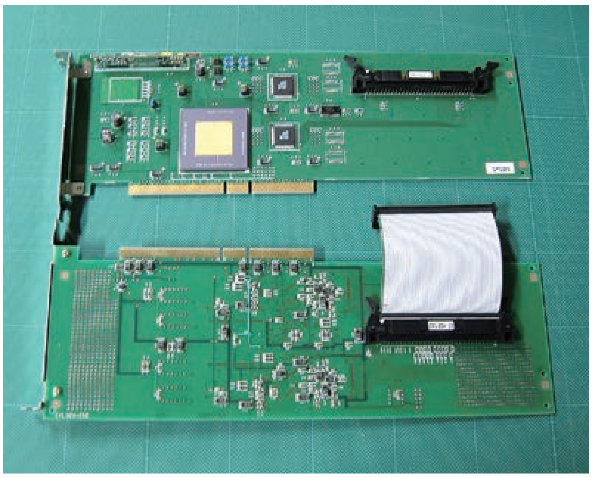


Figure 2: Hardware random number generator for Hitachi's supercomputer SR8000.
(1999, Generation speed is 25MB/s)

Ensemble Prediction and Estimation of Probability Density

Ensemble prediction

Ensemble prediction is a method of statistical prediction based on various results from numerical simulation models that have different configurations such as initial and boundary conditions, input parameters, and sub models. A set of the various results is called an ensemble, and each result is called an ensemble member. Based on statistics such as mean and variance of the ensemble members, ensemble prediction estimates the most probable event and its occurrence probability.

A role of each ensemble member is to represent an event depending on its configuration. Furthermore, each member may be generated from different simulation models. Different simulation models enhance diversity of the ensemble members, and reproduce ensemble members that are likely to occur. Such an ensemble generated by multiple simulation models is called a multi-model ensemble.

Estimation of probability density

What should we do for statistical inference based on an ensemble? The first step may be to take an average of the ensemble members, but is it reasonable? Taking an average is equivalent to one model one vote. Since each simulation model has one vote regardless of the goodness of the model, a good result may be buried in results that seem to be questionable. This is, of course, the situation we would like to avoid.

We now consider a way to improve ensemble prediction using observation data. While combination of ensemble simulation and observation may evoke a method of ensemble data assimilation such as the ensemble Kalman filter and the particle filter, the situation is not actually quite straightforward. Application of the methods of data assimilation requires specification of error parameters of the ensemble members, and more importantly, requires a restart process of temporal integration after replacing state variables. The latter requirement is difficult to satisfy especially for multi-model ensembles in a practical sense.

We then propose a method for density estimation using a regression model in which observation is explained by the ensemble members. The regression model can estimate the error parameters automatically and we do not need to specify in advance. Furthermore, we can select useful simulation models by introducing a concept of sparsity in the cost function. Consequently, we can discard a model that does not additional explanation abilities and we can estimate probability density considering the effect of redundancy of multiple simulation models.

Genta Ueno

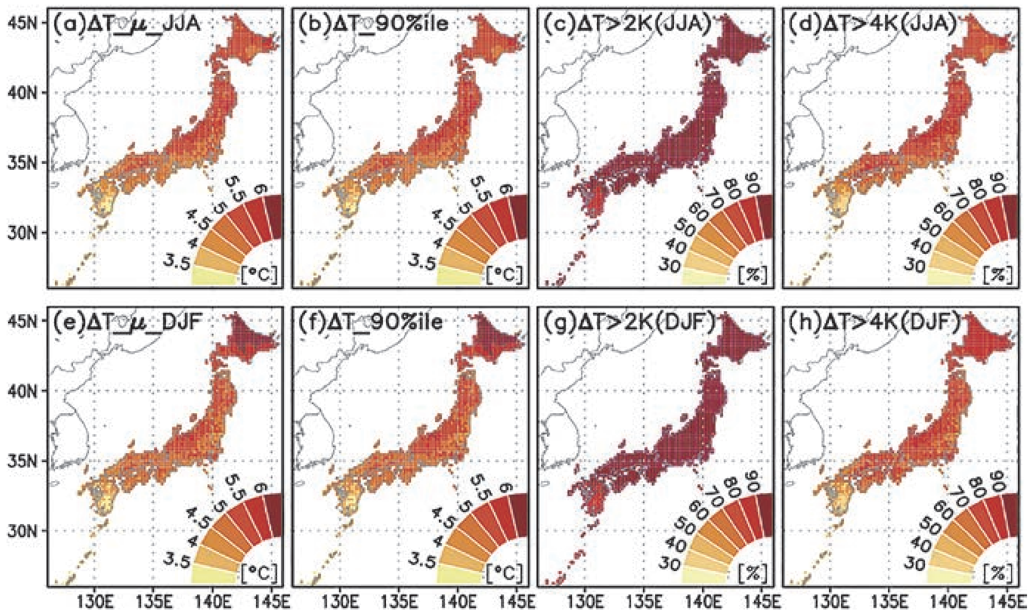


Figure: Probabilistic climate projections for surface air temperature for the end of the 21st century using the regression model. (provided by National Research Institute for Earth Science and Disaster Resilience)

Polynomial-time Algorithm for Some Non-convex Optimization Problems

Difficulty of non-convex problem

Mathematical optimization problem is to achieve better object under given constraints. If the problem objective function and constraints are all represented by convex functions, it is called convex problem. The Karush-Kuhn-Tucker (KKT) condition is a necessary and sufficient condition for the optimal solution if it is a convex problem. On the other hand, for non-convex problems, the KKT condition is not a sufficient condition, and local optimal solutions and stationary points also satisfy the KKT condition. So it is generally difficult to find a global optimal solution for non-convex problems.

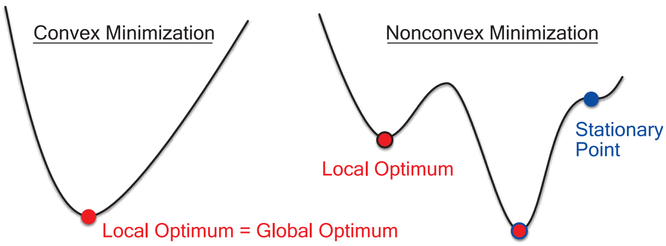


Figure 1: Convex optimization and nonconvex optimization.

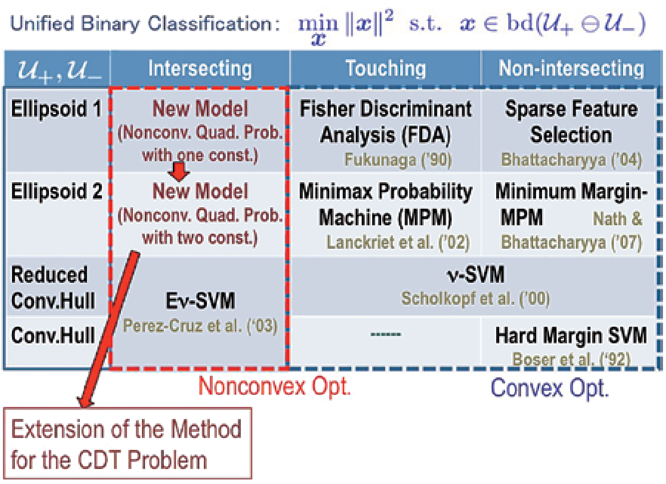


Figure 2: Extending binary classification models to nonconvex ones.

$$
\min_{x} \; x^\top Q x + 2q^\top x
$$
$$
\text{s.t.} \;\; \|x\|^2 \le s^2, \; \|A^\top x + c\|^2 \le u^2
$$

Figure 3: Celis-Dennis-Tapia (CDT) problem.

In recent years, we have seen non-convex problems in various fields. For example, a non-convex binary classification model Eν-SVM is also proposed. As solution methods for solving convex optimization problems have been established, research target has gradually shifted to non-convex optimization.

Polynomial-time algorithm for non-convex classification model

When the average vectors of the two classes are close and the number of data is extremely different between the two classes, the range of the hyper-parameter of usual SVM is narrowed and good prediction can not be done. Even in such a case, Eν-SVM can select hyper-parameter values from a wide range by sacrificing convexity, and consequently leads to good predictive performance. We mimicked Eν-SVM and developed non-convex variants of other classification models (Iwata, Nakatsukasa, Takeda; 2014). In order to obtain the decision rule, it is necessary to solve the non-convex quadratic problem, but the global optimal solution can be obtained with polynomial time. The algorithm is very simple; after enumerating all the solutions that satisfy the KKT condition by eigenvalue calculation, choose the one that achieves the smallest function value.

Polynomial-time solvability of Celis-Dennis-Tapia (CDT) problem

Furthermore, we showed that the proposed method can be applied to the CDT problem (the problem of non-convex quadratic function minimization under two convex quadratic constraints) by adding a little ingenuity (Sakaue, Nakatsukasa, Takeda, Iwata; 2016). Since the CDT problem was proposed in 1985, its polynomial-time solvability has been studied. Just before submitting the paper, Bienstock proposed a polynomial-time algorithm of the CDT problem (Bienstock; 2016). However, his method includes procedures that are considered to be difficult to implement. Therefore, our research has shown a solution method that can be implemented for the first time for the CDT problem.

Akiko Takeda

Anonymizing Location Data Based on the Space-state Model

Anonymization of location data

Nowadays, trajectory location data, which is collected from people's smart phones, can be used for various analytic purposes, such as traffic monitoring, urban city planning. However, due to significant concern about location privacy, location data must be anonymized properly before making it available for secondary usage, as shown in Figure 1.

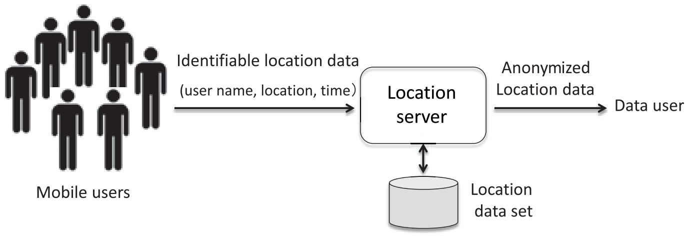
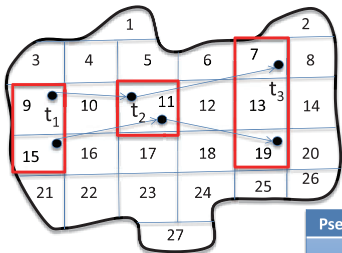


Figure 1: Privacy-preserving data publishing of location data.

Issues in k-anonymization

To address the issue of location privacy, we usually adopt a technique called k-anonymization, which ensures that every location in an anonymized dataset contains more than k people. Figure 2 shows the location trajectories of two users with grid IDs. When we use coarser granularity of location data, which is shown with red rectangles, we obtain 2-anonymized location data.

However, since trajectory location data involves strong temporal and spatial correlations among data points, it is often possible to restore original location data from aonymized one. Figure 3 shows 2-anonymized location data of the two users driving a car. Although the granularity of location data is generalized to achieve 2-anonymity, it is trivial to infer the exact locations of the two drivers if we learn the road model, which is shown with dotted lines.



Original location data

User	Time t_1	Time t_2	Time t_3
Tanaka	{9}	{11}	{7}
Suzuki	{15}	{11}	{19}

Generalization

2-anonymized location data

Pseudonym	Time t_1	Time t_2	Time t_3
A	{9, 15}	{11}	{7, 13, 19}
B	{9, 15}	{11}	{7, 13, 19}

Figure 2: An example of 2-anonymized location data.

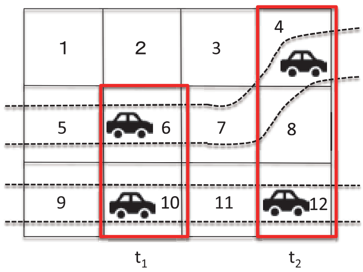


Figure 3: Inference of original location data using map information.

Anonymization model based on the hidden Markov model

We model users' mobility patterns based on the Markov chain and evaluate the safety of an anonymized dataset based on the hidden Markov model, that is, the disclosure risk is formulated as the conditional probability of inferring the sensitive internal state, given externally observable information. Figure 4 describes our framework for evaluating the safety of an anonymized dataset. The trajectory of internal states corresponds to the original location data, while observation data corresponds to the anonymized data.

Our experimental results with a real dataset show that the metrics of k-anonymization is not often sufficient to ensure expected safety property, and that it is necessary to additionally suppress non-sensitive location points to achieve the desired safety.

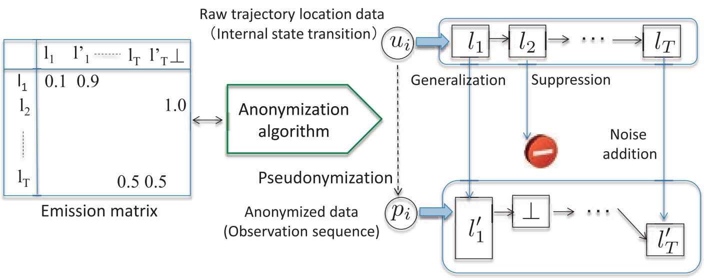


Figure 4: Anonymization model based on the hidden Markov model.

Kazuhiro Minami

Data Science Center for Creative Design and Manufacturing

Strategic goals

We aim to motivate advanced technologies in the field of data science, and foster scientific methodologies for innovative design and manufacturing. Various fields in design and manufacturing are a major part of our country's fundamental industry. They are now facing a revolutionary period. Population reduction and globalization change the current industrial structure in Japan, resulting in a rapid lost of our global predominance in the manufacturing industry. Furthermore, countries around the world has actively launched new data science programs for the next generation design and manufacturing, such as, the Materials Genome Initiative in the US and Industry 4.0. Following the global trend is no longer an effective way to survive in the intensive power game around the world. We have to develop innovative thinking, for which data science can provide the essential tools. The Institute of Statistical Mathematics has decided to establish a data science research center for the purpose of creative design and manufacturing. We have accumulated state-of-the-art data science technologies here, for instance, machine learning, optimization theory, data assimilation, Bayesian inference, materials informatics, etc. We are devoted to foster innovative methods for design and manufacturing based on co-created values through industry-academia collaboration. This is the mission of this center and our keywords are "smart" and "creative design and manufacturing".

Smart manufacturing

Current approach of material design relies on a classical cycle: initial guess based on researcher's intuition and experience, property estimation using large scale simulation and experiment, revision of the design based on the results. Such a process requires a large amount of time and financial costs to discover and produce a new material. On the other hand, recently, there are new attempts to substitute the heavy simulation and experiment by statistical models based on many existing data. This approach will achieve extremely efficient estimation of the material properties. The enormous cost and time required in a property test has limited the new material discovery within a small set of candidates. High throughput screening using data science may significantly increase the probability of new breakthroughs in material science. Application of such advanced methods to the traditional design and manufacturing process will drastically reduce the R&D cost and time. This is the basic concept of smart manufacturing in the perspective of data science.

Creative design and manufacturing

We recognize the importance of being at the absolute leading edge position in the manufacturing industry. This cannot be done by data science alone. Most of the data science analysis tools are designed for interpolative predictions. For example, we often assume that materials with similar chemical structure exhibit similar physical properties. However, by definition, new material is not likely to be similar to any of the existing materials. Combination of experiment, theory and data science methods is an essential step to a new breakthrough in the current state. In other words, we adopt a stepwise approach to expand the region of accurate prediction of a statistical model. We achieve the goal by careful design of an optimal experiment or simulation schedule for new data points that efficiently improve an existing predictive model. We have accomplished preliminary success in material science using an extrapolative prediction method based on a data science approach, and fostered new collaboration opportunities between academia and industry for the purpose of new material discovery. Our next step is to extend the application to various fields related to creative design and manufacturing.

Ryo Yoshida

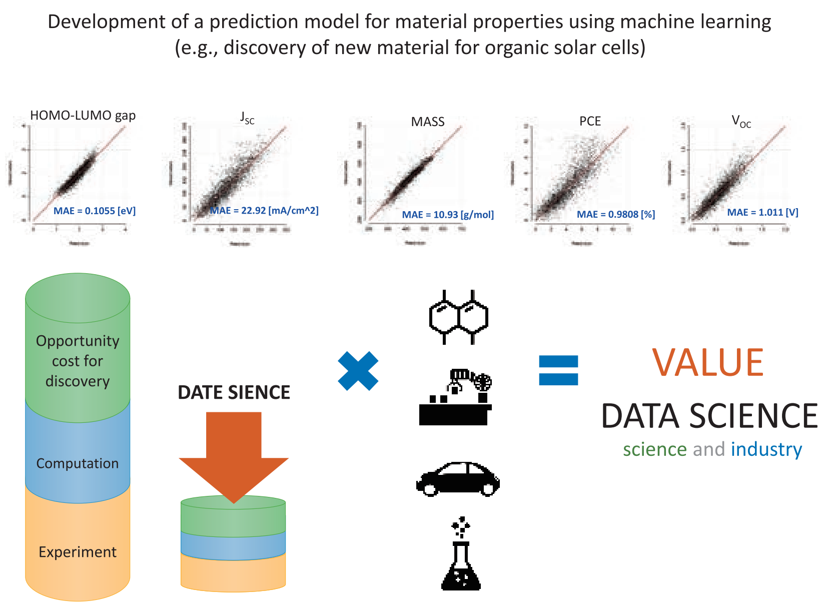


Figure: Smart manufacturing in the perspective of data science.

Towards Data-driven Materials Discovery

With state-of-the-art technologies in data science, we aim to discover novel functional materials. Target materials include drugs, dyes, solvents, polymers, polymeric composites and nanostructured materials. With the comprehensive technologies of machine learning, such as Bayesian modeling, kernel methods, natural language processing, sparse learning and optimization theory, we create the fundamental methodology and research infrastructures of Materials Informatics.

Materials Research by Information Integration Initiative (MI^{2}I)

Materials Informatics is an emerging cross-disciplinary field aimed at combining materials science and data science. The Materials Genome Initiative (MGI), announced by President Obama in 2011, was designed to create infrastructures that accelerate the pace of discovery and deployment of new materials for innovative products twice as fast. The MGI white paper has stated Materials Informatics as the key to achieving dramatic rationalization of time and costs in developments. In Japan, the Japan Science and Technology Agency (JST) launched the Materials Research by Information Integration Initiative (MI^{2}I) at National Institute of Materials Science (NIMS) on July 2015. The Institute of Statistical Mathematics has been designated to be a recommitment site of MI^{2}I as the central institute of data science in Japan.

Role of data science in material discovery and development

The design space of materials development is considerably high-dimensional. For instance, the chemical space of organic compounds consists of 10^{60} potential candidates. The challenge is to discover unidentified novel materials from the huge landscape that exhibit desirable material properties. In the traditional procedure, computational chemistry methods, such as the first principle calculation, have been put at the central analytic tool. Scientists hypothesize material structures based on experience and intuition, and properties of the designed materials are assessed computationally and experimentally. The data-centric approach has been paid much attention as a promising alternative that can promote enormous savings on time and costs in the laborious and time-consuming trial-and-error procedure.

Bayesian approach to data-driven materials discovery

The aim of our study is to create a novel material design method by the integration of machine learning and quantum chemistry calculation. The method begins by obtaining a set of machine learning models to forwardly predict properties of input material structures for multiple design objectives. These models are inverted to the backward model through the Bayes' law. Then we have a posterior probability distribution which is conditioned by desired properties. Exploring high probability regions of the posterior, it is expected to identify new materials possessing the desired target properties. Under industry-academia partnerships, we are putting into practice this Bayesian material design method.

Ryo Yoshida

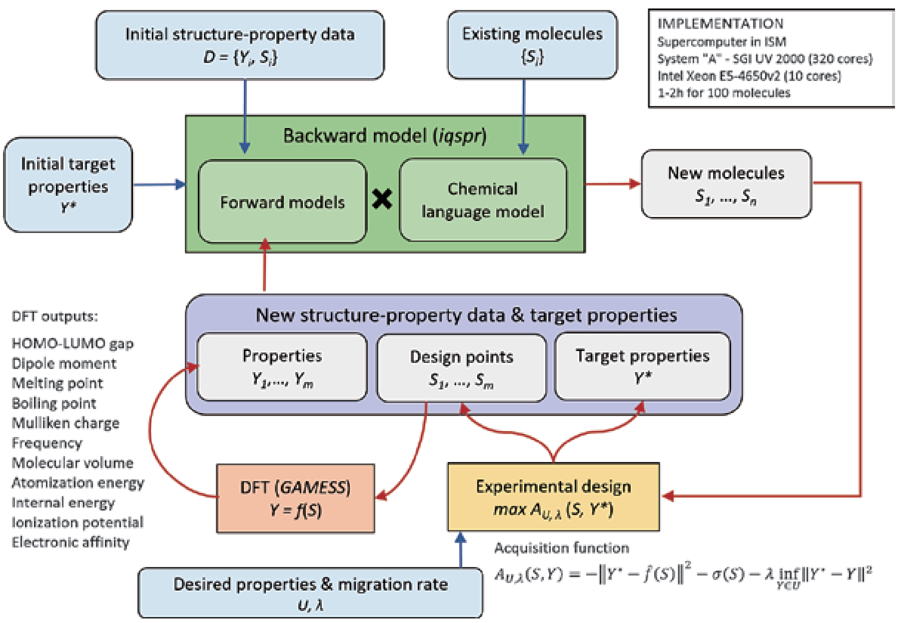


Figure: Material discovery algorithm: SPACIER.

NOE (Network Of Excellence) Project

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 along the two lines of basic research, and NOE (Network Of Excellence)-type research and professional development. These are respectively conducted by the basic research departments along a horizontal axis, and the NOE-type research centers and the school for professional development along a vertical axis (Figure 1). By its nature, the basic research departments (along the horizontal axis) cut across and link various disciplines, developing tools for interdisciplinary research. The field of statistical mathematics 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 remain unchanged as the field evolves. For that reason, we have chosen not to call it fundamental research or foundational research but "basic research", to reflect both the fixed and evolving qualities of statistical mathematics. There are three basic research departments: "Statistical Modeling", "Data Science", and "Mathematical Analysis and Statistical Inference". These departments engage in cutting-edge research to develop methodologies for rational prediction and decision making, based on data and existing knowledge. All tenured research staff members in ISM are assigned to one of these basic research departments. However, the time has come to reconsider "basic research" for the reason already stated — statistical mathematics must itself evolve to meet the changing needs of society and the data environment — and so we are planning to reorganize the basic research departments. The new organizations will be in place as of April 2018.

On the other hand, the NOE-type research centers and the school for professional development (along the vertical axis) are staffed by permanent researchers within ISM, project professors/researchers (post-doctoral staff), and visiting professors and researchers. We reorganized the NOE-type research centers for the previous FY2016. There are currently four NOE-type research centers, "Risk Analysis Research Center", "Research and Development Center for Data Assimilation", "Research Center for Statistical Machine Learning", and, set up on July 1, 2017, "Data Science Center for Creative Design and Manufacturing". These centers conduct research activities that interface statistical mathematics with individual scientific disciplines in order to find solutions to urgent social problems.

There is also the School of Statistical Thinking in ISM as a school for professional development, fostering and promoting statistical thinking in multiple programs of the project. In the School of Statistical Thinking, researchers, students, and contract researchers from private companies who have an eye on the creation of a new statistical research field, as well as various other people who realize the necessity of statistics in their particular research field, train together to foster statistical thinking. Of special importance, young project researchers receive on-the-job training from their senior mentors and thereby obtain the assorted skills of "statistical thinking". We also established the "Managing Committee of School of Statistical Thinking", whose members are experts in professional development from private industry and academia outside ISM. Please refer to the page "Project for Fostering and Promoting Statistical Thinking" for more details.

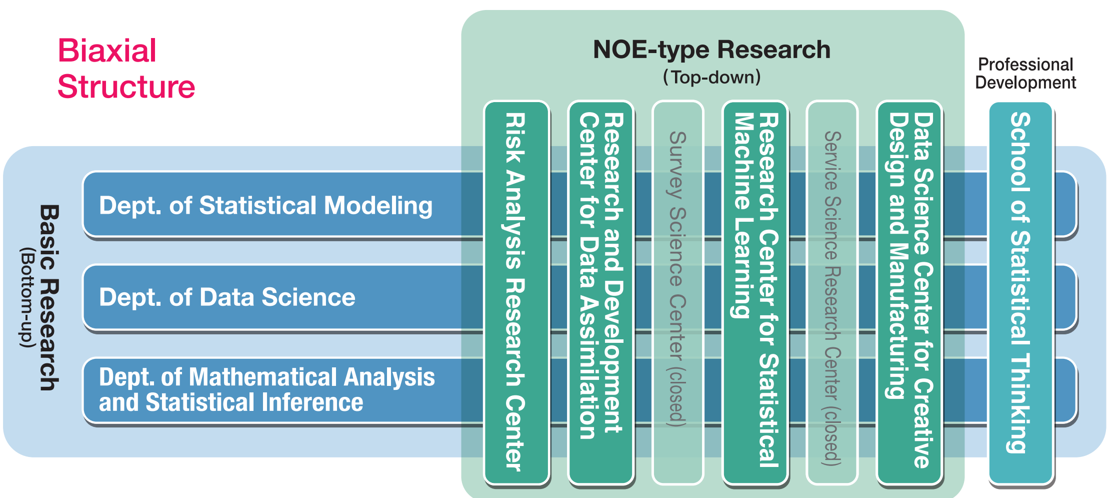


Figure 1: Biaxial structure for research and education

NOE (Network Of Excellence) Project

In accordance with the second medium-term plan of Research Organization of Information and Systems (ROIS, ISM's parent organization), ISM had set as a goal the establishment of NOEs (Networks Of Excellence) in statistical mathematics. With the formation of an NOE in each of five research fields —"Risk Research", "Next-Generation Simulation", "Survey Science", "Statistical Machine Learning", and "Service Science" —we have been conducting joint research activities that serve to deepen collaborative relationships with other institutes, both within Japan and overseas, for these last six years.

The previous FY2016 was the very first year of the third medium-term plan. We made a self-evaluation of the six years of the second medium-term plan and then reorganized the structure for managing the NOE Project and NOE-type centers. We closed the Survey Science Center and the Service Science Research Center. The projects of the Survey Science Center have matured and transferred to the "Joint Support-Center for Data Science" of ROIS. However, ISM will continue the study of the Japanese National Character as one important area of the Institute's research. Also, the "Survey Science Group" in the Department of Data Science is now the core of the Survey Science NOE. The activities of the Service Science NOE finished on January 31, 2017, and we transferred the projects of the former Service Science Research Center to other NOE-type centers according to their methodologies.

We set up a new NOE-type center, "Data Science Center for Creative Design and Manufacturing". As of the current FY2017, the research activities in the NOEs are Risk Research, Next-Generation Simulation, Survey Science, Statistical Machine Learning, and Data Science for Creative Design and Manufacturing.

Future Conception of NOE Activities

To fulfill the goal of establishing the new scientific methodologies ("Fourth Paradigm") in a knowledge-based society, in which the importance of knowledge goes beyond merely solving individual problems, NOE activities are being systematically pursued under the unified project guidelines decided by the "Managing Committee of NOE Project". At the same time, advice is also taken from the members of the "Advisory Board of NOE Project" (see Table 1), made up of experts from the industrial, academic, and government sectors.

The NOE Project, which is made possible by ISM's special focus in the cross-disciplinary field of "statistical mathematics", is attracting strong support from each of these communities. On the basis of this project, ISM, as an Inter-University Research Institute, will be providing further opportunities to the industrial, academic, and government communities for joint usage (of facilities) and joint research. ISM decided to continue to promote this NOE Project during the third medium-term plan of ROIS, which has gone into effect as of April 2016.

As described above, the NOE research centers serve as core hubs for their respective fields. ISM is promoting the signing of MOUs (Memorandums of Understanding) with research organizations within Japan and overseas, and the number of MOUs is increasing year by year, including MOUs which transit multiple NOE research fields. The goal of ISM is general research in statistical mathematics, which is in demand by various research fields, both in the humanities and science. ISM has to respond flexibly to requests from each community and contribute to them. Reorganization from last year to this year was based on the needs of each community and is for the purpose of more strongly promoting the NOE Project.

With its focus on methodology, ISM continues to plan research in each of the NOE research fields. Furthermore, with all research activities concentrated under the umbrella of the NOE Research Promotion Organization, the general body that oversees the five NOEs, ISM is expanding and developing its NOE projects with the aim of establishing new scientific methodologies ("Fourth Paradigm"), creating new research disciplines, and developing new styles of joint research. For the specifics of the new research structures of the NOE Project and more up-to-date information, please visit the website. We greatly appreciate your continued support and understanding for this Project.

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

Director of the Center for Materials Research by Information Integration, MDIS, National Institute for Materials Science	Dr. Satoshi Itoh
Professor Emeritus, Tokyo Institute of Technology	Dr. Takatoshi Imai
Adjunct Professor, Computational Science Education Center, Kobe University	Dr. Yoshio Oyanagi
President, The Japan Pharmaceutical Manufacturers Association	Mr. Yoshihiko Hatanaka
President, Toyota Technological Institute at Chicago	Dr. Sadaoki Furui
Director-General, Institute for Monetary and Economic Studies, Bank of Japan	Mr. Shigenori Hiratsuka

Table 1: Members of Advisory Board of "NOE Project" (As of April 1, 2017)

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 no academic institution other than ISM has a department of 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. The following are the principal projects.

Research Collaboration Start-up

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 start-up. 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 start-up program covers a variety of topics, ranging from introductory to more specialized studies. Half of the clients are from the private sector, and the rest are staff members of public organizations, university professors, or students. The Institute accepts more then 50 cases annually, some of which benefit society in diverse ways.

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 2017, five workshops have been accepted after review.

Statistical Mathematics Seminar Series

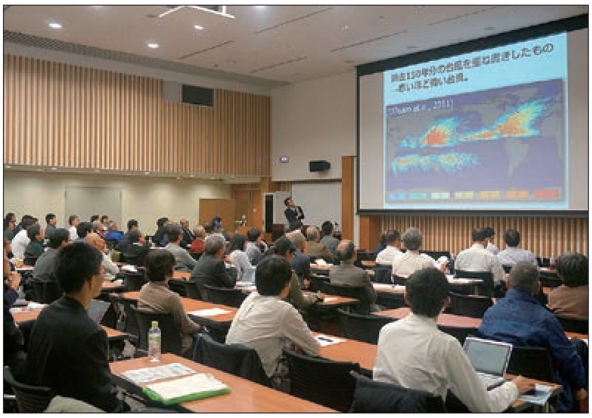
The Institute holds weekly seminar series on statistical mathematics every Wednesday. The seminars are led by in-house and external lecturers to showcase their latest studies. These lectures are free to attend. To view the seminar schedule and learn more about the program, please visit the Institute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

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

Open Lecture

We hold an open lecture during Education and Culture Week every year (November 1 through 7), to introduce the Institute's activities and to promote statistical science. We invite lecturers to speak on a timely topic relating to statistical science. The lecture is open to the general public. For further information, please visit the website of the Institute of Statistical Mathematics.

http://www.ism.ac.jp/kouenkai/



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.

When ISM joined the Inter-University Research Institute Corporation in 1985, the training center was formally shut down. We nevertheless tried to maintain 4 courses per year, relying on support from the private sector. The number of courses was tripled when ISM became an independent agency in 2005. Now the tutorial courses are operated by the School of Statistical Thinking, which was established in 2011.

In the 2016 academic year, 14 courses were held and the number of participants was 968. The total number of courses held from 1969 to March, 2017 was 349, with a total of 24,925 participants. These courses 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.

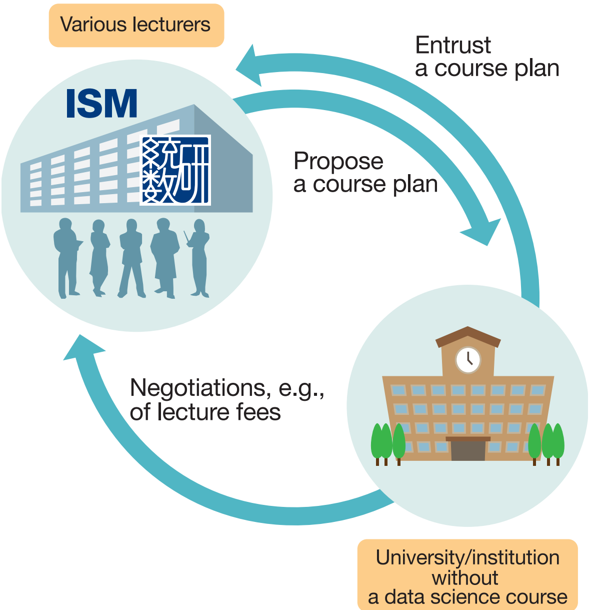
http://www.ism.ac.jp/lectures/kouza.html

Innovations in Our Data Science Program and Business-Academia Collaboration

Data Scientist Crash Course

To maintain an efficient eco-system for producing data scientists, the system should contain a proper balance of data scientists of various levels. In this regard, it has been said that Japan should increase its number of leading data scientists (comparable to JSSC class 1 qualifiers). As an attempt to fill the current gap, ISM held the “Statistical Machine Learning Crash Course”, which was co-hosted by the RIKEN Center for Advanced Intelligence Project (AIP). This course consisted of six lectures, and was held on February 9 and March 7 and 9, 2017. All the instructors were ISM researchers who were leading scientists in the area of statistical machine learning. Lectures covered (1) information processing with sparsity, (2) pattern recognition, (3) materials informatics, (4) statistical machine learning for discrete data, (5) optimization methods under uncertainty, and (6) nonlinear data analysis by the kernel method.

Data Scientist Crash Course



Conceptual drawing of entrusting a data science course

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. Supercomputer access is available to them as long as they submit their proposals to High Performance Computing Infrastructure; see the web site below. 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 consultants and funded research collaboration.
(http://www.hpci-office.jp/folders/english)

Data Science Course Entrusted on the Basis of Organizational Cooperation

For universities and institutions who have an MOU with ISM, or some other organizational agreement on mutual research/educational cooperation, ISM is ready to offer a data science course plan. These universities and institutions entrust the data science course plan (including possible lecturers) to ISM, and ISM proposes a plan based on their request. By exploiting the deep knowledge, expertise, and academic network of ISM professors, we plan an appropriate combination of course topics and instructors so that they fit each university’s educational goal, whether the level is undergraduate or graduate.

Towards the Formation of Network-based Research Foundations for Collaboration between Mathematical Science, and Various Scientific Fields and Industries

What is the Cooperation with Mathematics Program?

The Cooperation with Mathematics Program is a MEXT-funded project that was planned in an atmosphere of promoting research via collaborations between mathematics and other scientific fields, as well as industry. The aim of this Program is to provide mathematicians and researchers in various scientific fields and industries with opportunities for inter-field discussions, and thus, to promote the finding of solutions to challenging problems via collaborations. The Program was started in 2012 as a five-year project entrusted to The Institute of Statistical Mathematics. The Institute has from the beginning managed the following activities along six main themes decided by the steering committee under the Program with the aid of three related academic societies and nine academic institutions, including three joint usage/research centers on mathematical science.

Activities of the Cooperation with Mathematics Program

Visible activities of the Program include supporting and organizing workshops, study groups, working groups, and tutorial seminars, as well as conducting outreach activities for the general public.

The workshops aimed to discover new or challenging problems, which it is hoped will be solved by the collaboration of various scientific fields and industries with mathematical science. Study groups, which historically first appeared at Oxford University in 1968, differ from workshops. Generally, coordinators start by providing several problems from scientific fields or industry and each participant chooses one of these and concentrates on solving it for about a week. At the end of a study group, participants who worked on each problem give presentations about solutions or proposals for solutions to the problem. During its five years, the Program conducted 75 workshops and 27 study groups (11 focused on scientific fields and 16 focused on particular industries).

Panel discussion in a joint symposium held with JST CREST/PRESTO programs

The Program independently supported finding problems in specific fields that were expected to be solved by mathematicians, through organizing working groups consisting of mathematicians, statisticians, and engineers in the specific field. Such working groups were established under the Program in the three fields of material science, life science, and finance. Outcomes from these working groups' activities include publishing proposals for collaborations between mathematical science and these specific fields, which are available from our website shown below.

Tutorial seminars on specific themes meeting the demands from other scientific fields or industries were organized either independently or in workshops or study groups. The Program also supported series of tutorials organized by the National Institute of Materials Science or by the Society of Automotive Engineers of Japan, Inc.

In addition, the Program organized or supported various outreach activities. These include career-path seminars for graduate students or young researchers majoring in mathematical science, a series of talk-exhibition events at JST Science Agora for the general public, and disseminating related information through monthly mail magazines and SNSs such as Facebook and Twitter.

Detailed information about the Program can be accessed through its website (http://coop-math.ism.ac.jp), Facebook (https://www.facebook.com/CoopMath), and Twitter (@CoopMath).

Research Cooperation

International Cooperation

Associated Foreign Research Institutes

Organization name	Address	Conclusion day
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
Institute of Statistical Science, Academia Sinica	Taiwan (Taipei)	June 30, 2005
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
Department of Statistics, University of Warwick	The United Kingdom (Coventry)	January 16, 2007
The Indian Statistical Institute	India (Kolkata)	October 11, 2007
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
Human Language Technology Department, Institute for Infocomm Research	Singapore (Singapore)	February 16, 2012
Centre for Computational Statistics and Machine Learning, 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
The Department of Ecoinformatics, Biometrics and Forest Growth of the Georg-August University of Goettingen	Germany (Goettingen)	October 18, 2012
The Korean Statistical Society	The Republic of Korea (Seoul)	July 9, 2013
Toyota Technological Institute at Chicago	USA (Chicago)	February 10, 2014
Mathematical Sciences Institute Australian National University	Australia (Canberra)	May 15, 2014
RiskLab ETH Zurich	Switzerland (Zurich)	February 7, 2015
Institut de Recherche en Composants logiciel et materiel pour l'Information et la Communication Avancee (IRCICA)	France (Paris)	February 9, 2015
Le laboratoire de mathematiques de l'Universite Blaise Pascal	France (Clermont-Ferrand)	February 11, 2015
Centre de Recherche en Informatique, Signal et Automatique de Lille (CRIStAL) UMR CNRS 9189	France (Paris)	February 12, 2015
University College London (UCL) 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
Natinonal University of Laos	Laos (Vientiane)	March 15, 2017
Institute of Geophysics China Earthquake Administration	China (Beijing)	April 28, 2017

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 various 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

2011	2012	2013	2014	2015	2016
172	182	181	177	183	187

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	Number	Fields
a	Spatial and Time Series Modeling Group	f	Structure Exploration Group
b	Complex System Modeling Group	g	Mathematical Statistics Group
c	Latent Structure Modeling Group	h	Learning and Inference Group
d	Survey Science Group	i	Computational Inference Group
e	Metric Science Group	j	Others

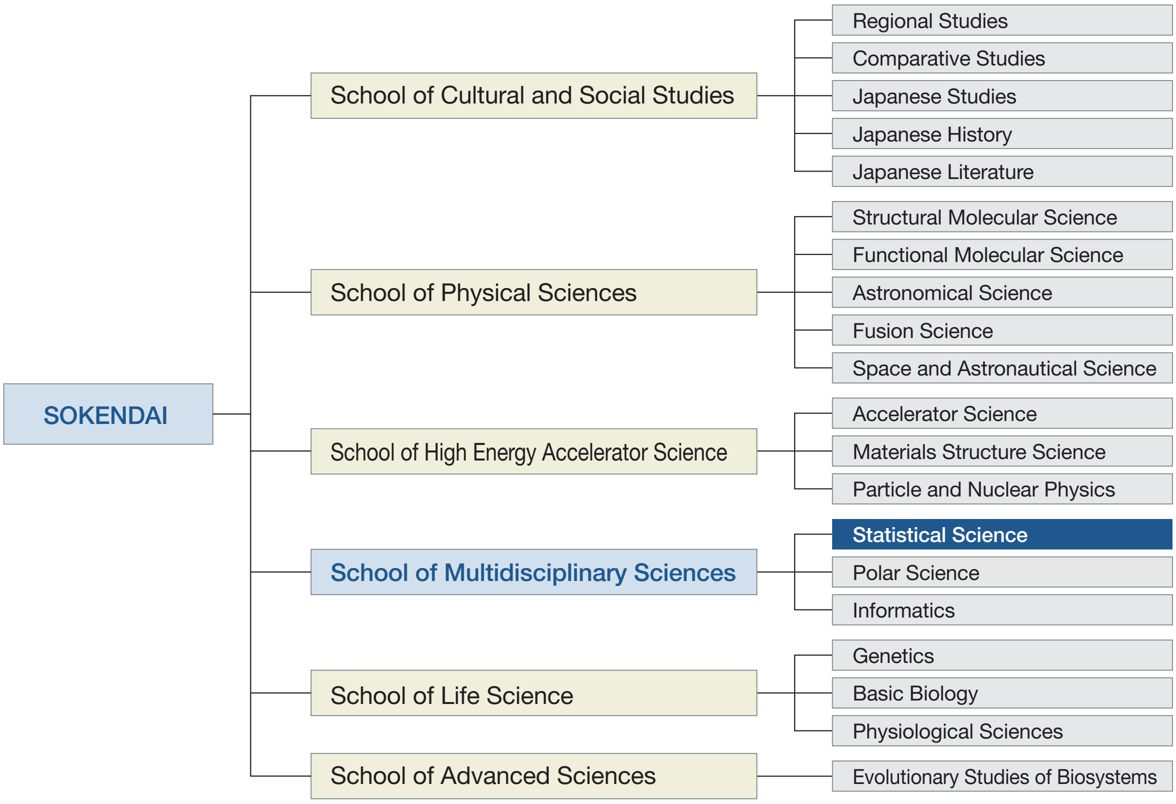
Major Research Fields

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, intends to cultivate individuals who possess creative research and educational skills and contribute to solving various important intricately-intertwined issues through extraction of information and knowledge from the real world taking advantage of their skills in modeling, prediction, inference, and collection of data, while conducting research and education on their foundations, i.e., mathematics, computation, and applications.

Field of Education and Research	Contents
Statistical Modeling	Education and research focuses 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.
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.
Mathematical and Statistical Inference	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 course is the only integrated doctoral program on statistical science in Japan. It has received students from a wide variety of disciplines and has offered education and research on statistical science by professors specialized in many different fields, from theory through to practical applications.
- 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 academic publications and books on statistical and mathematical sciences produced are some of the best in the world.
- In its role as an inter-university research institute, the Institute holds frequent workshops and seminars by visiting professors and researchers from both Japan and abroad. Students are free to attend and participate.
- It is possible to collaborate with researchers from other universities and institutions. It is also possible for students to develop their own projects by participating in research projects with other institutions through the Transdisciplinary Research Integration Center, Research Organization of Information and Systems.

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, including the required ones, 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 final 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, 2017)

■ Doctor's course five years: Quota,2

Year of enrollment	2010	2013	2014	2016	2017
Number of students	1	2 ①	2	1	1

■ Doctor's course three years: Quota,3

Year of enrollment	2011	2012	2013	2014	2015	2016	2017
Number of students	1 ①	1 ①	1 ①	5 ③	2 ②	5 ④	3 ②

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

University Background of Students

National and public universities

• Hokkaido University (4) • Tohoku University (3) • Fukushima University (1) • University of Tsukuba (6) • 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 (4) • The University of Tokyo (12) • Tokyo Metropolitan University (1) • Tokyo University of Agriculture and Technology (1) • Hitotsubashi University (6) • Shizuoka University (1) • Japan Advanced Institute of Science and Technology (1) • Nagoya University (3) • Toyohashi University of Technology (2) • Kyoto University (7) • Osaka City University (1) • Osaka University (2) • Nara Institute of Science and Technology (1) • Okayama University (2) • Shimane University (3) • Kyushu University (2) • Oita University (1)

University Background of Students

Private universities

• Kitasato University (1) • Keio University (8) • Shibaura Institute of Technology (1) • Chuo University (8) • Tokyo University of Science (6) • Toyo University (1) • Japan Women's University (1) • Nihon University (2) • Hosei University (7) • Waseda University (8) • Nanzan 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) • 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)

Degrees Awarded

Year	2011	2012	2013	2014	2015	2016
Doctor of Philosophy	4	6 [1]	6	5	5	7

* [ ] Ph.D. on the basis of the dissertation only (included in the total)

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

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

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. • Bank of Tokyo-Mitsubishi UFJ • 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.

Facilities and Equipment

Computational Resources (As of April 1, 2017)

Since July 2014, the ISM has maintained three different supercomputer systems: the Supercomputer System for Data Assimilation (nicknamed "A"), the Supercomputer System for Statistical Science (nicknamed "I"), and the Communal Cloud Computing System (nicknamed "C"). Those are nicknamed in tribute to a former director general, the late Professor Hirotugu Akaike, who invented the famous model selection criterion AIC. As of July 2015, the system I has just been expanded to have Haswell nodes.

System A is the world's largest shared-memory supercomputer system and consists of two sets of SGI UV 2000 (each 256 nodes of 10-core Xeon E5-4650v2, 64 TB memory). Half of this system is taking part in the high-performance computing infrastructure (HPCI) project.

System I is a large distributed-memory supercomputer that consists of 400 nodes of SGI ICE X with Ivy Bridge and 136 Haswell nodes, having 12,864 cores in total. The system also includes a large-scale shared storage system (2.5 PB disk storage), physical random number generator boards, and a visualization system that supports a maximum resolution of 4,096 × 2,160 and has a 200-inch rear projection screen for 3D visualization.

System C consists of 64 Dell PowerEdge R620 (two 10-core Xeon E5-2680v2, 256 GB memory). This system provides easy-to-use computing environments, such as distributed-memory statistical computing environments and Web servers, running on Apache CloudStack software.

In the main office, 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 systems A, I, and C are all connected to this network. A wireless LAN system is also available in the immediate area of the building occupied by the institute. 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 SINET5 (40 Gbps).

The Supercomputer System for Data Assimilation (nicknamed A)

The Supercomputer System for Statistical Science (nicknamed I)

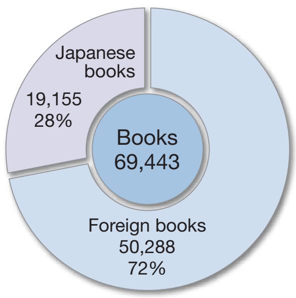
The Communal Cloud Computing System (nicknamed C)

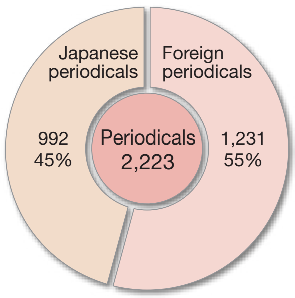
Library and Materials (As of April 1, 2017)

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 (2016)

Type	Personnel expenses	Non-personnel expenses	Total
Expenditure	729,430	864,105	1,593,535

Unit: ¥1,000

Accepted External Funds (2016)

Type	Joint research	Subcontracted research, Trustee business	Contract researchers	Contribution for scholarship	Total
Items	22	20	3	7	52
Income	41,112	164,170	1,393	9,850	216,525

Unit: ¥1,000

Grant-in-Aid for Scientific Research "KAKENHI" (2016)

Research Category	Items	Amount Granted
Grant-in-Aid for Scientific Research on Innovation Areas	2	11,570
Grant-in-Aid for Scientific Research (S)	—	—
Grant-in-Aid for Scientific Research (A)	3	23,010
Grant-in-Aid for Scientific Research (B)	9	38,090
Grant-in-Aid for Scientific Research (C)	15	19,110
Grant-in-Aid for Challenging Exploratory Research	4	4,810
Grant-in-Aid for Young Scientists (B)	5	7,020
Grant-in-Aid for Research Activity Start-up	2	2,340
Grant-in-Aid for JSPS Fellows	3	4,030
Total	43	109,980

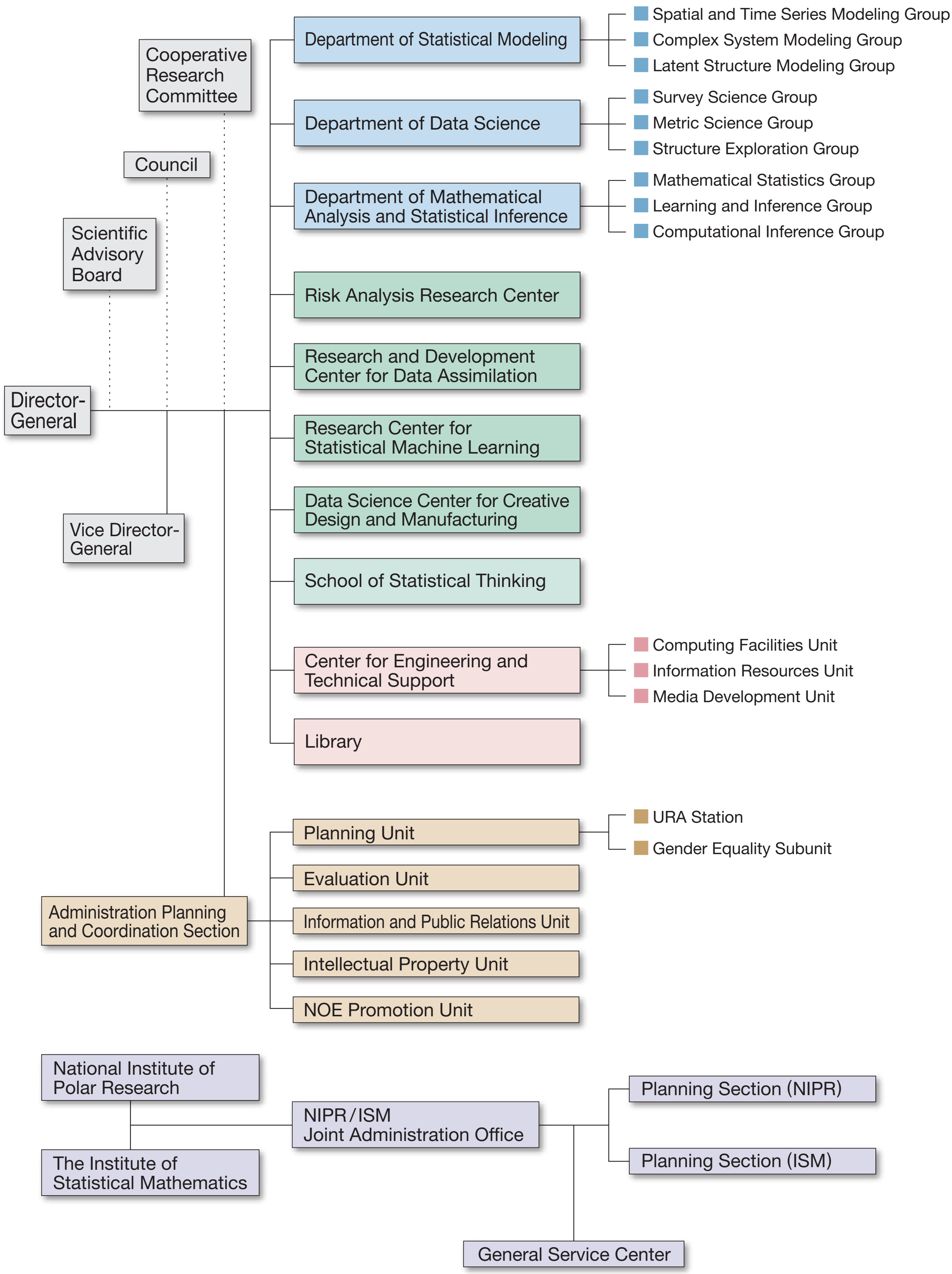
Unit: ¥1,000

Site and Buildings (As of April 1, 2017)

Site Area	62,450m²
Area for Buildings (total)	16,209m²

Organization

Organization Diagram (As of August 1, 2017)



Number of Staff (As of April 1, 2017)

Type	Director-General	Professor	Associate Professor	Assistant Professor	Administrative Staff	Technical Staff	Total
Director-General	1						1
Department of Statistical Modeling		4	8	3			15
Department of Data Science		3	7	3			13
Department of Mathematical Analysis and Statistical Inference		9	3	3			15
School of Statistical Thinking							0
Center for Engineering and Technical Support						10	10
Administration Planning and Coordination Section					1		1
NIPR/ISM Joint Administration Office					15(34)	1 (1)	16(35)
Total	1	16	18	9	16(34)	11(1)	71(35)

( ) Total number of staff of NIPR/ISM Joint Administration Office.

The number under Technical Staff at the Center for Engineering and Technical Support and Administrative Staff at the NIPR/ISM Joint Administration Office include one each staff member who retired because of age but was reemployed in a different position.

Staff (As of August 1, 2017)

Director-General	Tomoyuki HIGUCHI
Vice Director-General	Satoshi ITO
Vice Director-General	Satoshi YAMASHITA
Vice Director-General	Koji KANEFUJI

Department of Statistical Modeling

Director Junji NAKANO

Spatial and Time Series Modeling Group

Prof.	Tomoyuki HIGUCHI	Assoc. Prof.	Jiancang ZHUANG	Assoc. Prof.	Genta UENO
Assoc. Prof.	Shinya NAKANO	Assist. Prof.	Daisuke MURAKAMI		

Complex System Modeling Group

Prof.	Junji NAKANO	Prof.	Yukito IBA	Assoc. Prof.	Yumi TAKIZAWA
Assoc. Prof.	Fumikazu MIWAKEICHI	Assoc. Prof.	Shinsuke KOYAMA	Assist. Prof.	Ayaka SAKATA
Assist. Prof.	Momoko HAYAMIZU	Visiting Prof.	Hiroshi MARUYAMA	Visiting Assoc. Prof.	Yuji MIZUKAMI
Visiting Assoc. Prof.	Shigeru SAITOU	Visiting Assoc. Prof.	Tarou TAKAGUCHI		

Latent Structure Modeling Group

Prof.	Tomoko MATSUI	Prof.	Yoshinori KAWASAKI	Assoc. Prof.	Ryo YOSHIDA
Assoc. Prof.	Kazuhiro MINAMI	Assist. Prof.	Stephen WU		

Department of Data Science

Director Yoshiyasu TAMURA

Survey Science Group

Prof.	Ryozo YOSHINO	Assoc. Prof.	Tadahiko MAEDA	Assist. Prof	Yoo Sung PARK
Assist. Prof.	Masayo HIROSE	Project Assist. Prof.	Yusuke INAGAKI	Project Assist. Prof.	Kiyohisa SHIBAI

Staff

Department of Data Science

Visiting Prof.	Takatoshi IMADA	Visiting Prof.	Toru KIKKAWA	Visiting Prof.	Yoshimichi SATO
Visiting Assoc. Prof.	Wataru MATSUMOTO	Visiting Prof.	Masato YONEDA	Visiting Prof.	Shintaro SONO
Visiting Prof.	Kazufumi MANABE	Visiting Prof.	Fumi HAYASHI	Visiting Prof.	Masahiro MIZUTA
Visiting Prof.	Saeko KIKUZAWA	Visiting Assoc. Prof.	Takahito ABE	Visiting Assoc. Prof.	Koken OZAKI
Visiting Assoc. Prof.	Tadayoshi FUSHIKI	Visiting Assoc. Prof.	Hiroko TSUNODA	Visiting Assoc. Prof.	Taisuke FUJITA
Project Researcher	Naoko KATO				

Metric Science Group

Prof.	Yoshiyasu TAMURA	Prof.	Satoshi YAMASHITA	Assoc. Prof.	Kenichiro SHIMATANI
Assoc. Prof.	Masayuki HENMI	Assoc. Prof.	Ikuko FUNATOGAWA	Assoc. Prof.	Hisashi NOMA
Assist. Prof.	Nobuo SHIMIZU	Visiting Prof.	Michiko WATANABE	Visiting Prof.	Kenichi MIURA
Visiting Prof.	Hiroko NAKANISHI	Visiting Prof.	Makoto SHIMIZU	Visiting Assoc. Prof.	Fumitake SAKAORI
Visiting Assoc. Prof.	Michihiro OTA	Visiting Assoc. Prof.	Kazuhiro HIDE	Project Researcher	Ai KAWAMORI

Structure Exploration Group

Prof.	Koji KANEFUJI	Assoc. Prof.	Naomasa MARUYAMA	Assoc. Prof.	Jun ADACHI
Assist. Prof.	Shunichi NOMURA	Project Researcher	Hiroka HAMADA		

Department of Mathematical Analysis and Statistical Inference

Director Satoshi KURIKI

Mathematical Statistics Group

Prof.	Satoshi KURIKI	Assoc. Prof.	Shuhei MANO	Assoc. Prof.	Shogo KATO
Assist. Prof.	Takaaki SHIMURA	Assist. Prof.	Teppei OGIHARA	Visiting Prof.	Akimichi TAKEMURA

Learning and Inference Group

Prof.	Shinto EGUCHI	Prof.	Kenji FUKUMIZU	Prof.	Hironori FUJISAWA
Prof.	Shiro IKEDA	Assoc. Prof.	Daichi MOCHIHASHI		

Computational Inference Group

Prof.	Yoshihiko MIYASATO	Prof.	Atsushi YOSHIMOTO	Prof.	Satoshi ITO
Prof.	Akiko TAKEDA	Assist. Prof.	Mirai TANAKA	Visiting Prof.	Eitarou AIYOSHI

Risk Analysis Research Center

Director Satoshi YAMASHITA　　Vice Director Shogo KATO

Prof.	Satoshi YAMASHITA	Prof.	Satoshi KURIKI	Prof.	Shinto EGUCHI
Prof.	Koji KANEFUJI	Prof.	Atsushi YOSHIMOTO	Prof.	Yoshinori KAWASAKI
Prof.	Yoshinori KAWASAKI	Assoc. Prof.	Masayuki HENMI	Assoc. Prof.	Fumikazu MIWAKEICHI
Assoc. Prof.	Jiancang ZHUANG	Assoc. Prof.	Kenichiro SHIMATANI	Assoc. Prof.	Ikuko FUNATOGAWA
Assoc. Prof.	Shogo KATO	Assoc. Prof.	Yumi TAKIZAWA	Assoc. Prof.	Hisashi NOMA
Assoc. Prof.	Shuhei MANO	Assoc. Prof.	Kazuhiro MINAMI	Assist. Prof.	Takaaki SHIMURA
Assist. Prof.	Teppei OGIHARA	Assist. Prof.	Shunichi NOMURA	Project Assist. Prof.	Takahiro OTANI
Project Assist. Prof.	Shizu ITAKA	Project Assist. Prof.	Hayafumi WATANABE	Project Assist. Prof.	Yuta TANOUE
Project Assist. Prof.	Takao KUMAZAWA	Project Assist. Prof.	Junchao ZHANG	Visiting Prof.	Rinya TAKAHASHI

Risk Analysis Research Center

Visiting Prof.	Yo SHIINA	Visiting Prof.	Manabu IWASAKI	Visiting Prof.	Toshiya SATO
Visiting Prof.	Satoshi TERAMUKAI	Visiting Prof.	Tatsuhiko TSUNODA	Visiting Prof.	Naoki SAKAI
Visiting Prof.	Mihoko MINAMI	Visiting Prof.	Satoshi TAKIZAWA	Visiting Prof.	Toshihiro HORIGUCHI
Visiting Prof.	Shunji HASHIMOTO	Visiting Prof.	Yasuhiro KUBOTA	Visiting Prof.	Naoto KUNITOMO
Visiting Prof.	Toshio HONDA	Visiting Prof.	Hideatsu TSUKAHARA	Visiting Prof.	Hiroshi TSUDA
Visiting Prof.	Sadaaki MIYAMOTO	Visiting Prof.	Michiko MIYAMOTO	Visiting Prof.	Tadashi ONO
Visiting Prof.	Yoichi NISHIYAMA	Visiting Prof.	Satoshi FUJII	Visiting Prof.	Takaaki YOSHINO
Visiting Prof.	Masakazu ANDO	Visiting Prof.	Shusaku TSUMOTO	Visiting Prof.	Shigeyuki MATSUI
Visiting Prof.	Toshinao YOSHIBA	Visiting Prof.	Nakahiro YOSHIDA	Visiting Prof.	Masaaki FUKASAWA
Visiting Prof.	Yasutaka SHIMIZU	Visiting Assoc. Prof.	Hisayuki HARA	Visiting Assoc. Prof.	Takafumi KUBOTA
Visiting Assoc. Prof.	Hisateru TACHIMORI	Visiting Assoc. Prof.	Makoto TOMITA	Visiting Assoc. Prof.	Masakazu FURUKAWA
Visiting Assoc. Prof.	Ryota NAKAMURA	Visiting Assoc. Prof.	Kazushi MARUO	Visiting Assoc. Prof.	Atsushi GOTO
Visiting Assoc. Prof.	Masataka TAGURI	Visiting Assoc. Prof.	Takashi KAMEYA	Visiting Assoc. Prof.	Kenichi KAMO
Visiting Assoc. Prof.	Masashi KONOSHIMA	Visiting Assoc. Prof.	Tetsuji TONDA	Visiting Assoc. Prof.	Takaki IWATA
Visiting Assoc. Prof.	Bogdan Dumitru ENESCU	Visiting Assoc. Prof.	Hitoshi MOTOYAMA	Visiting Assoc. Prof.	Yukihiko OKADA
Visiting Assoc. Prof.	Toshihiko KAWAMURA	Visiting Assoc. Prof.	Seisho SATO	Project Researcher	Shonosuke SUGASAWA
Project Researcher	Hideaki NAGAHATA				

Research and Development Center for Data Assimilation

Director Genta UENO Vice Director Shinya NAKANO

Prof.	Tomoyuki HIGUCHI	Prof.	Yoshiyasu TAMURA	Prof.	Junji NAKANO
Prof.	Yukito IBA	Assoc. Prof.	Genta UENO	Assoc. Prof.	Ryo YOSHIDA
Assoc. Prof.	Shinya NAKANO	Assist. Prof.	Stephen WU	Assist. Prof.	Shunichi NOMURA
Project Assoc. Prof.	Masaya SAITO	Project Assist. Prof.	Yuya ARIYOSHI	Visiting Prof.	Takashi WASHIO
Visiting Prof.	Shinichi OTANI	Visiting Prof.	Yoichi MOTOMURA	Visiting Prof.	Nobuhiko TERUI
Visiting Prof.	Tadahiko SATO	Visiting Assoc. Prof.	Hiroshi FUJISAKI	Visiting Assoc. Prof.	Kazuyuki NAKAMURA
Visiting Assoc. Prof.	Hiromichi NAGAO	Visiting Assoc. Prof.	Hiroshi KATO	Visiting Assoc. Prof.	Eiji MOTOHASHI
Visiting Assoc. Prof.	Tsukasa ISHIGAKI	Visiting Assoc. Prof.	Yosuke FUJII		

Research Center for Statistical Machine Learning

Director Kenji FUKUMIZU Vice Director Tomoko MATSUI

Prof.	Kenji FUKUMIZU	Prof.	Tomoko MATSUI	Prof.	Shinto EGUCHI
Prof.	Yoshihiko MIYASATO	Prof	Satoshi ITO	Prof	Shiro IKEDA
Prof	Satoshi KURIKI	Prof	Akiko TAKEDA	Prof	Hironori FUJISAWA
Assoc. Prof.	Daichi MOCHIHASHI	Assoc. Prof.	Shinsuke KOYAMA	Assoc. Prof.	Kazuhiro MINAMI
Assist. Prof.	Mirai TANAKA	Project Assist. Prof.	Song LIU	Project Assist. Prof.	Mikio MORII
Project Assist. Prof.	Motonobu KANAGAWA	Project Assist. Prof.	Matthew Christopher AMES	Visiting Prof.	Katsuki FUJISAWA
Visiting Prof.	Takashi TSUCHIYA	Visiting Prof.	Masataka GOTO	Visiting Prof.	Yoshiki YAMAGATA
Visiting Prof.	Hiroshi KURATA	Visiting Assoc. Prof.	Yuji SHINANO	Visiting Assoc. Prof.	Hiroshi SOMEYA
Visiting Assoc. Prof.	Arthur GRETTON	Visiting Assoc. Prof.	Makoto YAMADA	Project Researcher	Jin ZHOU

Staff

Data Science Center for Creative Design and Manufacturing

Director Ryo YOSHIDA　　Vice Director Hironori FUJISAWA

Prof.	Hironori FUJISAWA	Prof.	Kenji FUKUMIZU	Prof.	Akiko TAKEDA
Assoc. Prof.	Ryo YOSHIDA	Assoc. Prof.	Shinya NAKANO	Assoc. Prof.	Daichi MOCHIHASHI
Assist. Prof.	Stephen WU	Project Assist. Prof.	Guillaume LAMBARD	Visiting Assoc. Prof.	Hiroshi YAMASHITA
Project Researcher	Hironao YAMADA				

School of Statistical Thinking

Director Yoshinori KAWASAKI　　Vice Director Genta UENO

Prof.	Satoshi ITO	Prof.	Yukito IBA	Prof.	Kenji FUKUMIZU
Assoc. Prof.	Naomasa MARUYAMA	Assoc. Prof.	Kenichiro SHIMATANI	Assoc. Prof.	Masayuki HENMI
Adjunct Prof.	Kunio SHIMIZU	Adjunct Prof.	Nobuhisa KASHIWAGI	Project Assoc. Prof.	Naoki KAMIYA
Project Assist. Prof.	Syogo MIZUTAKA	Visiting Assoc. Prof.	Osamu KOMORI	Visiting Assoc. Prof.	Kei TAKAHASHI

Center for Engineering and Technical Support

Director Yoshinori KAWASAKI　　Vice Director Jun ADACHI
Deputy Manager Yuriko WATANABE　　Senior Specialist Saeko TANAKA

Head of Computing Facilities Unit	Kazuhiro NAKAMURA	Head of Information Resources Unit	Saeko TANAKA
Head of Media Development Unit	Akiko NAGASHIMA		

Library

Head Yoshinori KAWASAKI

Administration Planning and Coordination Section

Director Tomoyuki HIGUCHI

Head of Planning Unit	Satoshi ITO	Head of Evaluation Unit	Koji KANEFUJI
Head of Information and Public Relations Unit	Koji KANEFUJI	Head of Intellectual Property Unit	Satoshi YAMASHITA
Head of NOE Promotion Unit	Satoshi ITO		

URA Station

Leader	Kozo KITAMURA	Subleader	Motoi OKAMOTO
Research Administrator	Keisuke HONDA	Research Administrator	Yoko OGAWA

Gender Equality Subunit

Head of Gender Equality Subunit	Satoshi ITO

NIPR/ISM Joint Administration Office

Director of NIPR/ISM Joint Administration Office Kazuhiko HASEGAWA　Director of General Service Center Atushi MATSUO

Planning Section (ISM)

Head of Planning Section Tsuyoshi ABE

Deputy Head	Masatoshi NAKAMURA	Team Leader	Koji MORITA	Team Leader	Ichiro KAWAJI
Team Leader	Junko MATSUYAMA				

Planning Section (NIPR)

Head of Planning Section Akiyoshi KOJIMA

Deputy Head	Motokazu TOYODA	Team Leader	Masaki ONIZAWA	Team Leader	Hitoshi HIRAYAMA
Team Leader	Michihito SAKURAI				

General Service Center

Vice Director of General Service Center Tatsuya NAKANO

Deputy Head	Koji SAKAMOTO	Deputy Head	Hiroki TERAUCHI	Deputy Head	Masayuki KOBAYASHI
Team Leader	Hiromi KATO	Team Leader	Hiroaki ARAI	Team Leader	Kentaro TSUJII
Team Leader	Takeshi KUWAHARA	Team Leader	Takuya SAITO	Specialist	Yoshihiro YAMADA
Specialist	Yoriko HAYAKAWA				

Council of The Institute of Statistical Mathematics (As of April 1, 2017)

Yasushi AKIYAMA	Professor, Graduate School of Information Science and Engineering, Tokyo Institute of Technology
Masahiro MIZUTA	Professor, Information Initiative Center, and Graduate School of Information Science and Technology, Hokkaido University
Shigeru OBAYASHI	Director Institute of Fluid Science Tohoku University
Nakahiro YOSHIDA	Professor, Graduate School of Mathematical Sciences, The University of Tokyo
Masayuki UCHIDA	Professor, Graduate School of Engineering Science, Osaka University
Ryuei NISHII	Professor, Institute of Mathematics for Industry, Kyushu University
Yasuhiro OMORI	Professor, Faculty of Economics, University of Tokyo
Shoichi YOKOYAMA	Professor, Language Change Division, National Institute for Japanese Language and Linguistics
Masato OKADA	Professor, Graduate School of Frontier Sciences, The University of Tokyo
Michiko WATANABE	Professor, The Graduate School of Health Management, Keio University
Ryozo YOSHINO	Professor, Research Organization of Information and Systems
Satoshi ITO	Professor (Vice Director-General, ISM)
Satoshi YAMASITA	Professor (Vice Director-General, ISM)
Kouji KANEFUJI	Professor (Vice Director-General, ISM)
Junji NAKANO	Professor (Director of Department of Statistical Modeling, ISM)
Yoshiyasu TAMURA	Professor (Director of Department of Data Science, ISM)
Satoshi KURIKI	Professor (Director of Department of Mathematical Analysis and Statistical Inference, ISM)
Yshinori KAWASAKI	Professor (Director of Center for Engineering and Technical Support, ISM)
Tomoko MATSUI	Professor (Department of Statistical Modeling, ISM)
Kenji FUKUMIZU	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)
Yoshihiko MIYASATO	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)

Cooperative Research Committee (As of June 1, 2017)

Tadahiko SATO	Professor, Faculty of Business Sciences, University of Tsukuba
Kunihiko TAKAHASHI	Associate Professor, Department of Biostatistics, Nagoya University Graduate School of Medicine
Akinobu TAKEUCHI	Professor, Faculty of Humanities and Social Sciences, Jissen Women's University
Takahiro TSUCHIYA	Professor, Center for Data Science, Yokohama City University
Hiroyuki MINAMI	Professor, Information Initiative Center, Hokkaido University
Junji NAKANO	Professor (Director of Department of Statistical Modeling, ISM)
Koji KANEFUJI	Professor (Director of Department of Data Science, ISM)
Shiro IKEDA	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)
Shinto EGUCHI	Professor (Department of Mathematical Analysis and Statistical Inference, ISM)

Managing Committee of School of Statistical Thinking (As of April 1, 2017)

Satoshi IMURA	Professor (Bioscience Group, National Institute of Polar Research)
Yoshimichi OCHI	Trustee, Vice-president (National University Corporation OITA UNIVERSITY)
Takafumi KUSANO	Representative Director / Co-Founder (BrainPad Inc.)
Wataru SAKAMOTO	Professor (Graduate School of Environmental and Life Science, OKAYAMA UNIV.)
Yo SHEENA	Professor (Academic Assembly School of Humanities and Social Sciences Institute of Social Sciences, Shinshu University)
Yoshinori KAWASAKI	Director (School of Statistical Thinking, ISM)
Genta UENO	Vice Director (School of Statistical Thinking, ISM)
Yukito IBA	Professor (Department of Statistical Modeling, ISM)
Kenichiro SHIMATANI	Associate Professor (Department of Data Science, ISM)
Satoshi ITO	Professor (ViceDirector-General, ISM)

Research Ethics Review Committee (As of April 1, 2017)

Specialist on epidemiology and social research	Kazuo SEIYAMA	Professor Emeritus, Tokyo University / Deputy Director, Research Center for Science Systems of Japan Society for the Promotion of Science
Specialist on epidemiology and social research	Keiko SATO	Associate professor, Kyoto University Hospital, Institute for Advancement of Clinical and Translational Science Department of EBM Research
Specialist in the field of ethics and law	Hitomi NAKAYAMA	Lawyer, Kasumigaseki-Sogo Law Offices
Person in citizen's position	Yutaka KURIKI	Kindergarten Director and Elementary School Director, KEIMEI GAKUEN
Research education staff of ISM	Tadahiko MAEDA	Associate Professor (Department of Data Science, ISM)
Research education staff of ISM	Yoo Sung PARK	Assist Professor (Department of Data Science, ISM)
Research education staff of ISM	Koji KANEFUJI	Professor (Department of Data Science, ISM)
Research education staff of ISM	Ikuko FUNATOGAWA	Associate Professor (Department of Data Science, ISM)
Research education staff of ISM	Shuhei MANO	Associate Professor (Department of Mathematical Analysis and Statistical Inference, ISM)

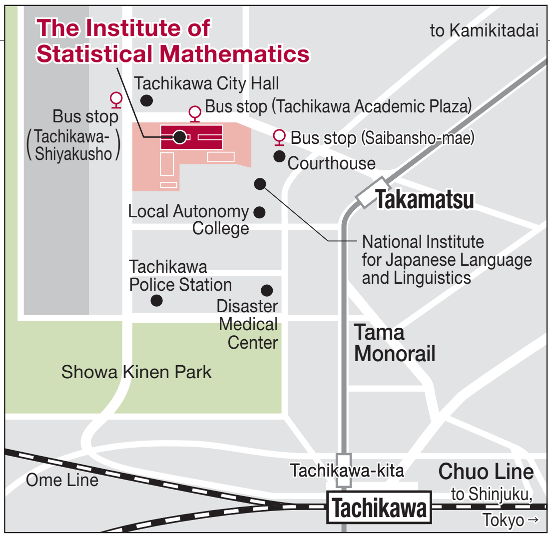
Professor Emeritus (As of April 1, 2017)

Kameo MATUSITA	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		

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	July	Data Science Center for Creative Design and Manufacturing was instituted.

The Institute of Statistical Mathematics



Access to the ISM

◎ Tama Monorail
—10 min walk from Takamatsu Sta.

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

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
http://www.ism.ac.jp/