2022

Kyoto University
Graduate School of Informatics

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Graduate School of Informatics

Graduate School

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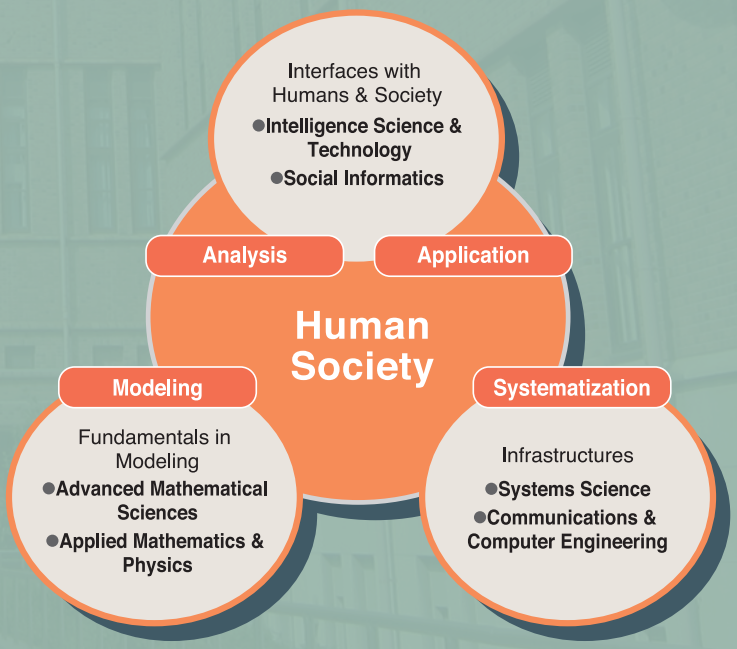
Introduction of the Departments

Information

of Informatics

Informatics is a cutting-edge interdisciplinary field for the 21st century which assimilates information with humans and society.



Graduate School

Welcome to the Graduate School of Informatics

Tatsuya Kawahara
Dean, Graduate School of Informatics

of Informatics

Information as the Foundational Infrastructure of Society, Industry, and Science

What do you think is the biggest difference in our society and lifestyle between now and your childhood? Most likely, it is the high availability of smartphones and social networking services (SNSs). While it is a truly revolutionary change to be able to communicate with anyone, any time, and anywhere during your waking hours, it all happened within the last 10 years or so. IT companies such as those whose services you use daily, like Google and LINE, are around 20 years old. I wonder how many people 10 or 20 years ago could have predicted where we would be today (anyone that did would now be wildly successful).Some of the by-products of the COVID-19 pandemic are online lectures and meetings, something which would have been close to impossible 10 to 20 years ago.

I myself have been involved in the research of speech recognition and interaction for nearly 30 years, and I am excited that these technologies have found their way into many corners of society. It is safe to say that an advanced information-oriented society is here to stay, and it happened faster than anyone could have imagined.

Information has triggered dramatic changes in the realms of industry and science, too. Some say that we are in the middle of the fourth industrial revolution. All sorts of natural and social phenomena and production and distribution processes of goods have been digitalized (IoT), stored in large databases together with search, purchase, travel, and other human behavioral data (big data), and optimized by AI. Meanwhile, we are witnessing the advent of the fourth paradigm in science, where the methodology of pooling data to build a model is being applied across disciplines in fields as diverse as humanities and social sciences, such as economics and linguistics, as well as natural sciences, including medicine, pharmacology, engineering, and agriculture. There is no denying that information has thus come to form the foundation of industry and science.

The Fourth Industrial Revolution

①Mechanization	②Electrification	③Automation	④Optimization
Steam engines	Electric motors	Computers	AI + IoT

The Fourth Paradigm in Science

①Empirical science	②Theoretical science	③Computational science	④Data-intensive science

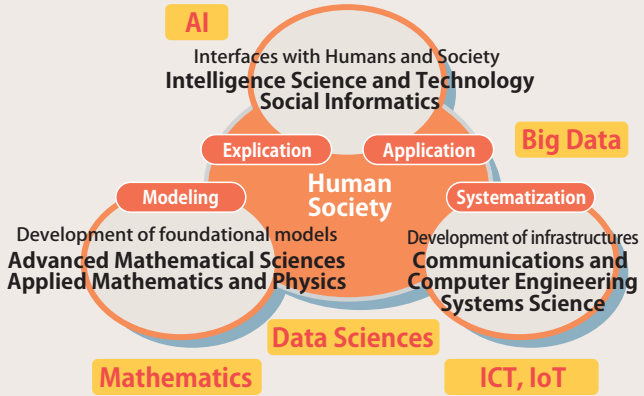
Kyoto University Graduate School of Informatics

It was in the context of this cross-disciplinary spanning of information that the Kyoto University Graduate School of Informatics was established in 1998. Prior to that, there existed faculties and graduate schools that called themselves "computer science/engineering" or "information science" in Japan, but ours was the first graduate school to adopt the term "informatics." Around the same time, other universities in Japan began to establish graduate schools focusing on information, but the Kyoto University Graduate School of Informatics distinguishes itself from others by the breadth of fields it covers (the study of information in a broad sense of the term). For example, we have a wide spectrum of courses and chairs on information and communications technology (ICT), some of which focus on computers and others on communication. Our courses and chairs on mathematical and data sciences, on the other hand, encompass wide-ranging fields from mathematics and statistical machine learning to physics and control theory. We even have courses and chairs on human intelligence, on top of those with a focus on AI. We also have cooperating chairs and courses that cover an even broader range of fields such as ecology and environment as well as healthcare and disaster management.

What makes our graduate school even more special is that leading experts in all respective fields are in charge of these courses and chairs. When new professors are recruited, their achievements are read aloud in the faculty meeting, and I am always impressed by their outstanding qualifications. Our students also come from diverse backgrounds in terms of the undergraduate programs they attended, the universities/colleges from which they graduated, and the countries from which they hail, and they are well motivated to attend to their academic pursuits and research with passion.

The Graduate School of Informatics has over 100 faculty members, making it the sixth largest among the 15 graduate schools at Kyoto University and one of the largest graduate schools in this discipline in Japan.

Every year, we admit about 200 students for the Master's program and about 60 students for the Doctoral program, a capacity that is more than double the size of the Kyoto University Undergraduate School of Informatics and Mathematical Sciences. Many international students are enrolled, too.



To Prospective Students: What AI Can't Do

The Graduate School of Informatics opens its doors wide to prospective students who seek to learn "the study of information in the broad sense of the term." This is evidenced by the fact that we accept both domestic and international students from a variety of backgrounds, unfettered by the conventional framework of sciences versus humanities.

I hope that you will learn to do things that AI cannot accomplish. AI has already surpassed humans in terms of knowledge capacity and the ability to make inferences from large-scale data, with the result that what used to be regarded as intellectual professions are increasingly being replaced by AI. What then are the things that AI cannot do?

First, it is the ability to identify a problem and formulate it. AI that we have now functions only when both the input and output are clearly defined. However, many of the problems in the natural world and in human societies are so complex that it is extremely difficult to clearly formulate them. For example, the problem to "develop a robot that is capable of having natural conversations as humans do," could be reduced to questions such as how to generate natural backchannels and responsive actions, or to understand/express emotions. In other words, once you formulate your problem, you have only to collect data and leave the training and inference to AI.

The second thing that AI is not good at is communicate. The ability to solve problems through dialogue is what current AI is lacking. As science and technology have advanced this much, most of the remaining tasks are hard to be resolved alone. For instance, it took cross-border collaboration among researchers from various fields to visualize a black hole.To address various challenges caused by the COVID-19 pandemic, too, we need to bring together the wisdom of many experts. In many of the informatics research fields, code and data are shared within the international community of researchers, thus making rapid progress even as I write this. We are virtually "standing upon the shoulders of giants," and we must have good communication within and outside of labs to continue to progress.

This third thing that AI is incapable of is having a broad perspective. As I mentioned earlier, respecting diversity is crucial. Unfortunately, AI is blind to the deeper meanings that underlie data. For example, AI that has learned from data gathered in a male-dominated society will make decisions advantageous to males in recruitment and promotion. To find a good model and make a good decision, I would like you to take an interest in what is going on in the world and what persons around you are doing, rather than exclusively focusing inward on your own circumstances and activities. Coming from diverse backgrounds and conducting fascinating studies, the faculty and researchers at Kyoto University and its Graduate School of Informatics will surely stimulate your intellectual curiosity.

For Potential Partners to the Graduate School of Informatics: What Private Enterprises Can't Do

The Graduate School of Informatics is most proactive in joint research with other institutions and industry-government-university collaboration. This is because, as I stated at the outset, information serves as the foundational infrastructure for society and industry, and "the study of information in the broad sense of the term" is interdisciplinary by nature. True to this belief, we have conducted numerous joint research and contract research projects and signed academic exchange agreements with universities outside of Japan.

Needless to say, the Graduate School of Informatics is working on research projects that private enterprises find it difficult to do for one reason or another. Every year, we sponsor a joint seminar with overseas universities, and many of our counterparts say that the research themes our faculty members often choose are both "basic and long-term." If you seek to collaborate with us, therefore, I would appreciate it very much if you would share our long-term perspective. We also promote open innovations and I would appreciate your understanding in this regard.

Preparing for the Future

As I mentioned before, information technology is innovating every second. Just as it was 10 or 20 years ago, it is extremely difficult to predict what the future will hold 10 or 20 years from now. It is even more difficult to predict what will come next after the fourth Industrial Revolution and fourth paradigm in science.

Yet, one cannot help wonder if today's world is better than how it was 20 years ago. Is our lifestyle truly more affluent now? It could be argued that the COVID-19 pandemic is a natural disaster, but some of the major social problems, including political division, economic disparity, and global warming, may be regarded as side effects of the advanced information-oriented society.

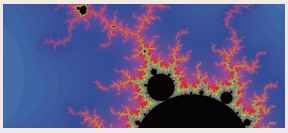
Or it could be the case that more people suffer from stress, depression, and dependence because society as a whole has become busier and less generous and tolerant. I believe that it is the responsibility of informatics researchers to find clues to solutions to these various problems and shape a better society by taking these aspects into account. After all, this approach has much in common with Society 5.0, a vision for the future society which is being promoted in Japan, and with the Sustainable Development Goals (SDGs) proposed by the United Nations.When this pandemic is behind us, our world will become increasingly computerized and virtualized, which in turn will enhance the importance of informatics. It would bring me great joy if we can produce individuals who, with solid foundations and broad perspectives, challenge themselves by journeying into the great unknown.

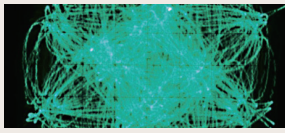
Tatsuya Kawahara

Dean, Graduate School of Informatics

1987 B.E. degree from the Department of Information Science, Faculty of Engineering, Kyoto University
1989 M.E. degree from the Graduate School of Engineering, Kyoto University
1990 Research Associate, Faculty of Engineering, Kyoto University
1995 Dr.E from the Graduate School of Engineering, Kyoto University
1995 Associate Professor, Faculty of Engineering, Kyoto University
1998 Moved to the then newly-established Graduate School of Informatics, Kyoto University
2003 Professor, Academic Center for Computing and Media Studies and Graduate School of Informatics, Kyoto University, where he majors in speech processing, particularly speech recognition and interaction systems
2012 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology of Japan
Board member, International Speech and Communication Association (ISCA)
APSIPA President-Elect
Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Associate Member, Science Council of Japan

Graduate School





Departments

Division	Group / Unit / Research Group			
Department of Intelligence Science and Technology P.09				
Brain and Cognitive Sciences	Neuroinformatics	Psychoinformatics	Cognitive Informatics	Computational Cognitive Neuroscience (Adjunct Unit)
Cognitive System	Computational Intelligence	Collective Intelligence	Conversational Informatics	
Intelligent Media	Language Media Processing	Speech and Audio Processing	Computer Vision	
Application of Multimedia (Affiliated)	Video Media	Network Media	Text Media	
Bio-system Informatics (Affiliated)	Biological Information Networks			
Department of Social Informatics P.19				
Social Information Model	Distributed Information Systems	Human-Robot Interaction	Social Media	
	Sociotechnical Design			
Social Information Network	Consensus Informatics	Information Security (Adjunct Unit)		
Biosphere Informatics	Bioresource Informatics	Environmental Informatics		
Regional and Disaster Management Information Systems (Affiliated)	Integrated Disaster Management Systems	Emergency Management for Disaster Reduction Systems	Crisis Information Management System	
Medical Informatics (Affiliated)				
Learning and Educational Technologies (Affiliated)	Learning and Educational Technologies	Data Engineering and Platform Research		
Department of Advanced Mathematical Sciences P.29				
Applied Analysis	Applied Analysis			
Nonlinear Physics	Nonlinear Physics			
Applied Mathematical Sciences	Computational Mechanics	Industrial Mathematics		
Department of Applied Mathematics and Physics P.35				
Applied Mathematics	Applied Mathematical Analysis	Discrete Mathematics		
Applied Mathematical Systems	System Optimization	Control Systems Theory	Applied Mathematical Modeling (Adjunct Unit)	
Mathematical Physics	Physical Statistics	Dynamical Systems		
Department of Systems Science P.41				
Human Machine Symbiosis	Mechanical Systems Control	Human Systems	Integrated Dynamical Systems	Mobility Research
Systems Synthesis	Mathematical Information Systems	Statistical Intelligence	Computational Intelligence Systems (Adjunct Unit)	
Systems Informatics	Learning Machines	Integrated Systems Biology	Biomedical Engineering	Computational Neuroscience (Adjunct Unit)
Applied Informatics (Affiliated)				
Department of Communications and Computer Engineering P.49				
Computer Engineering	Computer Algorithms	Computer Architecture	Computer Software	
Communications Systems Engineering	Digital Communications	Integrated-Media Communications	Intelligent Communication Networks	
Integrated Systems Engineering	Processor Architecture and Systems Synthesis	Ultrafast Signal Processing		
Radio Atmospheric Sciences (Affiliated)	Remote Sensing Engineering	Atmospheric Observations		

Department of Intelligence Science and Technology

Department of Intelligence Science and Technology

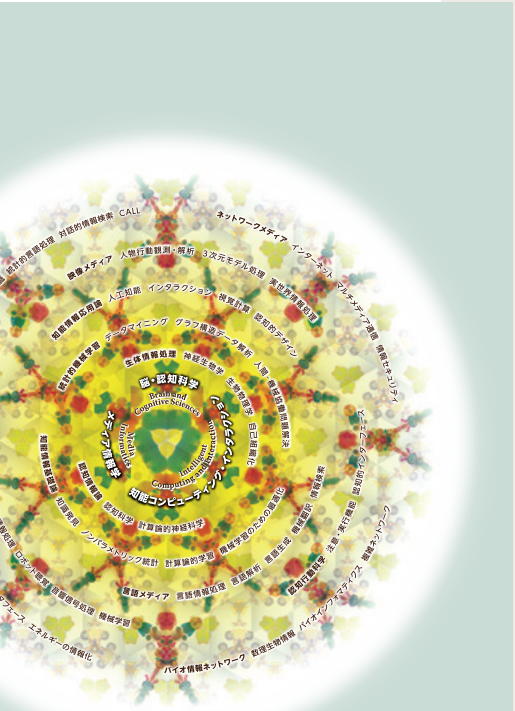
Construction and Elucidation of Intelligence Realization of Flexible, Human-like Information Processing.

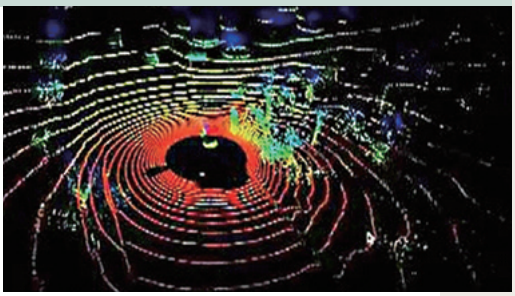
In an advanced information-oriented society, we require information processing with flexible, human-like information capabilities.

Information processing in human and animal organic systems has developed by means of structural and functional adaptation to the environment through a long process of evolution; there is no other high-level processing capacity quite like it.

Intelligence Science and Technology is a multidisciplinary field that aims to clarify the mechanisms of biological- particularly, human-information processing for the development of higher-level information processing.

Welcome to the World of Intelligence Science and Technology.





Welcome to Department of Intelligence Science and Technology

Intelligence Science and Technology is an interdisciplinary research field in which we study sophisticated human information processing and develop new technologies on the basis of an understanding of human intelligence. By "intelligence," we do not mean simply "`artificial intelligence" but rather a wider scope embracing intelligent aspects of human, systems, and information technology. More specifically, our research and educational activities include (i) basic mechanisms of human beings, such as life, brain, cognition, and behavior, (ii) information media related to language, speech/auditory, and visual information, and (iii) a broad range of topics related to intelligence and informatics, such as interaction between human and intelligent systems, artificial intelligence and machine learning, and software and networks. One of our distinguishing features is integration of these topics under a unique discipline, "intelligence science and technology," notwithstanding that these topics are also investigated in separate research fields such as neuroscience, psychology, engineering, and computer science. Faculty members and students coming from a wide variety of academic backgrounds devote themselves to cooperating in pursuit of this common goal. We hope that, in this unique academic environment, many young students will engage in this exciting research field, tackle the mysteries of complex human intelligence, and develop new ideas for addressing challenging issues regarding intelligent media and computation.

Our department welcomes outstanding students from various fields besides those of computer science and engineering. We provide interdisciplinary curricula and research projects. Join us, and enjoy an intellectually exciting experience!

Ko Nishino

Professor, Department of Intelligence Science and Technology

2002 Sc.D., University of Tokyo
2002 Postdoctoral Research Scientist, Columbia University
2005 Assistant Professor, Drexel University
2011 Associate Professor, Drexel University
2016 Professor, Drexel University
2018 Professor, Kyoto University

Outline

Divisions and Groups

Division	Group	Research and Education Topics	Professor
Brain and Cognitive Sciences	Neuroinformatics	Operating Principles of the Nervous System and the Brain and Basic Principles of Information Processing	Yukiyasu Kamitani
	Psychoinformatics	Human Attention and Executive Function, and Cognitive Interface	Takatsune Kumada
	Cognitive Informatics	Human Sensory and Cognitive Processing	Shin'ya Nishida
	Computational Cognitive Neuroscience (Adjunct Unit)	Neural Information Processing and Computational Models	Hiroyuki Nakahara Wataru Sato
Cognitive System	Computational Intelligence	Information Modeling for Intelligent Information Processing Mechanism	Akihiro Yamamoto
	Collective Intelligence	Machine Learning and Data Mining	Hisashi Kashima
	Conversational Informatics	Understanding and Designing Interaction, Human Computer Interaction Using Visual Information	
Intelligent Media	Language Media Processing	Natural Language Processing, Knowledge Engineering	Sadao Kurohashi
	Speech and Audio Processing	Recognition and Understanding of Speech, Audio and Music	Tatsuya Kawahara
	Computer Vision	Visual Information Processing, Visual Intelligence	Ko Nishino
Application of Multimedia (Affiliated)	Video Media	Interaction through images and physical sensations	Yuichi Nakamura
	Network Media	Techniques to Realize Multimedia Information Network	Yasuo Okabe
	Text Media	Advanced Digital Archiving via Speech and Language Processing	Shinsuke Mori
Bio-system Informatics (Affiliated)	Biological Information Networks	Bioinformatics, Computational Systems Biology	Tatsuya Akutsu

Graduate Curriculum

Courses for the Master's Program

Introduction to Cognitive Science
Introduction to Information Science
Introduction to Bioinformatics
Seminar on Cognitive Science
Computational Cognitive Neuroscience
Computational Learning Theory
Pattern Recognition (Advanced)
Conversational Informatics
Multimedia Communication
Speech Processing (Advanced)
Language Information Processing (Advanced)
Computer Vision
Visual Interface
Statistical Learning Theory
Bioinformatics (Advanced)
Seminar on Intelligence Science and Technology I, II, III, IV
Advanced Study in Intelligence Science and Technology I
Advanced Study in Intelligence Science and Technology II

Courses for the Doctoral Program

Seminar on Intelligence Science and Technology, Advanced
Seminar on Brain and Cognitive Sciences, Advanced
Seminar on Cognitive System, Advanced
Seminar on Intelligence Media, Advanced
Seminar on Application of Multimedia, Advanced
Seminar on Bio-system Informatics, Advanced

Teaching Staff

(M) : Academic Center for Computing and Media Studies

Professors

Yukiyasu Kamitani; Takatsune Kumada; Shin'ya Nishida; Hiroyuki Nakahara (RIKEN, Adjunct); Wataru Sato (RIKEN, Adjunct); Akihiro Yamamoto; Hisashi Kashima; Sadao Kurohashi; Tatsuya Kawahara; Ko Nishino; Yuichi Nakamura (M); Yasuo Okabe (M); Shinsuke Mori (M); Tatsuya Akutsu (Institute for Chemical Research)

Associate Professors

Ryoichi Nakashima; Natsuhiro Ichinose; Makoto Yamada; Atsushi Nakazawa; Chenhui Chu; Kazuyoshi Yoshii; Shohei Nobuhara; Kazuaki Kondo (M); Shuichi Miyazaki (M); Hiroaki Nanjo (M); Takeyuki Tamura (Institute for Chemical Research)

Senior Lecturers

Hiroshi Hosokawa; Hiroaki Mizuhara; Yugo Murawaki

Assistant Professors

Shingo Maegawa; Kiyofumi Miyoshi; Koh Takeuchi; Fei Cheng; Koji Inoue; Eita Nakamura; Keiko Ochi; Kei Shimonishi (M); Daisuke Kotani (M); Hirotaka Kameko (M); Tomoya Mori (Institute for Chemical Research)

Brain and Cognitive Sciences

We aim to investigate both the cognitive and the physiological mechanisms of advanced biological, especially human, information processing and to explore possible applications of such mechanisms. For this purpose, we plan to analyze the information processing mechanisms of the nervous system at the molecular, biochemical and physiological levels; to elucidate the underlying principles; and to develop new artificial information processing systems. Moreover, we will analyze the processes of human sensation, perception, learning, memory, thought and inference from both a cognitive perspective and a computational neuroscience perspective in order to examine the mechanisms of these types of information processing.

Neuroinformatics

Decoding neural codes

Brain signals can be seen as "codes" that encode our mental contents. We study methods for modeling brain functions and representations using information science and technology including machine learning and artificial neural networks. Our approach is based on data-driven predictive models that relate brain data and mind states via analysis of massive neural, behavioral, and multimedia data. Using these models, we aim to understand basic principles of neural information processing, and seek to develop real-life applications such as brain–machine interfaces that exploit decoded brain information.

[Professor: Yukiyasu Kamitani;
Senior Lecturer: Hiroshi Hosokawa;
Assistant Professor: Shingo Maegawa]

Psychoinformatics

Toward understanding human cognition and applying it to human-machine interface

Human activities in daily life are supported by basic cognitive functions, such as perception, attention, memory and high-order executive control. We investigate the psychological and neuroscientific bases of these cognitive functions (especially focusing on attention and executive function), using psychological experiments, brain-imaging and computational techniques. We are interested in human behavior not only in well-controlled experimental settings in a laboratory, but also in real-world settings such as IT-equipment use and real car driving. We are also interested in cognitive functions in a wide range of populations, from healthy young adults to older or disabled individuals.

[Professor: Takatsune Kumada;
Associate Professor: Ryoichi Nakashima]

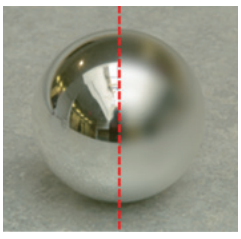
An experiment examining eye and action coordination

Cognitive Informatics

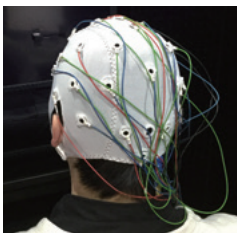
Understanding Human Sensory and Cognitive Information Processing

Our lab studies the computational principle and the neural mechanisms of human functions including perception, cognition and language processing, by means of psychophysics, computer simulations and EEG recordings. By comparing human brains with cutting-edge artificial intelligent systems, we attempt to reveal the characteristic nature of the human information processing. We are also interested in leveraging human scientific studies for innovation of information technologies.

[Professor: Shin'ya Nishida; Senior Lecturer: Hiroaki Mizuhara;
Assistant Professor: Kiyofumi Miyoshi]



Material perception is one of our research topics.



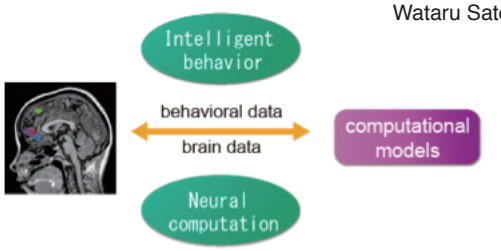
Brain researches by EEG measurements

Outline

Computational Cognitive Neuroscience (Adjunct Unit)

Neural information processing and computational models

We aim to understand the computational principles that underlie the way neural systems realize adaptive behavior and complex minds: e.g., decision-making, reinforcement learning, motivation and emotion, and social behaviors. Our approaches are tightly linked to statistical and information science including machine learning and neural networks, as well as to questions in neuroscience and psychology. To address our questions, we build computational and mathematical models, and develop data analysis methods for linking those behavioral functions and brain signals through computations. We use human fMRI to examine neural signals and computations, combined with those modeling and quantitative methods. We also seek to use our insights to be applied to constructing brain-based intelligence. [Professors: Hiroyuki Nakahara, Wataru Sato]



Cognitive System

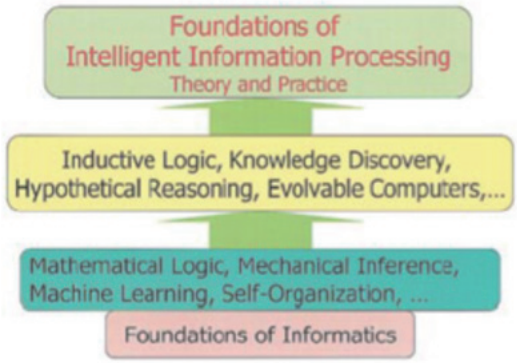
Our goal is to develop flexible and intelligent information processing. We will identify the basic components and structures of information, as well as study extraction, recognition, understanding, and representation of information. We are developing new approaches of intelligence information research including advanced data analysis, reasoning, inference, and interaction.

Computational Intelligence

Formulation of principles to support intelligent information processing

We will formalize the intelligent information processing seen in human activities and conduct studies on the basic principles that underlie these processes, as well as realization methods. Specifically, this will involve education and research relating to artificial intelligence information processing such as inductive logic, knowledge discovery, hypothetical reasoning, and evolvable computers, using mathematical logic, inference procedures, machine learning theories and self-organization.

[Professor: Akihiro Yamamoto;
Program-Specific Associate Professor: Natsuhiro Ichinose]

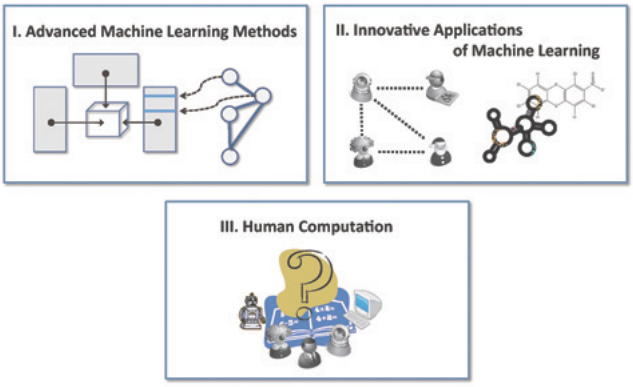


Collective Intelligence

Data Analysis That Matters

Our research focus is on advanced data analysis methods such as machine learning and data mining, and on their applications to important real-world problems in various fields including marketing, healthcare, and industrial systems. Our research interest also includes human-computer cooperative problem solving for hard problems computers alone cannot solve.

[Professor: Hisashi Kashima;
Associate Professor: Makoto Yamada;
Assistant Professor: Koh Takeuchi]

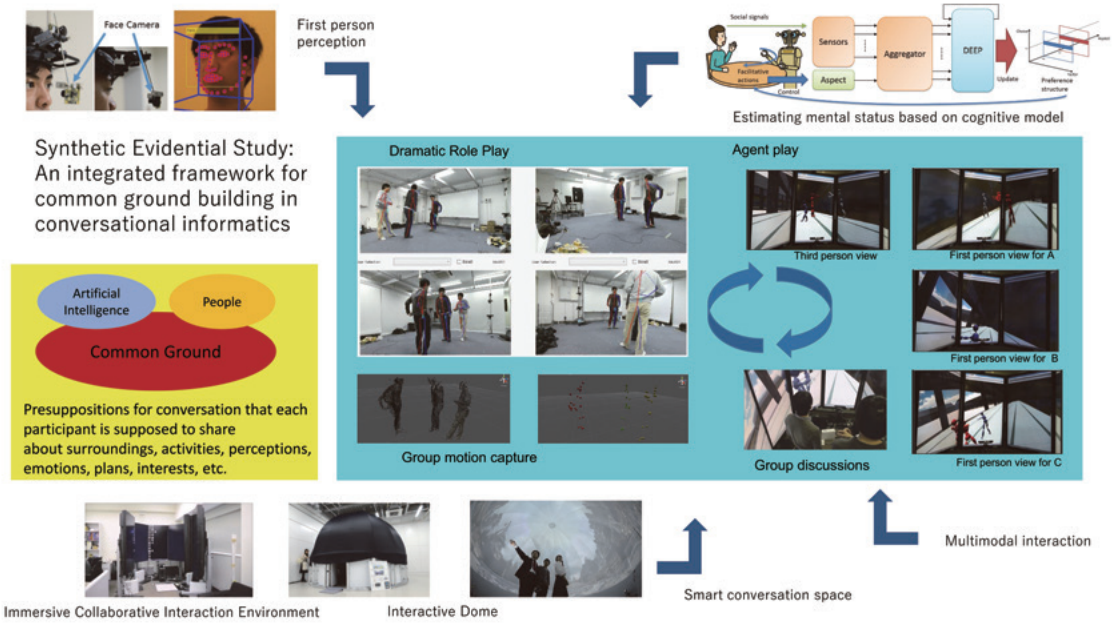


Conversational Informatics

Design and understanding of social intelligence and interaction

People converse with each other for many reasons: to exchange information, to discuss an issue, to resolve a conflict, to increase mutual understanding, to compose a joint story, or just for fun. Conversation will remain as a vital means for people to communicate with other people and autonomous agents in the emerging human-agent symbiotic society. Our group centers on understanding and augmenting conversational interactions. We are keen to provoke and support empathic conversation in which participants are engaged in a game-like activity to make tacit thoughts explicit and organize them into a larger discourse in a very effective trial-and-error fashion. Building and management of common ground consisting of a shared knowledge and belief among participants is a key issue to make it happen. We take a data-intensive approach to acquire and utilize data entailing how participants interact with each other, what information to be shared, and which aspects of the environment are relevant. We aim at building a computational framework for sharing and cultivating wisdom through enhancing conversational interactions and facilitating conversational content in a community. The primary theoretical backbone is conversation quantization that characterizes conversation as a series of conversational quanta, each of which packages information about relevant participants, references to the objects and events discussed in the discourse, a series of verbal and nonverbal utterances exchanged by the participants, commitments to previous discourse (themes), and new propositions in the discourse (rhemes). We focus on smart conversation space, conversation capture, conversation production, cognitive approach, and synthetic evidential study.

[Associate Professor: Atsushi Nakazawa]



Outline

Intelligent Media

The Intelligence Media Division deals with language, speech, and visual information, which are the fundamental media that represent, accumulate and communicate information. Research and education conducted at the Division cover a wide range of topics in theory and application, including analysis, recognition and understanding of information contents represented in these media, as well as media generation/editing to effectively represent and communicate information.

Language Media Processing

Making computers that can understand language

Language is the most reliable medium of human intellectual activities. Our objective is to establish the technology and academic discipline for handling and understanding language, in a manner that is as close as possible to that of humans, using computers.

■Fundamental studies on text understanding

By analyzing over 10 billion sentences collected from the Web using a computer cluster, we are conducting research on automatic learning of predicate-argument structures, inter-event relations, as well as knowledge-based sentence understanding.

■Application of language processing

Through cooperation with various institutions that possess real data, we are working on ways to apply language processing in a real world context.

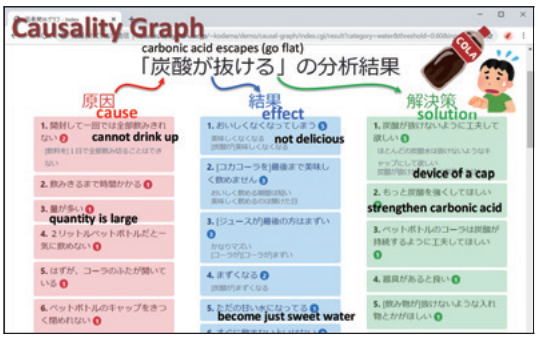
・Advanced information aggregation from SNS texts, contact center inquiry logs, etc.

・Structuring and knowledge processing of medical texts for development of medical AI

・Construction of a dialogue system as a new communication channel between governments and citizens

・Research into practical use of machine translation (simultaneous translation of lectures at universities, etc.)

[Professor: Sadao Kurohashi;
Program-Specific Associate Professor: Chenhui Chu;
Senior Lecturer: Yugo Murawaki;
Program-Specific Assistant Professor: Fei Cheng]

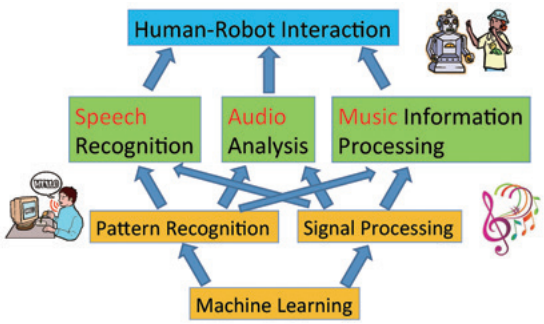


Speech and Audio Processing

Recognition and understanding of speech, audio and music

Speech communication plays a key role in human intelligence. We are studying the intelligent processing of speech, audio and music as exchanged by human beings for automatic recognition, understanding and interaction systems, specifically (1) automatic speech transcription of meetings and lectures, (2) analysis of audio scenes and music signals composed of multiple sound sources, and (3) humanoid robots capable of natural interaction by combining non-verbal information.

[Professor: Tatsuya Kawahara;
Associate Professor: Kazuyoshi Yoshii;
Assistant Professor: Koji Inoue;
Program-Specific Assistant Professors: Eita Nakamura, Keiko Ochi]



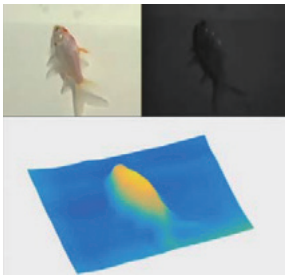
Computer Vision

Making Computers See

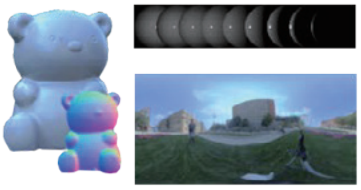
Neural substrates dedicated to vision is said to occupy about 40 percent of the cerebral cortex. Realizing computer vision as a truly intelligent perceptual modality is fundamental for artificial intelligence, and would also inform our understanding of human visual intelligence. Towards computational visual intelligence, our research is focused on establishing the theoretical foundations and efficient implementations of computational methods for better understanding people, objects and scenes from their appearance in images and video, as well as the development of novel computational imaging systems that can see beyond what we see.

[Professor: Ko Nishino;
Associate Professor: Shohei Nobuhara]

Tracking People in Crowds



Shape from Water



Reflectance and Natural Illumination from a Single Image

Application of Multimedia (Affiliated)

Multimedia processing with computer devices has new and great potential for expression, information gathering and real-time dialogue processing. We aim to teach and study the technology of multimedia applications through the construction of educational environments in which we can make use of multimedia consisting of images, texts, sound, etc. In this way, students can engage in their studies while creating something of practical use in university courses.

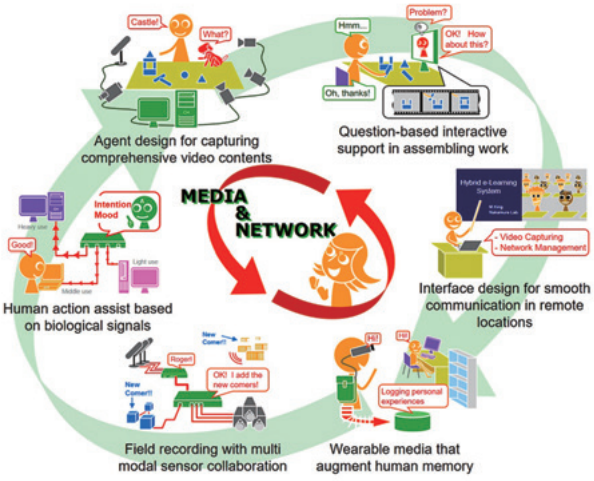
Video Media

Toward human-centered information and machine systems through visual and embodied interactions

The main purpose of this group is to create information media and mechanical systems that support human with respecting their subjective actions.
Such media include watching over humans to provide supports in appropriate way and time, supplying only deficient force in motions, interfaces that connects humans and computers, and assisting human memory.

A common approach in all of these media is that information or mechanical systems notice human's intention and augment their abilities for meeting what they want to do.

To realize this support scheme, this group is engaged in basic researches involving (1) artificial intelligence and knowledge processing, (2) recognition of human physical and physiological activities using visual, acoustic, and biological measurements, (3) modeling human behaviors in motion and communication, while (4) designing and implementing the human-centered supporting media using (5) robotic and artificial agent control technology.



- Interface of visualizing human intentions inferred from motions
- Wearable computers for recording and supporting personal/group experiences
- Motion assist based on behavioral analysis using electromyography
- Facial expression recognition for health science and care of dementia persons
- Joint research using image analysis and AI with other laboratories and research centers within and outside of Kyoto University

[Professor: Yuichi Nakamura; Associate Professor: Kazuaki Kondo; Assistant Professor: Kei Shimonishi]

Outline

Network Media

Towards a ubiquitous networking world

In a ubiquitous networking world, everything is capable of computing and networking, enabling constant Internet connectivity. Our research goal is to achieve just such an environment. To that end, we are working on fundamental research issues pertaining to the next-generation Internet, including IPv6 architecture and programmable networks, operation technologies such as automatic network configurations, platform technologies that support various services, such as identity federation, and security. We are also working on technologies for integration of information, communication through application of Internet protocols and algorithms such as routing, matching, reservation and interruption, and power management. We also work on design and analysis of algorithms for combinatorial optimization problems, and on proving the intractability of problems.

[Professor: Yasuo Okabe;
Associate Professor: Shuichi Miyazaki;
Assistant Professor: Daisuke Kotani]

Demonstration of on-demand power network

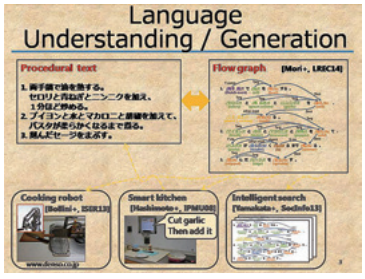
Text Media

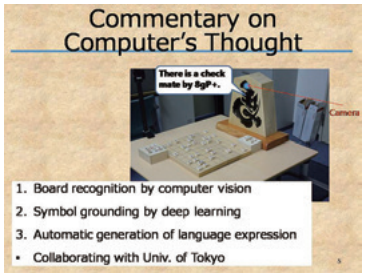
Speech and Natural Language Processing for Multi-media Archives

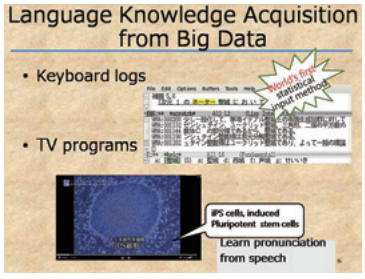
Since time immemorial human knowledge has been recorded as text. The research activities of this group focus on computers capable of understanding these texts and describing new knowledge. As a basis we are studying fundamental natural language processing. And we are studying natural language generation to explain data analysis and future prediction by computer or to describe other media such as video and speech.

Specifically, we deal with real-world media, including procedural texts such as cooking recipes with execution videos, academic knowledge such as history/geography research, and game/data analysis by computers.
We also try to expand human knowledge based on our research results.

[Professor: Shinsuke Mori;
Associate Professor: Hiroaki Nanjo;
Assistant Professor: Hirotaka Kameko]







Bio-system Informatics (Affiliated)

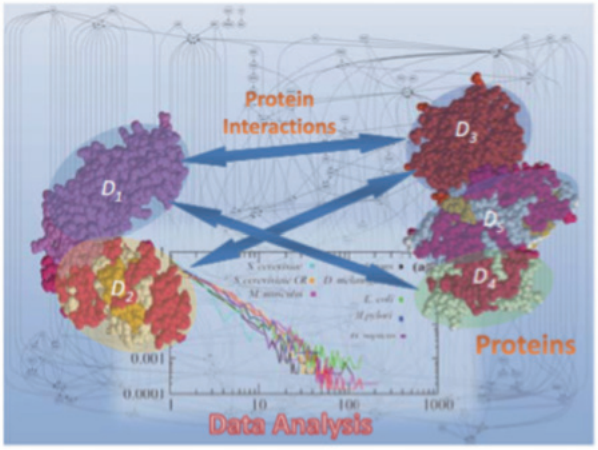
Biological systems and creatures are ineffably complex systems in which many kinds of chemical structures, proteins, genes and other objects interact with one another. We examine these as interactive networks to implement education and research aimed at elucidating and understanding the system, mainly from the perspective of information science.

Biological Information Networks

IT for analysis of biological information

We develop algorithms for inferring interactions among genes, proteins and chemical structures, and for analyzing their interactive networks based on mathematical methods. We also develop algorithms and software tools for other problems in bioinformatics, including sequence analysis and inference of higher-order structures and functions of protein.

[Professor: Tatsuya Akutsu;
Associate Professor: Takeyuki Tamura;
Assistant Professor: Tomoya Mori]

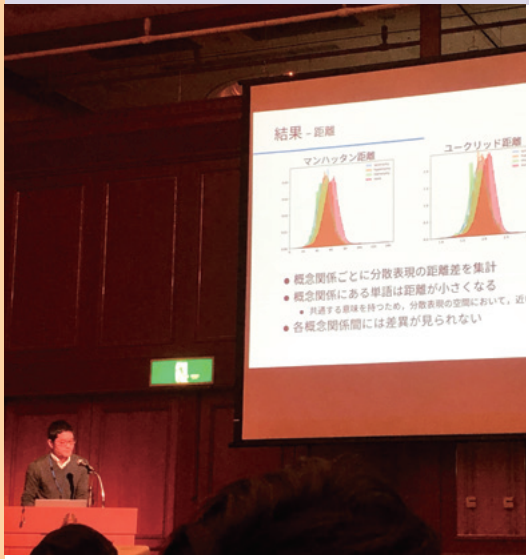


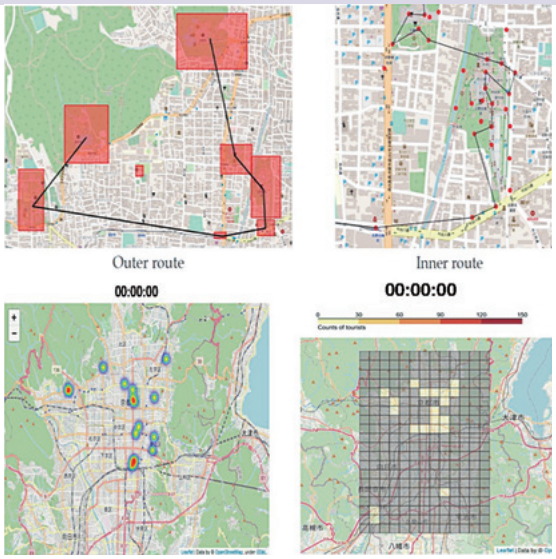
Analysis of three-dimensional structures and interactions of protein

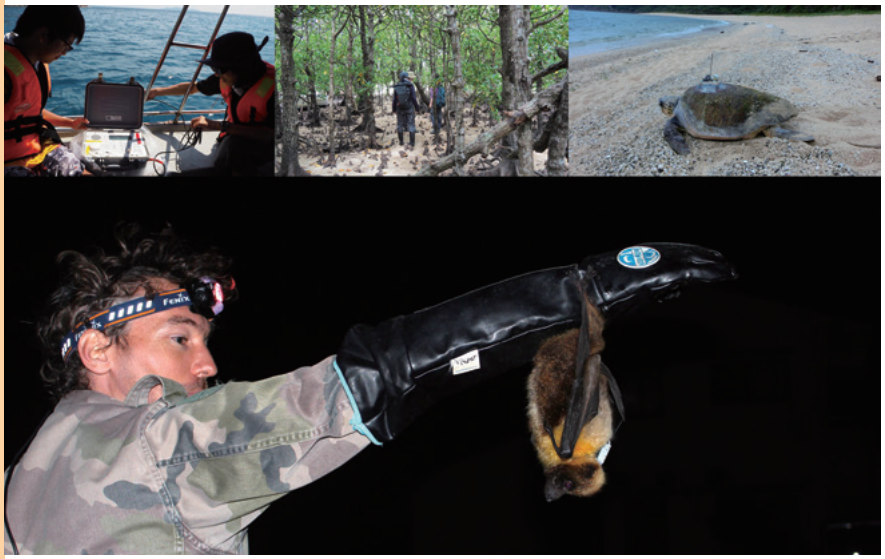
Department of Social Informatics

Harmonizing Society and Information Technology

Global networking is rapidly expanding via information technology. Based upon the trends of technologies that interact with our daily lives, the Department of Social Informatics seeks to clarify the structures of highly complex information societies and actually design information systems that are globally useful. Therefore, we endeavor to support globalizing activities in the areas of culture, economics, ecology, disaster management, healthcare and education.







Information is Born in the Lives of People

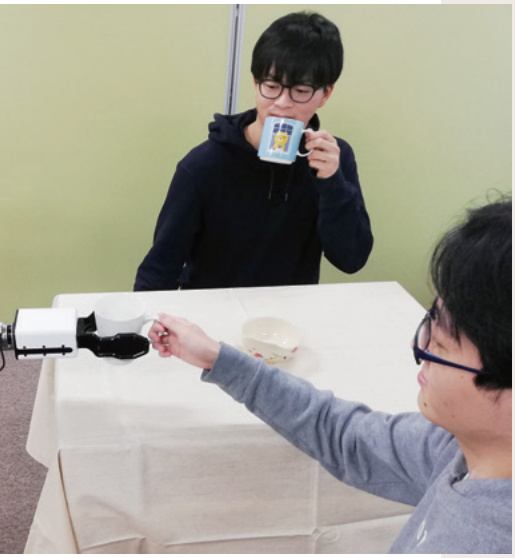
Sources of social information do not exist on the Internet. These sources are usually found in people's daily lives. Social informatics includes processes from the acquisition of information from the sources, through constructing systems to utilize the information, to designing a better society using those information systems. For example, we collect ecological information relevant to fish by using bio-logging techniques for fishery resource conservation. We also glean biological information from forest ecosystems using various types of sensors to optimize the sustainable utilization of ecosystem services. Then, we study methods for database development to organize that information on natural resources and environments. Moreover, we study informatics applications in the fields of medical services and education, and also determine what types of information are needed for disaster prevention and harm minimization. We consider ways to utilize the data to design societies and social systems. We, the people in the Department of Social Informatics, work to acquire data directly related to our lives and societies, and to reformulate and store it in the most accessible and useful way to enable the development of our sustainable future.

Nobuhito Ohte
Department of Social Informatics

He is a Professor of the Biosphere Informatics Laboratory in the Department of Social Informatics at Kyoto University. His research themes are to understand mechanisms of hydrological controls of nutrient transformations and transportations in the forested catchment, and to elucidate the geographical variations of those ecosystem dynamics among various types of climatic and geological conditions. He holds a BA in forestry from Graduate School of Agriculture at Kyoto University in 1987, and a PhD also from Kyoto University in forest hydrology in 1992. He was awarded Biwako Prize for Ecology in 2013. He is currently an associate editor of Biogeosciences (European Geoscience Union).

Applications of Information Technologies Expanding

Information technologies are causing our society to make great strides, with data science, artificial intelligence (AI), and information search becoming an integral part of our lifestyles. Meanwhile, robots, autonomous vehicles, and other information systems with advanced AI continue to blend into our physical world. As one new information technology after another is being developed, how can information systems be created that achieve harmony with society and are accepted and utilized? The Department of Social Informatics is privileged to have a faculty comprised of experts in information technologies and teaching staff versed in applications of information technologies in such fields as biology, agriculture, medical science, disaster management, and education. If you wish to create information technologies that lead to practical applications or information systems that are of genuine use to society, this is the place you want to conduct your research!



Takayuki Kanda
Department of Social Informatics

He received a bachelor's degree from the Department of Information Science, Kyoto University Faculty of Engineering, in 1998, and completed his doctoral program at the Department of Social Informatics, Kyoto University Graduate School of Informatics, in 2003 to earn a Ph.D. in Informatics. He joined ATR Intelligent Robotics and Communication Laboratories in 2003 to successively assume the positions of researcher, senior researcher, and Group Leader. Since 2018, he has held a professorship at the Department of Social Informatics, Kyoto University Graduate School of Informatics. His research interests include human-robot interactions, especially robots' autonomous dialogue mechanisms and social competencies, dialogues by anthropomorphic robots using their bodies, and their applications to everyday life settings.

Outline

Divisions and Groups

Division	Group / Unit	Research and Education Topics	Professor
Social Information Model	Distributed Information Systems	Technical Issues and Applications Used in the Formation of Distributed Information Systems	Masatoshi Yoshikawa
	Human-Robot Interaction	Intelligent Robotics for Our Daily Society	Takayuki Kanda
	Social Media	Acquisition, Analysis, Extraction, and Retrieval of Social Information	Keishi Tajima
	Sociotechnical Design	Basic communication technology to enhance human relations	Naomi Yamashita
Social Information Network	Multiagent Systems	The Formation of Social Systems Based on Information Networks	Takayuki Ito
	Information Security (Adjunct Unit)	Encryption and Authentication System	Masayuki Abe
Biosphere Informatics	Bioresource Informatics	The Processing and Analysis of Biosphere Resource Data	
	Environmental Informatics	Investigating Interactions between Human Society and the Biosphere Environment	Nobuhito Ohte
Regional and Disaster Management Information Systems (Affiliated)	Integrated Disaster Management Systems	Disaster Information Systems and Building Disaster Prevention Systems	Hirokazu Tatano
	Emergency Management for Disaster Reduction Systems	Social Scientific Research for Disaster Damage Reduction	Katsuya Yamori
	Crisis Information Management System	Practical Disaster Management for Business Continuity	Michinori Hatayama
Medical Informatics (Affiliated)		Interaction between Information Systems and Medical and Social Organizations	Tomohiro Kuroda
Learning and Educational Technologies (Affiliated)	Learning and Educational Technologies	Information Systems that Support Learning and Education	Hiroaki Ogata
	Data Engineering and Platform Research	Research to support internet-scale data infrastructure	Kazuyuki Shudo

Graduate Curriculum

Courses for the Master's Program

Social Informatics
Information System Analysis
Practice of Information Systems
Multiagent Systems
Distributed Information Systems
Human-Robot Interaction
Biosphere Informatics
Disaster Information
Emergency Management
Medical Informatics
Informatics of E-business
Information Education
Distributed Systems
Cryptography and Information Society
User Experience
Theories of Service Modeling
Advanced Study in Social Informatics 1
Advanced Study in Social Informatics 2
Field based Learning/Problem based Learning (FBL/PBL) 1
Field based Learning/Problem based Learning (FBL/PBL) 2

Courses for the Doctoral Program

Advanced Seminar on Social Information Models
Advanced Seminar on Social Information Networks
Advanced Seminar on Biosphere Informatics
Advanced Seminar on Regional Disaster Prevention Information Systems
Advanced Seminar on Medical Informatics
Advanced Seminar on Information Education
Advanced Seminar on Social Informatics

(D) : Disaster Prevention Research Institute, Kyoto University
(H) : Division of Medical Information Technology and Administration Planning, Kyoto University Hospital
(M) : Academic Center for Computing and Media Studies, Kyoto University
(I) : Institute of Liberal Arts and Sciences, Kyoto University

Teaching Staff

Professors

Masatoshi Yoshikawa; Takayuki Kanda; Keishi Tajima (I, Secondary Appointment); Takayuki Ito; Nobuhito Ohte; Hirokazu Tatano (D, Affiliated); Katsuya Yamori (D, Affiliated); Michinori Hatayama (D, Affiliated); Tomohiro Kuroda (H, Affiliated); Hiroshi Tamura (I, Affiliated); Hiroaki Ogata (M, Affiliated); Kazuyuki Shudo (M, Affiliated); Naomi Yamashita (NTT, Adjunct); Masayuki Abe (NTT, Adjunct)

Associate Professors

Qiang Ma; Kazunari Sugiyama; Yang Cao; Dražen Brščić; Donghui Lin; Lina A. Koyama; Toshio Fujimi (D, Affiliated); Subhajyoti Samaddar (D, Affiliated); Masamitsu Onishi (D, Affiliated); Kei Hiroi (D, Affiliated); Goshiro Yamamoto (H, Affiliated); Mehdi Tibouchi (NTT, Adjunct)

Senior Lecturers

Jani Even; Yukiko Mori (H, Affiliated); Brendan John Flanagan (M, Affiliated); Rwitajit Majumdar (M, Affiliated)

Assistant Professors

Stela H. Seo; Malcolm Doering; Ryuta Arisaka; Rafik Hadfi; Jawad Haqbeen; Sofia Sahab; Hideaki Nishizawa; Christian Vincenot; Huan Liu; Genta Nakano (D, Affiliated); Chang Liu (H, Affiliated); Izumi Horikoshi

Social Information Model

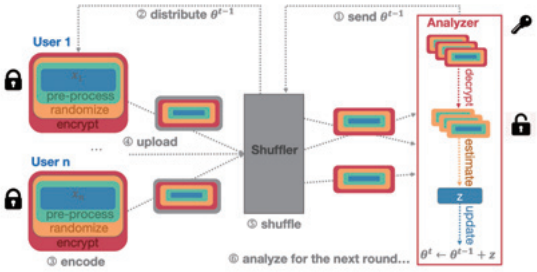
The development of information networks has enabled the widespread use of information bases distributed throughout the world. The Social Information Model Division's Groups are based around a discussion of the formation of these distributed information bases. Through a study of the creation of working social information systems such as multimedia libraries, the Groups in this Division teach and study information models of today and their possible forms in the future, covering such topics as the problems that information systems cause and their impact on society.

Distributed Information Systems

New technologies for managing and utilizing distributed information can make our society evolve much more

Contemporary society relies heavily upon the massive amount of information that is found mostly on the Internet. Social progress will depend upon the establishment and continuous evolution of a) technologies to enable the rapid and accurate transmission of data; and b) technologies to allow rapid searches of vast volumes of data to retrieve required information in a timely manner. For this reason, we conduct fundamental research on data mining, geographic information systems, Web information systems, social network analysis, and privacy protection. We also carry out application-oriented research such as health/medical big data analysis, scientific data management, integrated utilization of knowledge bases and search engines, utilization of scholarly data, educational information systems, in cooperation with domain experts.

[Professor: Masatoshi Yoshikawa; Associate Professor: Qiang Ma; Program-Specific Associate Professors: Kazunari Sugiyama, Yang Cao]



Differentially Private Federated Learning in the Shuffle Model

Human-Robot Interaction

Intelligent robotics for our daily social environments

There are a growing number of everyday applications for artificial intelligence and robotics such as social robots, self-driving cars, and automated shops. We expect that future society will be ubiquitous with various robots. Towards such a robotized society, we aim to study robots that interact with people and operate in harmony alongside them. Such robots are embodied agents with sensory feedback that have the ability to interact in real-time with their environments. Consequently, we conduct fundamental research in intelligent robotics, human interaction, sensor networks, and artificial intelligence (AI). We are aiming for applications in the service industry, elderly care, health care, collaborative work places, and learning.

[Professor: Takayuki Kanda; Associate Professor: Dražen Brščić; Program-Specific Senior Lecturer: Jani Even; Assistant Professor: Stela H. Seo; Program-Specific Assistant Professor: Malcolm Doering]

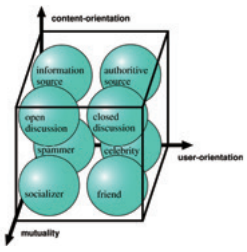
Social Media

Information environment for sharing and utilizing all useful information in the world

"Sharing and utilizing all useful information in the world" may sound to you like a mission statement of a major search engine company. It has, however, been the dream of researchers in the area of database systems and information retrieval since a long time ago. Thanks to the advance of computer and network technologies, we can now easily share and utilize data of large volume and high diversity which we cannot even think about until decades ago, and this "dream" is not a daydream anymore but is the goal. To achieve this goal, we conduct research on technologies for collecting, analyzing, extracting information and technologies for retrieving information you want from the extracted information. Our recent research themes includes: extraction of social information from the Web, social network analysis, information retrieval, and information access interface.

[Professor: Keishi Tajima]

Extraction of social information from the Web



Example of Twitter follow link classification

Outline

Social Information Network

Information networks enable us to communicate by various means, regardless of spatial or temporal constraints, and influence the structure of our society. The use of these information networks will create new social information systems and contribute to social change on a global scale. The Social Information Network Division consists of the Global Information Network Group, and the Information Security Adjunct Unit.

Consensus Informatics

Creating the Next-Generation Social Systems with Multi-Agent Technology

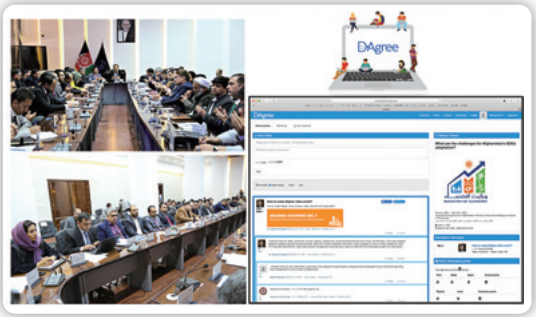
The explosive diffusion of SNSs and smartphones has brought about intrinsic changes in the way we interact. Social systems that we avail ourselves to daily are the epitome of human wisdom and collective intellect, yet most social systems are classical and were developed when there were no SNSs or smartphones. Meanwhile, groups of insects and fish are advancing their collective intellect at a tremendous speed for their evolutionary survival. We humans need to realize new social systems to expedite the development of collective human intellect.

The multi-agent system presents a methodology and concepts that allow us to realize such new social systems and promote them with collective intellect and intelligent information technology. In multi-agent systems, we mainly explore possibilities of new social systems and implement such systems, while seeking the essence of social intelligence, with a focus on interdisciplinary studies with such fields as distributed AI, simulations, robotics, and game theory.

Our laboratories are conducting research on the theories, models, simulation, and social implementation of multi-agent systems, in particular, advanced research into support for consensus formation, computational mechanism design, automated negotiating agents, and social simulations.

We will pursue both high ideals (theoretical studies) and down-to-earth approaches (commercialization of research achievements).

[Professor: Takayuki Ito;
Program-Specific Associate Professor: Donghui Lin;
Assistant Professor: Ryuta Arisaka;
Program-Specific Assistant Professors: Rafik Hadfi, Jawad Haqbeen, Sofia Sahab]

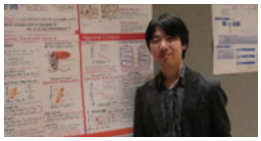


Column

From the World to Japan, from Japan to the World

Over 40 foreign students are enrolled in the Department of Social Informatics, representing more than 15 countries. You may obtain a sense of global community by studying in such a diverse environment. Many students from the Department of Social Informatics make presentations, discuss research, and join internship programs abroad.

A welcome party is held in October to welcome newcomers from foreign countries, and various kinds of international exchanges happen on a daily basis.



Research presentation at an international conference (Canada)

An international event

Biosphere Informatics

There is a great variety of organisms in the biosphere, for example in environments such as forests, farmlands or seas. These organisms have complex interrelationships, and influence our society in various ways. Our division attempts to comprehensively understand the information about individual animals as well as bioresources and production by using various methods and techniques to gather data about the biosphere. We also study the influence of human activities on the global environment and human society itself through the production and management of bioresources and ecosystems.

Bioresource Informatics

Seeking utilization and conservation of bioresources

This group discusses and studies a wide range of themes including system evaluation for the sustainable production of bioresources, the conservation of endangered species, and the revitalization of local communities engaged in bioresource production. In order to gather and analyze bioresource data, this group works in the development and application of new research methods involving the use of GPS, biotelemetry, biologging and image analysis.

[Assistant Professor: Hideaki Nishizawa]



Various methods and techniques are applied

Environmental Informatics

Seeking conservation and utilization of ecosystems

Recently, society has been interested in environmental changes at various spatial/temporal scales. This group works on topics such as understanding/monitoring environmental information or the role of various organisms in ecosystems. Our research interests cover various fields related to terrestrial ecosystems, ranging from their diverse inhabitants such as plants, animals and microbes to their complete physical environment. We study how these relate to other organisms or environments in the ecosystems, or how human society influences them with respect to their sustainability in a changing environment. Various methods/approaches such as field investigation, questionnaires, remote-sensing or chemical/isotopic analyses are applied to collect and analyze key information about these ecosystems and organisms.

[Professor: Nobuhito Ohte;
Associate Professor: Lina A. Koyama;
Assistant Professor: Christian Vincenot]



Fieldwork is conducted in various types of sites

Outline

Regional and Disaster Management Information Systems (Affiliated)

Disasters are abrupt and large-scale environmental changes. The natural, artificial and social environments (and especially the balance among them) that have been constructed and maintained by regional communities are forced to change. If the impact of a disaster is sufficiently severe, local communities may be unable to recover the balance that they had before the catastrophe, and may be forced to create a new balance. This was demonstrated in dramatic fashion by the catastrophic damage inflicted by the Great Hanshin-Awaji (Kobe) Earthquake and the subsequent suffering in the stricken area. The objective of disaster prevention is to minimize the effects of disastrous events. Unfortunately, it is beyond our power to eliminate natural threats, such as the disasters wrought by earthquakes and typhoons. Efforts at disaster prevention help to make society more resistant to disasters by: (1) enhancing our ability to foresee and predict threats; (2) improving our ability to limit the degree of damage; and (3) minimizing the effects of the damage. Disasters are the greatest obstacle to the sustainable development of humankind. According to figures from the International Red Cross, disasters annually take the lives of 130,000 people and cause some $US440 billion in damage. Population growth is driving urbanization. Societies are becoming more complex and diverse. Meanwhile, disasters are growing in scale and occurring more frequently. It could be said that society's ability to withstand disasters is rapidly diminishing. Information processing lies at the heart of disaster prevention. This Division will focus primarily on disaster prevention in urban areas and will teach students about establishment of information systems designed to achieve "urban disaster reduction" that both minimizes the immediate effects of disasters and shortens aftermath duration.

Integrated Disaster Management Systems

Aiming to build disaster prevention systems to ensure a safe and secure society

To build a safe and secure society, we need to put in place disaster prevention systems that will enable the planning and implementation of disaster risk control, financing, and other integrated policies in a rational manner. We will take an informational, organizational and economic approach to find out what kind of disaster prevention system will result in cities with greater resistance to natural disasters.

[Professor: Hirokazu Tatano;
Associate Professors: Toshio Fujimi, Subhajyoti Samaddar;
Program-Specific Assistant Professor: Huan Liu]

Flood Risk Communication Support System

Emergency Management for Disaster Reduction Systems

Social scientific research for disaster damage reduction

Society is required to prepare and take actions to reduce the potential damage of disasters by sharing information and knowledge concerning potential disaster risks through communication among the members of society. This laboratory aims at developing disaster risk reduction systems through practical studies from the perspective of social psychology and systems analysis. The research interests include disaster psychology, disaster risk information and communication, disaster education, regional crisis management and decision making support, financing for disaster recovery.

[Professor: Katsuya Yamori; Associate Professor: Masamitsu Onishi;
Assistant Professor: Genta Nakano]

Disaster education materials developed in our lab

Crisis Information Management System

Disaster Information Systems with Information Technology

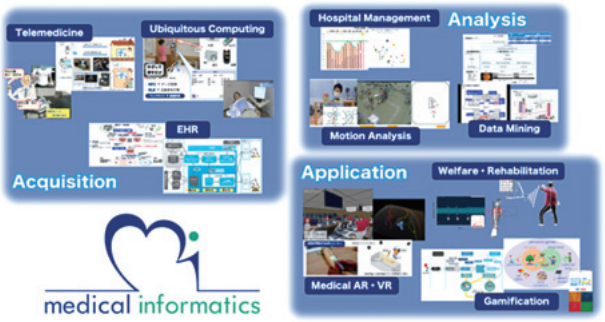
Our goal is to establish design methodologies for the department of effective disaster management systems against various types of disaster for National/Local Governments, local communities in affected areas and disaster relief organizations. One of the most important key technologies are spatial temporal database to record, visualize and analyze current/near future status in affected areas. In addition our laboratory focuses on human behavior before/during/after disasters as targets to supply valuable services.

[Professor: Michinori Hatayama;
Associate Professor: Kei Hiroi]

Development of Building Damage Certification System considering Operator's Ability in the Great East Japan Earthquake

Medical Informatics (Affiliated)

Exploring approaches to medicine in the information age



The Medical Informatics Laboratory seeks to create a new vision for medicine in the information age by developing information platforms, analyzing real-life clinical information, and providing feasible information support for existing clinical entities. Our research covers all areas at the interface of information and medicine, including system development for ubiquitous hospital information systems, remote medical information systems, electronic health records, and other systems, hospital administration analysis, clinical epidemiological information analysis, data health research, VR-based medical education, clinical decision and surgery support, and information support for health tourism.

[Professors: Tomohiro Kuroda, Hiroshi Tamura; Associate Professor: Goshiro Yamamoto;
Senior Lecturer: Yukiko Mori; Assistant Professor: Chang Liu]

Learning and Educational Technologies (Affiliated)

Learning and Educational Technologies

Information Systems that Support Learning and Education

Our research focuses on information technology that supports activities in education and learning by analyzing their log data:

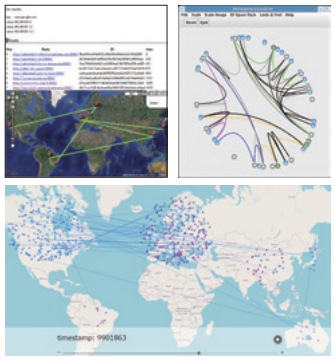
(1) Development of the infrastructure for accumulation and analysis of educational big data
(2) Analysis of learning experiences by using life log technologies
(3) Knowledge awareness for collaborative learning support
(4) Educational systems for Information security and ethics

[Professor: Hiroaki Ogata;
Senior Lecturers: Brendan John Flanagan,
Rwitajit Mujumdar]

Outline

Data Engineering and Platform Research

Research in support of internet-scale data infrastructure



Centering on the configuration of distributed systems ranging from several computers to tens of thousands of computers in size, this laboratory's research addresses topics from core systems for the handling of big data to methods for analysis of such data. Specific topics include:

- Peer-to-peer (decentralized-distributed system) algorithms
- Large-scale distributed system simulations
- Blockchain networks
- Decentralized-distributed machine learning methods
- Social graph analysis methods

[Professor: Kazuyuki Shudo]

Adjunct Units

Sociotechnical Design

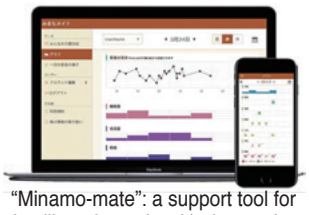
Toward an inclusive future society (in collaboration with NTT Corporation)

The progress of the information society has enabled people to connect with anyone more easily, but at the same has given rise to problems such as weakening of interpersonal relations, fragmentation, and isolation. These problems cannot be resolved simply by providing more opportunities to connect with other people or support for those who are isolated. It is crucial to engage the surrounding community and environment in order to achieve solutions. This laboratory pursues research on basic communication technologies that foster deeper human relations and ensure that diverse individuals are included rather than left isolated.

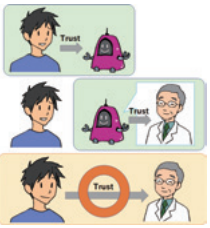
The research topics addressed include:

- Information technologies for the realization of inclusive societies
- Basic communication technologies that foster deeper human relations
- Information technologies that serve the collective good
- Collaborative technologies that enable sustainable work styles

[Professors: Naomi Yamashita, Takayuki Kanda]



"Minamo-mate": a support tool for families of people with depression



Dialogue agents fostering person-to-person trust

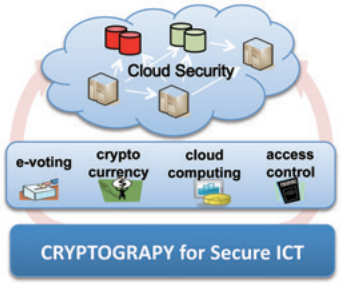
Support for non-native speakers in multilingual projects

Information Security Adjunct Unit

Creating a safe networked society through cryptography (in collaboration with NTT Corporation)

In today's world, where the Internet is increasingly used to conduct electronic transactions such as electronic settlements and bidding in online auctions, or to carry out functions required by the government, such as the filing of tax returns, the maintenance of safe and secure network services is becoming increasingly important. Modern cryptography is a technology to achieve this safety and security, and goes far beyond concealment technology to prevent eavesdropping. It is a field of intense study that is developing rapidly. It involves technical and logical systems which include digital signatures that verify the identity of the party you are communicating with and guarantee the authenticity of the data (which means that the data have not been altered), as well as cryptographic protocols that enable advanced network services which guarantee privacy. In our laboratory, we will study and develop various applied cryptographic technologies commonly used today such as public key cryptosystems, crypto currency, electronic voting, and other applications suitable for cloud computing with rigorous security analysis based on a firm theoretical foundation.

[Professors: Masayuki Abe, Takayuki Kanda;
Associate Professor: Mehdi Tibouchi]



Information Security Adjunct Unit
— Creating a safe networked society through cryptography —
(in collaboration with NTT Corporation)

Special Education Program of the Department of Social Informatics

1. Specialized Subjects and Special Lecture

Special lecture

In the first year of the Master's program, students are introduced to specialized subjects including the design and analysis of information systems, and the relationship between information and society. They can acquire the fundamentals of informatics from the ground up through these subjects, and even students with less specific experience in informatics can benefit by combining their informatics and other expertise. In addition, we have more than 30 special lectures a year in our department, for which we invite lecturers from various universities, research institutes and government offices.

2. Education for Innovation

FBL (Field based Learning)/ PBL (Problem based Learning)

The Department of Social Informatics joins Kyoto University Design School, in which students take a course titled "FBL (Field based Learning)/ PBL (Problem-based Learning)" that helps them acquire the skills needed to find and solve real-world problems. In this course, students select one of a variety of themes, and form small groups to tackle specific problems. The themes include "Designing a new environment for education: creating a place that fosters creativity", "Design of places for conversation over books and tea", and "Organization design in crowd-sourcing" Kyoto University Summer Design School arose from activities mainly led by the Department of Social Informatics, and has become a seasonal tradition in summer, attracting more than 250 participants to share the same innovative space. Over 20 different kinds of themes were proposed by companies and universities, and were tackled by many students eager to solve real-world problems: they went into the field, and used trial-and-error methods by actually creating prototypes. The Department of Social Informatics proposed themes such as "Predicting Kyoto in 2050 by simulation" and "Designing safety into apartment buildings: first priority, disaster prevention".

3. Education for Globalization

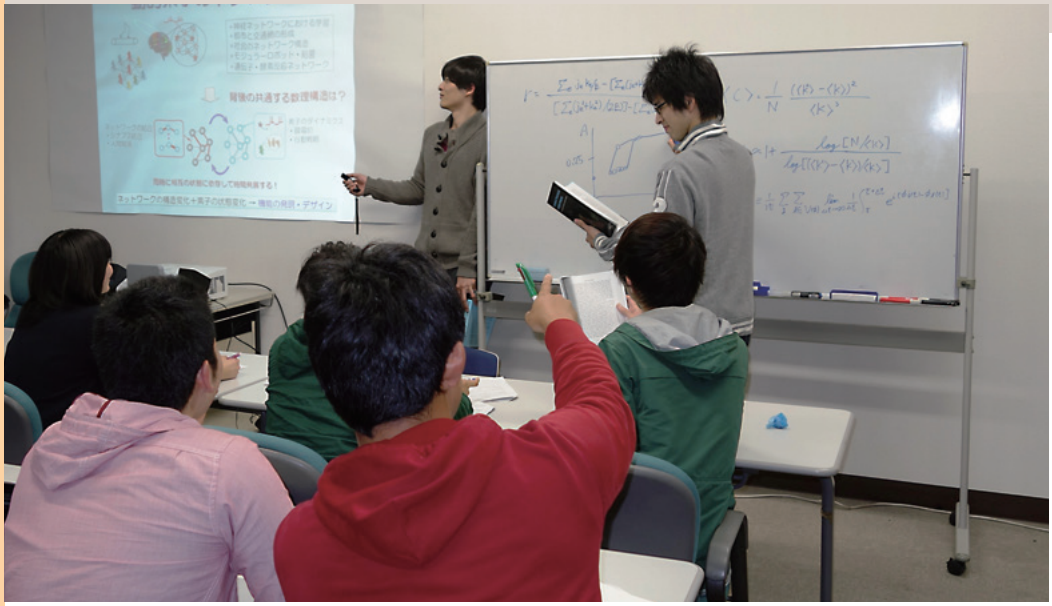
Strategic communication seminar

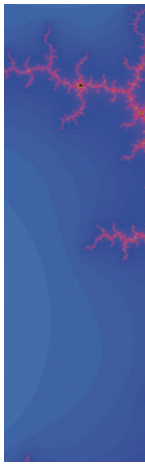
Department of Social Informatics has an International Course Program in the curriculum. Students in the International Course Programs can take lectures in English, receive guidance in English from their supervisors, and acquire Master's and Doctoral degrees exclusively in English. Students who complete the course will receive a certificate of completion for the international course.

Mathematical Modeling and Analysis of Phenomena

—In Pursuit of Integration of Science and Engineering—

The essence of science is to derive principles from observations, thereby revealing the simple structures that underlie what appear to be complex phenomena.
Mathematical sciences, in particular, use mathematical approaches to investigate "mathematical models", which are derived through experimentation.
The modern frontier of mathematical sciences considers various new mathematical models, including those for biological and social phenomena, in addition to more traditional models in natural sciences. These models are investigated through analytical approaches as well as numerical simulations in order to understand the phenomena.
The knowledge thus obtained is employed to develop innovative technologies or to predict future developments, and new methodologies are devised for deeper understanding of phenomena.
In its research and educational activities, our department pays particular attention to large-scale and/or highly non-linear complex phenomena.
Particularly in education, we aim at providing students with both scientific perspectives, which help them to understand principles, and engineering perspectives which are useful in solving real problems in manufacturing.
This two-pronged approach gives students comprehensive overviews on both science and engineering in mathematical sciences.





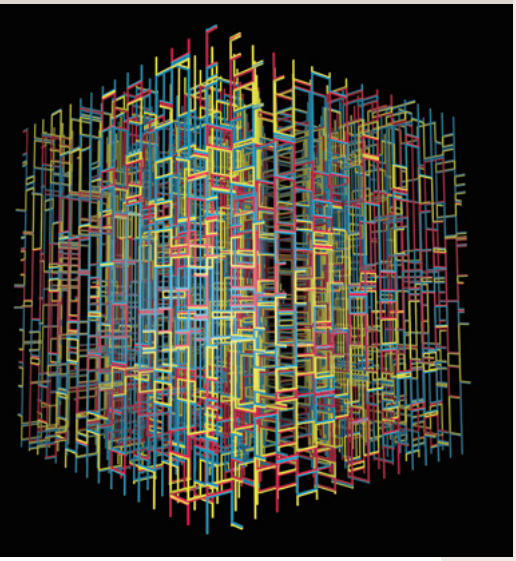
Advanced Mathematical Sciences

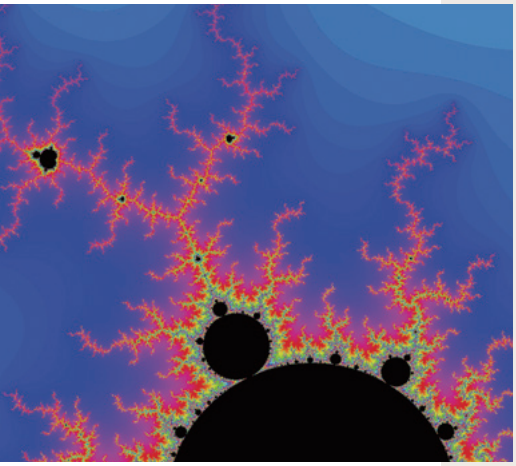
An Invitation to Mathematical Sciences

In the Graduate School of Informatics, we regard "mathematical modeling and analysis of natural, social and biological phenomena" as an important foundation of what we aim at; i.e., "informatics" in the broad sense of the term, which includes not only traditional computer science but also related disciplines such as mathematical sciences, applied physics, etc. Indeed, we have placed importance on research and education in mathematical sciences since the establishment of our school in 1998 because they are considered to form the academic basis of our disciplines. At the time of inauguration of the school, we considered it appropriate to name ourselves the "Department of Applied Analysis and Complex Dynamical Systems", since "complex dynamical systems" was the phrase that symbolized the advanced mathematical sciences of the time. However, the relentless advancement of mathematical sciences gradually made "complex dynamical systems" not necessarily the best phrase to express what we are. Meanwhile, development of computers and networks has made it possible to deal more easily with so-called “big data,” thus making computers and networks increasingly important in social life as well as in research and education in mathematical modeling and analysis of natural, social and biological phenomena. With these developments in mind, we have decided to change the name of our department to "Department of Advanced Mathematical Sciences," as of April 2017. We believe that the new name reaffirms and clarifies our directions for both education and research.

In the broad research area of "advanced mathematical sciences," we are particularly interested in "mathematical modeling and computer simulations of phenomena," which constitute the basis of our activities. Computer simulations and data analyses are now vitally important in several branches of science and engineering. New applications of computational methods are found in biology, social sciences, etc. and, of course, as more conventional applications in mechanics. These new trends in mathematical modeling of phenomena call for new methodologies, including probabilistic and fractal approaches in addition to classical differential equations and discrete models. New developments in computer simulation include large-scale, high-performance computing, use of new computational environments such as multiple-precision arithmetics, etc. Our department conducts research and education in such new and advanced areas of mathematical sciences.

Traditionally in Japan, fundamental education in mathematical sciences has been carried out in schools of science and more application-oriented education has been provided by engineering schools. However, despite its small size, our department has some faculty members with science backgrounds and others with engineering backgrounds. Our aim is to "integrate science and engineering" and develop students with comprehensive perspectives of advanced mathematical sciences. We also emphasize individualized teaching as well as independent learning by each student, in line with Kyoto University's principle of "self-learning based on dialogue."





Toshio Aoyagi
Department of
Advanced Mathematical Sciences

Toshio Aoyagi, Sc.D., earned his doctoral degree from Kyoto University Graduate School of Science in 1993. Since graduating, he has held such positions as Research Associate, Department of Applied Mathematics and Physics, Kyoto University Faculty of Engineering and Lecturer and then Associate Professor, Department of Applied Analysis and Complex Dynamical Systems, Kyoto University Graduate School of Informatics, before assuming his present position in 2014. His research specialties are non-linear physics and theoretical neuroscience, with a focus on the analysis of rhythmic phenomena and research into coupled dynamical systems on networks. He is a member of the Physical Society of Japan, Japan Neuroscience Society, Japanese Society for Mathematical Biology, and Japanese Neural Network Society.2021 Chairperson of Department.

Outline

Divisions and Groups

Division	Group	Research and Education Topics	Professor
Applied Analysis	Applied Analysis	Inverse and Ill-Posed Problems, Fractal Theory, Nonlinear Differential Equations, Numerical Analysis, Probability	Yuusuke Iso Jun Kigami
Nonlinear Physics	Nonlinear Physics	Theoretical Neuroscience, Network Science, Nonequilibrium or Nonlinear Physics, and Computational Condensed Matter Theory	Toshio Aoyagi
Applied Mathematical Sciences	Computational Mechanics	Computational Mechanics	
	Industrial Mathematics	Kinetic theory, Fluid Mechanics	Satoshi Taguchi

Graduate Curriculum

Courses for the Master's Program

Applied Analysis A
Applied Analysis B
Nonlinear Physics A
Nonlinear Physics B
Applied Mathematical Sciences A
Applied Mathematical Sciences B
Topics in Differential Equations A
Topics in Differential Equations B
Topics in Nonlinear Analysis A
Topics in Nonlinear Analysis B
Seminar on Applied Analysis I
Seminar on Applied Analysis II
Topics in Applied Analysis I
Topics in Applied Analysis II
Topics in Nonlinear Dynamics A
Topics in Nonlinear Dynamics B
Topics in Nonequilibrium Physics A
Topics in Nonequilibrium Physics B
Seminar in Nonlinear Physics I
Seminar in Nonlinear Physics II
Topics in Nonlinear Physics I
Topics in Nonlinear Physics II
Topics in Computational Mechanics A
Topics in Computational Mechanics B
Topics in Mathematical Sciences A
Topics in Mathematical Sciences B
Seminar in Applied Mathematical Sciences I
Seminar in Applied Mathematical Sciences II
Topics in Applied Mathematical Sciences I
Topics in Applied Mathematical Sciences II
Advanced Study in Mathematical Sciences I
Advanced Study in Mathematical Sciences II

Courses for the Doctoral Program

Seminar on Mathematical Sciences (Advanced)
Seminar on Applied Analysis (Advanced A & B)
Seminar on Nonlinear Physics (Advanced A & B)
Seminar on Applied Mathematical Sciences (Advanced A & B)

Teaching Staff

Professors
Yuusuke Iso;
Jun Kigami;
Kazunori Hayashi;
Toshio Aoyagi;
Satoshi Taguchi

Associate Professors
Hiroshi Fujiwara;
Daisuke Shiraishi;
Jun-nosuke Teramae;
Hitoshi Yoshikawa;
Tetsuro Tsuji

Senior Lecturers
Masayoshi Kubo;
Li Douglas;
Syuji Miyazaki

Assistant Professors
Daisuke Kawagoe;
Hiroki Tutu;
Kenji Harada;
Kazuki Niino

Admission, Curriculum and Other Efforts in Our Department

In study and research of advanced mathematical sciences, one needs both basic mathematical skills as well as knowledge of his/her specialist field. Accordingly, in the entrance exam, all applicants for our Master's course are required to solve basic problems in linear algebra and calculus together with one problem of their choice related to their respective specialties. Final decisions on acceptance are made through interviews with those applicants who score above a certain level in the written exam, since it is not desirable to make such decisions based only on the results of the written exam where one point may be the difference between a pass mark and failure. The interviews will be conducted by all the faculty members in order to determine if applicant's interests match the expertise of our faculties. In the entrance exam for the Ph.D. course, final decisions on acceptance are made based on the achievements of each candidate in his/her research work, which are evaluated in interviews conducted by all the faculty members.

Our curriculum for the Master course consists of both general and specialized subjects. All students are advised to take three general subjects, which help them to develop both scientific and engineering perspectives in mathematical sciences. Research advice is given mainly on a one-to-one basis, taking into account each student's aptitude. For those wishing to go on to Ph.D. courses, we provide Seminar II (for second-year students), which is designed to give students opportunities to learn advanced topics in addition to receiving standard research mentoring. In the Ph.D. course, students can receive mentoring not only from their advisers but also from other professors in our department and affiliated professors from science and engineering schools. This system gives students access to a broader spectrum of state-of-the-art knowledge in the mathematical sciences. Students thus have opportunities to deepen their expertise and to obtain a broad appreciation of mathematical sciences from both scientific and engineering perspectives, which we believe to be a unique feature of the education provided by our department.

In addition, almost every year, we offer open, public seminars on topical subjects.

Applied Analysis

Applied mathematics seeks to go far beyond mere application of pure mathematics to solution of physical and mechanical problems. Through research into mathematical models of phenomena, applied mathematics creates new mathematics. Our Division teaches and carries out research in applied analysis where there is particular emphasis on analysis in fields of applied mathematics. We seek to improve our understanding of existing analytics and create new analytics for the 21st Century. To give specific examples of the kinds of research we do, we analyze mathematical models of physical and mechanical phenomena by applying mathematical and numerical analysis and stochastic theory to get a better understanding of both the analytical methods and the mathematical structure of the model, and to establish new analytical techniques. In this Division, the key words are “nonlinear analysis” and “inverse problem analysis,” and our staff constantly interacts with one another while they teach and conduct research.

Nonlinear Analysis and Inverse Problem Analysis

Analysis in the 21st Century

Faculty Members and Their Research Interests

■Numerical Analysis of (Partial) Differential Equations, Numerical and Mathematical Analyses
I am interested in both mathematical and numerical analyses in research regarding the determination of unknown coefficients and other inverse problems, as well as boundary value problems and other forward problems with respect to partial differential equations that describe mechanical and physical phenomena. [Professor: Yuusuke Iso]

■Fractal Analysis, Fractal Geometry
I am interested in the mathematical theory of problems concerning heat and wave propagation in fractal concept models –new models for the natural world. [Professor: Jun Kigami]

■Statistical Signal Processing, Data Science
I am working on various problems in the fields of data science taking advantage of statistical signal processing, which is a theoretical framework to extract valuable information from raw data. My recent research interest includes underdetermined linear inverse problems with sparse and/or discrete constraints. [Professor: Kazunori Hayashi]

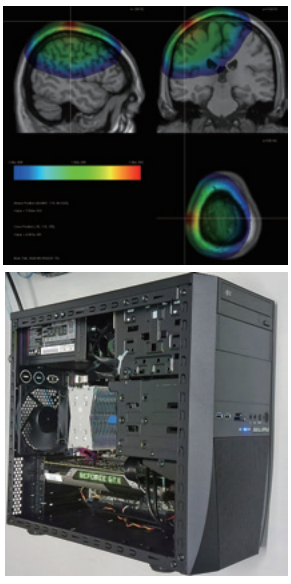
■Numerical Analysis of Ill-posed Problems, Design and Implementation of Multi-precision Arithmetic Environments
I am interested in research concerning regularization methods and numerical analysis of multiple-precision calculations with the aim of solving inverse problems that occur in mechanics and geophysics. [Associate Professor: Hiroshi Fujiwara]

■Structure of Brownian Motion and Random Walk
How does the trace of Brownian motion look like? What can we say about the structure of random walk trace? Such questions have fascinated probabilists and mathematical physicists for a long time, and they continue to be an unending source of challenging problems. I am interested in the nature of sample paths of these fundamental processes. [Associate Professor: Daisuke Shiraishi]

■Inverse Problem Analysis, Numerical Analysis of (Partial) Differential Equations, Partial Differential Equations, Brain Model Mathematical Research
I mathematically analyze partial differential equations that appear in mathematical physics and mathematically and numerically analyze the inverse problems found in these partial differential equations, where the unknown coefficients of these inverse problems are determined by observed data. [Senior Lecturer: Masayoshi Kubo]

■Numerical Analysis of Differential Equations and Data-Driven Science
I am interested in numerical simulations of differential equations and data driven modelling in natural science, technology and social sciences. [Senior Lecturer: Li Douglas]

■Integro-Differential Equations, Spectral Analysis
I study regularity of solutions to integro-differential equations appearing in kinetic theory and optics. Also, I work in spectral analysis on boundary integral operators which are related to the theory of elasticity. [Assistant Professor: Daisuke Kawagoe]



Numerical Simulation of Light Propagation in a Human Brain (top) and Hardware used in Simulation (bottom).

Outline

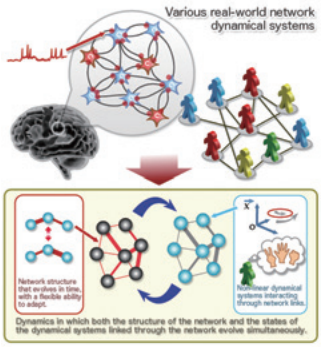
Nonlinear Physics

The dynamic behavior of systems that have a high degree of freedom and engage in nonlinear mutual interactions is both complex and richly diverse; nevertheless, many of these systems share common characteristics, e.g., exhibiting coherent structures and high-level functions, and are fascinating subjects for research. In our division, we use theoretical analysis and computer simulations to gain a better understanding of the complex behaviors and control of these types of dynamic systems and to clarify their universal principles. Our research covers topics in dynamical systems that range from nonlinear and nonequilibrium physics to theories of networks appearing in living and social systems; moreover, our staff members constantly interacts with each other while teaching and conducting research on these subjects.

From nonlinear physics to theory of networks, as well as living and neural systems

I am particularly interested in systems composed of many simple elements that, through cooperative interactions, come to exhibit complex behavior and high-level functions, such as not only many physical systems, but also biological and social systems. Co-evolution involving the intricate interplay between the dynamics of the network and the elements is a key concept for understanding the self-organized, flexible nature of real-world network systems. I study such cooperative phenomena in systems of this kind, focusing on rhythmic phenomena and chaos from the perspective of nonlinear dynamics.

[Professor: Toshio Aoyagi]



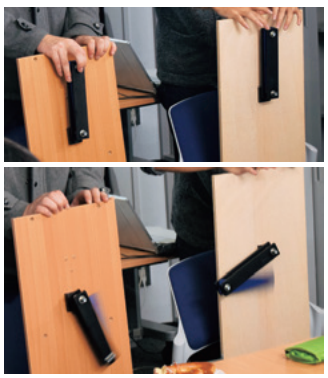
Neural systems and social networks are nonlinear dynamic systems that have a high degree of freedom and develop as their dynamic elements change the structure of their interconnections.

Nonlinear physics of computation and learning in the brain

The brain is a highly complex network composed of about 100 billion of neurons. Spike propagation along the network and plasticity of synaptic connection of them cause high-dimensional nonlinear dynamics, which is the nature of neural computation and learning. Central questions, however, still remain elusive. What is intelligence? What is underlying principles of neural computation and learning? Our recent study, for example, reveals significant roles of spontaneous fluctuation in neural computation. By integrating neuroscience, computer science, and nonlinear physics, here we are trying to answer these questions and trying to develop fully brain-inspire AIs. [Associate Professor: Jun-nosuke Teramae]

Study on powders and charged particles under cyclic external forces

Inspired by experiments in which several micron-size charged corpuscles are injected into an AC trap, a simplified version of a Paul ion trap, and prior studies into the particle model of ion channels and its anomalous transport, we mainly study collective motions of granular materials and charged corpuscles, which are subject to periodic external force. We also propose mathematical models for numerical analysis that faithfully reproduce experiment settings and analyze critical phenomena incidental to collective motions of macroscopic charged corpuscles injected into an AC trap and various types of bifurcations that occur in vibrating powder. [Senior Lecturer: Syuji Miyazaki]



Double pendula showing chaotic motion: Starting from almost identical initial conditions as shown in the upper figure, we observe quite different time evolution, as shown in the lower figure; thus, we say that the system has a sensitive dependence upon initial conditions.

Mathematical models for molecular machines

Biological molecular motors are amazing machines that generate useful movement (as a pump or a porter). The relationship between the structures of proteins and their highly efficient energy conversion, even under a fluctuating environment, remains mysterious. I explore the underlying principles of such molecular machines with mathematical models.

[Assistant Professor: Hiroki Tutu]

Statistical physics using computational approaches

The various structures and properties that arise in systems due to the nonlinear effects of many elements on each other are the research areas in statistical physics.I am working on this problem mainly by using simulation techniques.My research areas include various many-body systems from micro to macro (e.g., quantum critical phenomena due to quantum fluctuations at the atomic scale to quantum systems such as infectious diseases) and the construction of classical and quantum machine learning theories using tensor network formalisms, which are tools for describing quantum information.

[Assistant Professor: Kenji Harada]

Applied Mathematical Sciences

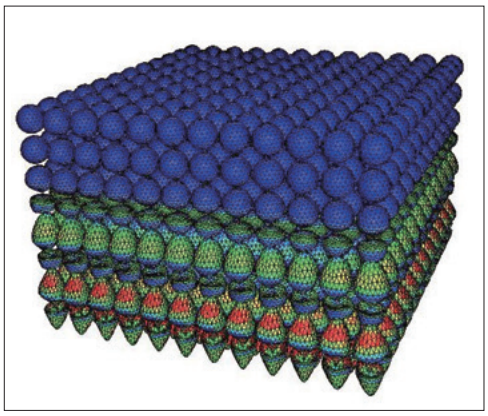
Many of objects that we study in mechanics are large and complex, and often exhibit behavior that is uncertain and difficult to predict. Although the most important issue for us is to accurately predict this behavior and control it, this is generally not easy to do. It is essential to establish sophisticated mathematical models of physical systems and to develop high-speed and accurate simulation techniques to analyse them. Numerical simulation techniques are particularly important in nano-scale and/or global phenomena where experimental approaches are extremely difficult. This division investigates mathematical modeling and simulation techniques and their applications from the viewpoints of applied mathematical sciences.

Computational Mechanics

Computer simulations: development of fast BIEMs and their applications to engineering problems

Numerical simulations provide powerful tools for solving various problems in science and engineering. Computational mechanics, together with theoretical and experimental mechanics, is an effective method of investigating mechanical phenomena in engineering based on numerical simulations. Our group specializes in Boundary Integral Equation Methods (BIEM) which are among major techniques in computational mechanics. BIEMs are particularly effective in wave and fracture problems. We focus on fast BIEMs and their applications to large-scale problems with special interest in electromagnetic wave propagations in periodic structures, which have many applications in optics. Other topics of interest include shape optimization problems, eigenvalue problems and inverse problems.

[Associate Professor: Hitoshi Yoshikawa;
Assistant Professor: Kazuki Niino]



Example of analysis using a time domain fast multipole boundary integral equation method

Industrial Mathematics

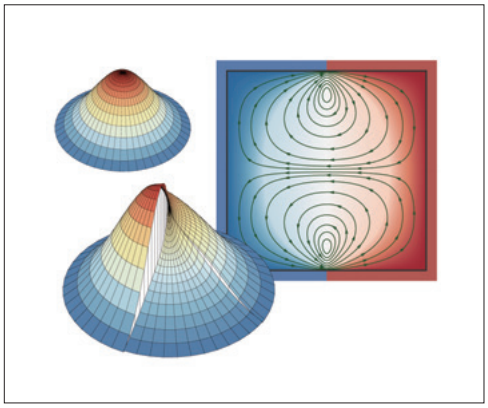
Toward new fluid mechanics for non-equilibrium flows

In our group we investigate the behavior of non-equilibrium flows based on kinetic theory describing the collective behavior of innumerable particles. We aim at understanding mechanical and/or thermodynamic properties of non-equilibrium flows both theoretically and numerically. We also aim at elaborating continuum theory and applying it to non-equilibrium flows, by deriving suitable mathematical models for non-equilibrium flows.

[Professor: Satoshi Taguchi]

Recent advances in micro/nanoscale technologies require the understanding of transport phenomena in micro/nanoscale and their control. For this reason there is a growing interest in the research of non-equilibrium flows. In particular, we aim at investigating moving boundary problems for non-equilibrium flows and the motion of tiny materials (or particles) driven by non-equilibrium effects from the view point of mathematical sciences and from experimental view points. We also aim at integrating them in industrial applications.

[Associate Professor: Tetsuro Tsuji]



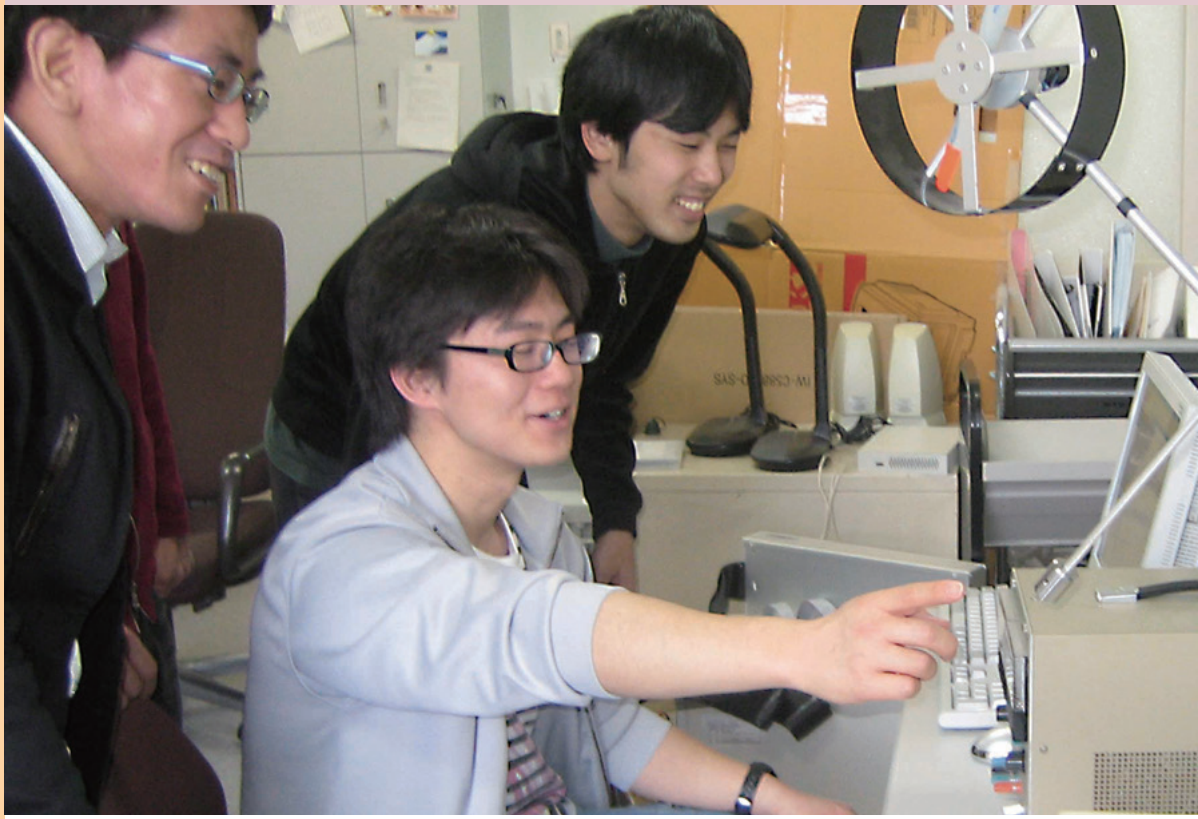
Example of velocity distribution function expressing the dynamic state of molecules. Local equilibrium state (top left) and locally non-equilibrium state (bottom left); example of non-equilibrium flow induced by discontinuous wall temperature distribution (right).

Using Applied Mathematics and Physics to Seek Solutions to Problems in Engineering/Natural Systems

In the highly advanced information society of today, we encounter various situations that involve modeling and analysis of complex and large-scale systems, their control, design, and operation.

In these situations, it is extremely important to uncover common mathematical structures shared by those problems which are seemingly unrelated, and to develop mathematical methods to solve them, in addition to acquiring specialized knowledge of individual disciplines such as information technology, electricity, mechanics, and chemistry.

From this viewpoint, the seven laboratories of the Department of Applied Mathematics and Physics undertake leading-edge research on applied mathematical analysis, discrete mathematics, system optimization, control systems theory, applied mathematical modeling (adjunct unit), physical statistics, and dynamical system theory.



Modeling and Control: Describing and Manipulating Systems

The science of control is the study of trying to manipulate the movement of various things, from mobile vehicles such as automobiles and aircraft to production systems for the steel production process. For example, preventing vibration on robot manipulators is also a control task. We need to extract characteristics that are important to control from a control object that displays complex movements, create a model, and use that model to come up with a control rule to produce the desired movement. We invite you to expand the field of application for the science of control and have a go at developing new modeling methods and control rules.

Yoshito Ohta
Department of Applied Mathematics and Physics

Professor Ohta graduated from the Department of Electronic Engineering, School of Engineering, Osaka University in 1980. He was appointed as a Research Associate in Osaka University in 1983, and obtained his Doctorate Degree in Engineering from Osaka University in 1986. He was promoted to a Lecturer in 1991, to an Associate Professor in 1994, and to a Professor in 1999 at Osaka University. Since 2006, he is a Professor at the Department of Applied Mathematics and Physics at Kyoto University.

Optimization of Discrete Structures

The objective of applied mathematics and physics is to create a model to explain phenomena that are seemingly intangible and to formulate "theories for actual use" that can produce optimum answers to problems. In this regard, my laboratory deals with problems that have discrete structures. For instance, it would take an enormous amount of time to check all possible routes between two points on a map. However, we can produce a solution for instantly identifying the shortest route between those two points if we were to use a theory known as dynamic programming. We invite you to take up the challenge of creating your own solution to unsolved problems.

Hiroshi Nagamochi
Department of Applied Mathematics and Physics

Professor Nagamochi received his Doctorate degree in March 1988 from the Graduate School of Engineering, Kyoto University. In April 1988 he was appointed a Research Associate at the Informatics Division, Toyohashi Institute of Technology. In April 1990 he became a Research Associate at the Section of Applied Mathematics and Physics, School of Engineering, Kyoto University, and in April 1993 promoted to Associate Professor. In April 2000 he returned to the Informatics Division of Toyohashi's Institute of Technology as a Professor. As of July 2004 he is a Professor at the Graduate School of Informatics, Kyoto University. His research specialty is discrete optimization, covering a broad range of fields which include, among others, graph algorithms, scheduling, and enumeration algorithms.

Outline

Divisions and Groups

Division	Group	Research and Education Topics	Professor
Applied Mathematics	Applied Mathematical Analysis	Applied Integrable Systems and Numerical Algorithms	
	Discrete Mathematics	Theory and Application of Discrete Optimization, Graph Theory, and Discrete Algorithms	Hiroshi Nagamochi
Applied Mathematical Systems	System Optimization	Optimization Theory & Algorithms and Operations Research	Nobuo Yamashita
	Control Systems Theory	Systems Control Theory, System Identification, and Large-scale and Stochastic Dynamical Systems	Yoshito Ohta
	Applied Mathematical Modeling (Adjunct Unit)	Applied Mathematical Modeling and Social Information Systems Modeling	Yoichi Nonaka
Mathematical Physics	Physical Statistics	Physical Statistics, Basic Theory of Nonlinear and Complex Systems, and Stochastic Process Fundamentals and Applications	Ken Umeno
	Dynamical Systems	Dynamical Systems, Ordinary and Partial Differential Equations, and Mathematical Physics	Kazuyuki Yagasaki

Graduate Curriculum

Courses for the Master's Program

Operations Research (Advanced)
Mathematical Physics (Advanced)
Systems Analysis (Advanced)
Mathematical Analysis (Advanced)
Discrete Mathematics (Advanced)
Optimization Theory (Advanced)
Control Systems Theory (Advanced)
Physical Statistics (Advanced)
Dynamical Systems (Advanced)
Introduction to Mathematical Finance
Financial Engineering
Topics in Applied Mathematics and Physics A, B
Advanced Study in Applied Mathematics and Physics I
Advanced Study in Applied Mathematics and Physics II

Courses for the Doctoral Program

Seminar on Applied Mathematics (Advanced)
Seminar on Applied Mathematical Systems (Advanced)
Seminar on Mathematical Physics (Advanced)
Seminar on Applied Mathematics and Physics (Advanced)

Teaching Staff

Professors

Hiroshi Nagamochi; Nobuo Yamashita; Yoshito Ohta;
Yoichi Nonaka (Hitachi Ltd., Adjunct); Ken Umeno; Kazuyuki Yagasaki

Associate Professors

Satoshi Tsujimoto; Kazuya Haraguchi; Ellen Hidemi Fukuda; Hiroyuki Sato; Kenji Kashima;
Yoshiyasu Takahashi (Hitachi Ltd., Adjunct); Mitsuru Shibayama

Assistant Professors

Shuhei Kamioka; Yuya Yamakawa; Kentaro Ohki; Atsushi Iwasaki; Yoshiyuki Yamaguchi

Applied Mathematics

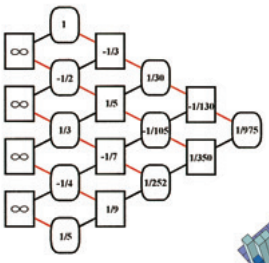
This Division consists of two Groups: first, the Applied Mathematical Analysis Group, which carries out research into the applied analysis of the tremendous range of functions and the mathematics of algorithms and other integrable and discrete integrable systems; and second, the Discrete Mathematics Group, which studies combinatorial problems, graph and network problems, logical functions, discrete optimization, and other topics. The Applied Mathematics Division conducts research and education in many topics, including the creation of new mathematical models, the development of algorithms, the understanding of the complexity of mathematical computation, and system modeling.

Applied Mathematical Analysis

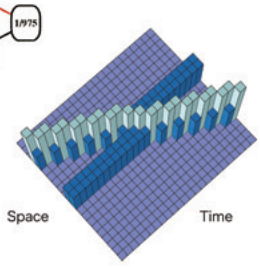
Developing algorithms from integrable systems

We carry out research in the areas of contemporary soliton research and integrable system research, not only regarding the applied analysis of orthogonal polynomials and special functions that are closely associated with integrable systems, but also regarding the application of the mathematical methods developed by integrable system studies to the solution of various problems hitherto thought to be unrelated to integrable systems (such as numerical calculation and algorithm development). Our Group is a pioneer in this research field, and conducts studies into the applied analysis of integrable systems in the development of algorithms and other new branches of mathematics from the perspective of computer science.

[Associate Professor: Satoshi Tsujimoto;
Assistant Professor: Shuhei Kamioka]



η-algorithm
(discrete KdV equation)



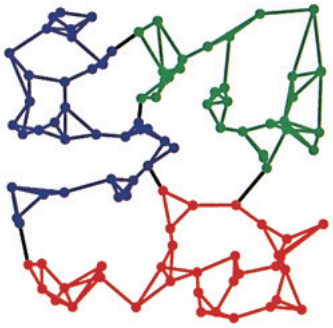
Ultra-discrete soliton

Discrete Mathematics

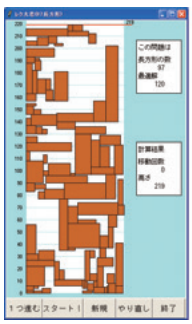
Exploring the complexity of discrete mathematics problems and developing algorithms

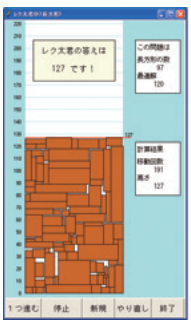
Topics in discrete mathematics, such as the graphs and networks used to represent systems, schedules to enhance the efficiency of production, and the logical analysis of large volumes of data, are closely related to applications of research results. We explore the complexity of the calculations used to solve these problems; design logical approximation algorithms; develop taboo search algorithms, genetic algorithms and other metaheuristic algorithms; and apply them to solving actual problems.

[Professor: Hiroshi Nagamochi;
Associate Professor: Kazuya Haraguchi]



Computation of a minimum cut that separates a network into three components with the same number of vertices





A puzzle in which you have to fit the pieces into a box of fixed width without any of the rectangular pieces overlapping and try to make the height of the packed pieces as low as possible (left). Illustrations of the calculations performed by "Rekuta-kun," a packing solution developed at the Applied Mathematics and Physics Laboratory: start (middle) and final result (right).

Outline

Applied Mathematical Systems

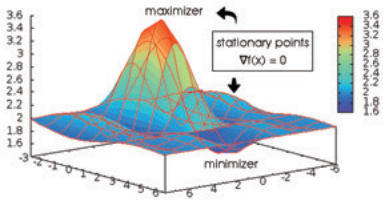
We carry out education and research regarding mathematical theories that are used in the analysis, planning, management and evaluation of a wide range of complex systems that occur in a computer-networked society and in modern production systems. Examples of these theories include mathematical programming, applied probability theory, network theory, modern feedback control theory, estimation and identification of probability systems, and robust control theory. We also apply these theories in the development of problem-solving algorithms. In an adjunct unit, we also engage in education and research for applying various methodologies in real-world systems.

System Optimization

Optimization is the keyword for solving problems

We conduct education and research regarding the theory and methodology of system optimization, which plays an important role as a mathematical approach that is used to resolve many different kinds of practical problems. In particular, we develop efficient mathematical optimization approaches to actual large-scale systems, complex nonlinear systems, and systems with uncertainty, as well as basic research regarding mathematical programming.

[Professor: Nobuo Yamashita;
Associate Professor: Ellen Hidemi Fukuda;
Program-Specific Associate Professor: Hiroyuki Sato;
Assistant Professor: Yuya Yamakawa]



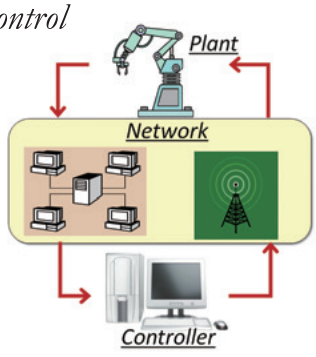
Optimal solutions of an unconstrained problem

Control Systems Theory

Mathematical approaches to modeling and control

We carry out teaching and research regarding the mathematical methodologies of modeling, analysis and design of control systems, and their application with the aim of developing practical and expansive control theories. Our main research themes are robust control, control systems with input/output constraints, networked control systems, algebraic system theory, mathematical optimization in control, stochastic realization, system identification and quantum control theory.

[Professor: Yoshito Ohta; Associate Professor: Kenji Kashima;
Assistant Professor: Kentaro Ohki]



A sketch of networked control systems

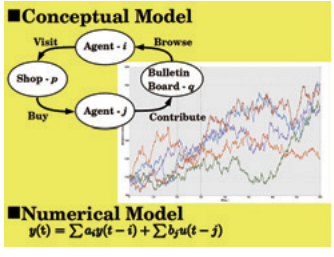
Applied Mathematical Modeling Adjunct Unit

(In collaboration with Hitachi, Ltd.)

Infusing information systems with intelligence

To make information systems useful to our day-to-day lives and industry at large, we need to be able to mathematically model both the behavior of people and the movements of objects that these systems deal with. The form of these models ranges from the conceptual to the numerically precise. We will examine case studies from industry in our research of modeling technology, including methods of using human knowledge (structural modeling) and methods using actual data (multivariate analysis).

[Professor: Yoichi Nonaka; Associate Professor: Yoshiyasu Takahashi]

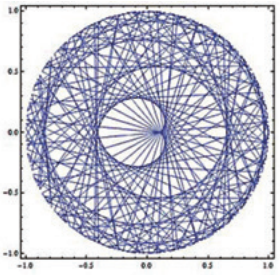


A conceptual and its numerical model

Mathematical Physics

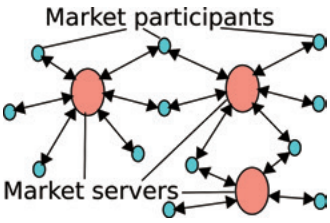
We look into mathematical models in physics, chemistry and biology that form the foundations of engineering and investigate those models from a dynamic system perspective by applying methods developed in statistical physics, dynamical systems theory, differential equations, probability theory, stochastic process theory, and computer simulation; and we conduct applied research with the goal of gaining a better understanding of their mathematical structure and building fundamental theories.

Various coupled multi-element systems



Chaos code for signal analysis and multiuser communications system

A conceptual diagram of a complex network



A model of the financial market and the market participants

Physical Statistics

The mathematical studies on dynamics of coupled multi-element network systems and design theory of complex engineering systems

We aim to gain a mathematical and unified understanding of the complex and diverse phenomena that arise out of the intense mutual interactions of multiple elements (units) in a system and apply this understanding to information processing and design of complex engineering systems. For example, we will use stochastic process theory, ergodic theory, statistical physics, dynamical system theory, computer simulations, and large-scale data processing techniques to analyze information processing and performance evaluation in neural networks; the structure of the Internet and other complex networks such as social media systems, and the propagation of information within them; and the dynamical properties of price change, stock markets and other economic phenomena.

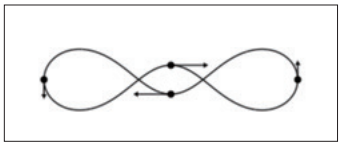
[Professor: Ken Umeno;
Assistant Professor: Atsushi Iwasaki]

Dynamical Systems

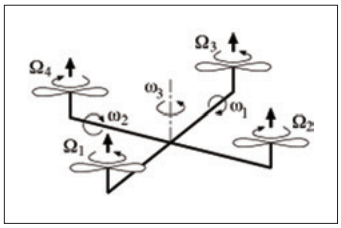
Looking into the world through dynamical systems theory

Our research purpose is to analyze complicated phenomena such as chaos and bifurcations in various systems appearing in science, engineering and other disciplines using dynamical systems approaches, and apply them to develop novel engineering technologies. For this purpose, we not only use standard approaches but also establish new innovative theories in dynamical systems. Moreover, we utilize numerical approaches such as verifiable computation and large-scale numerical simulation, and study the nonintegrability of dynamical systems and differential equations, nonlinear waves in partial differential equations, periodic motions in the n-body problem of classical mechanics and kinetic theory of many-body systems, design of spacecraft transfer trajectories and dynamics and control of flying objects such as quadcopters.

[Professor: Kazuyuki Yagasaki; Associate Professor: Mitsuru Shibayama;
Assistant Professor: Yoshiyuki Yamaguchi]



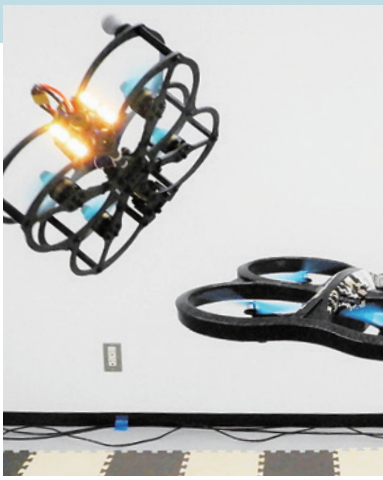
4-body super-eight solution which is proven to exist by using variational methods

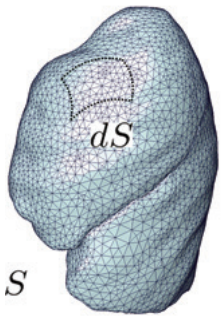


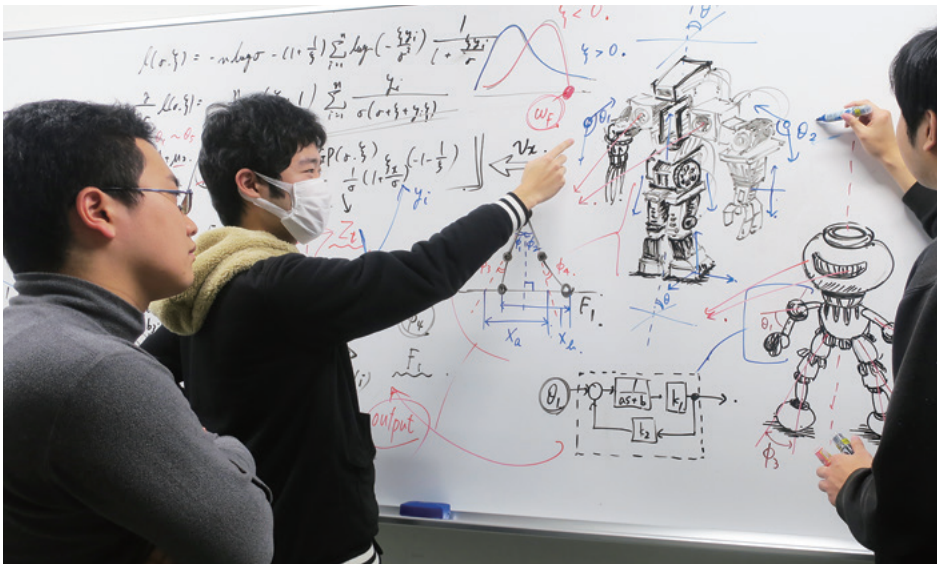
Mathematical model of quadrocopters

New Frontier in Informatics and Systems

Research and education in the Department of Systems Science are concerned with a new and unified approach to a variety of technological problems arising in computer communication networks, mechatronics systems, cyber-physical systems, medical information systems, and biological systems. In particular, we are seeking theoretical methodologies applicable to these complex systems of large scales.
Emphasis is also placed upon understanding of complicated mutual interactions among human-beings, systems and environments.







Capturing the Essence of "Motion" for Broad Application

Systems science is an academic approach that attempts to understand the world by abstracting all objects and viewing them as "systems." I specialize in dynamical systems theory and control engineering, which use mathematical expressions to shed light on general properties of "motion" and formulate principles for realizing desirable "motion." Different kinds of "motion" within events occurring around us, such as mechanical motion and natural phenomena, may have underlying commonality, no matter how unrelated to each other they may seem. Hence, dynamical systems theory and theories and algorithms of control engineering may be universally applicable in various fields, including vehicles, robots, aircraft, environment and energy, and society and economics. Students and researchers of such an academic discipline not only learn things that are practical in the real world but also enjoy the satisfaction of identifying essences without being misled by superficial differences among individual objects. I believe that there is beauty in the concept and methodology of systems science because it deals with the essential qualities of things. If you have an interest in principles common to various events that take place around us and wish to acquir knowled of systems science while cultivating the capability to penetrate to what is essential, then the Department of Systems Science is the place for you!

Toshiyuki Ohtsuka
Department of Systems Science

1990: Received a bachelor's degree from the Department of Aerospace Engineering, Faculty of Engineering, Tokyo Metropolitan Institute of Technology. 1995: Received a doctoral degree in engineering from the Graduate School of Engineering, Tokyo Metropolitan Institute of Technology. Previously Assistant Professor in the Institute of Engineering Mechanics, University of Tsukuba, Assistant Professor then Associate Professor in the Graduate School of Engineering, Osaka University, and Professor in the Graduate School of Engineering Science, Osaka University. 2013-present: Professor in the Department of Systems Science, Graduate School of Informatics, Kyoto University. Member of the Society of Instrument and Control Engineers, Institute of Systems, Control and Information Engineers, and IEEE. Engaged in research into nonlinear systems theory and theory and applications of optimal control.

Learning "How" to Address Unknown Issues

In the Department of Systems Science, we are working on scientific research across a variety of fields. For instance, we use sensors to measure information from biological and mechanical systems in order to infer their internal states, project their future behavior, and control them. Also, by elucidating how the brain's neural circuits process information, we are working to create a system that is capable of not only learning and making inferences but also adjusting itself to an uncertain and changing environment. Furthermore, we are studying algorithms and theory for making inferences and discoveries from the vast amount of image and document data available online and elsewhere, together with the high-performance parallel computing that makes such systems possible.

Not only are these research fields related to systems but, in many cases, research projects conducted in these fields share a common approach - researchers conduct their studies through mathematical models, constantly aware of the flow of information. Using mathematical models, researchers can treat different objects as if they were the same, thereby gaining broad perspectives. For example, by using a "graph" that consists of vertexes and edges, researchers can express not only networks (neural networks, website link structures, railway systems, etc.) but also structures of relevant data, such as tagged images on social media. Because the objects thus modeled can be treated mathematically, scientists can advance their research even further. In the field of machine learning, significant research is being carried out into a technique called graph embedding for efficient information search. One drawback of this technique was that a graph with a hierarchical structure is not expressed very well in Euclidean space. This problem has been solved by a mathematical idea of using a curved space called "hyperbolic space."

Another characteristic of students/researchers in the Department of Systems Science is strongly conscious of systems in the real world, in addition to conducting mathematical study at an abstract level. Issues in the real world can be often solved with established methods, but very new methods occasionally arise out of addressing the challenges posed by difficulties. In the study of methodology of statistics, for instance, we are constantly exploring new ways to make inferences and predictions from data. What is important for such a situation is again knowledge in mathematical fields such as probability theory and optimization.

Thus, mathematical foundations and applications interact with each other in the Department of Systems Science. Students are invited to learn an aspect of this scientific discipline, broaden their perspectives, and acquire universal approaches and attitudes; that is, "how" to address unknown issues, through research activities and lectures at the Graduate School of Informatics. We would be delighted if their experience here motivates them to address unknown issues and find clues to developing new techniques or academic disciplines.

Hidetoshi Shimodaira
Department of Systems Science

March 1990: Received a bachelor's degree from the Department of Mathematical Engineering and Information Physics, School of Engineering, The University of Tokyo. March 1995: Received a doctoral degree from the Department of Mathematical Engineering and Information Physics, Graduate School of Engineering, The University of Tokyo. April 1995: Received a Research Fellowship for Young Scientists from the Japan Society for the Promotion of Science. July 1996: Assistant Professor, Department of Prediction and Control, Institute of Statistical Mathematics. June 2002: Lecturer, Department of Mathematical and Computing Sciences, Graduate School of Information Science and Engineering, Tokyo Institute of Technology. May 2005: Associate Professor, Department of Mathematical and Computing Sciences, Graduate School of Information Science and Engineering, Tokyo Institute of Technology. April 2012: Professor, Division of Mathematical Science, Graduate School of Engineering Science, Osaka University. September 2016-present: Team Leader (concurrent position), Mathematical Statistics Team, RIKEN Center for Advanced Intelligence Project (AIP). April 2017-present: Professor, Department of Systems Science, Graduate School of Informatics, Kyoto University.

Outline

Divisions and Groups

Division	Group	Research and Education Topics	Professor (Associate Professor)
Human Machine Symbiosis	Mechanical Systems Control	Advanced Control Theories and Their Application to Mechanical Systems	
	Human Systems	Human-Centered System Design, Modeling, Virtual Sensing and Control	Manabu Kano
	Integrated Dynamical Systems	Optimal Control, Nonlinear Systems Distributed Control , Stochastic Systems	Toshiyuki Ohtsuka
	Mobility Research	Advanced Safety Vehicle, Active Safety, Collision Avoidance	(Osamu Nishihara)
Systems Synthesis	Mathematical Information Systems	Mathematics of probabilistic information processing and its applications	Toshiyuki Tanaka
	Statistical Intelligence	Statistics, Machine Learning	Hidetoshi Shimodaira
	Computational Intelligence Systems (Adjunct Unit)	Data Mining and Pattern Recognition Based on Statistical Machine Learning	Naonori Ueda
Systems Informatics	Learning Machines		Jun Morimoto
	Integrated Systems Biology	Modeling of Intelligence (Brain) and Life, and Its Application	Shin Ishii
	Biomedical Engineering	Information Systems for the Medical Field	
	Computational Neuroscience (Adjunct Unit)	Computational Neuroscience, Brain Network Interface	Mitsuo Kawato
		Neural circuit information processing, free energy principle, attractor dynamics	(Takuya Isomura) (Louis Kang)
		Basal Ganglia, Neuromodulators, Evolutionary Robotics	Kenji Doya
Applied Informatics (Affiliated)		Supercomputers and High-Performance Parallel Processing	(Keiichiro Fukazawa)

Graduate Curriculum

Courses for the Master's Program

Control Theory for Mechanical Systems
Theory of Integrated Dynamical Systems
Information-theoretic Systems Theory
Statistical Systems Theory
Theory of Learning Machines
Theoretical Life-Science
Medical Information Systems
Industrial Mathematics and Design
Advanced Study in Systems Science 1
Advanced Study in Systems Science 2
Systems Sciences 1 (Advanced)
Systems Sciences 2 (Advanced)
Modeling and Problem-Solving of Complex Systems
Theory of Human-Machine Systems
Supercomputing (Advanced)

Courses for the Doctoral Program

Seminar on Systems Science (Advanced)
Seminar on Human Machine Symbiosis (Advanced) A, B
Seminar on Systems Synthesis (Advanced) A, B
Seminar on Systems Informatics (Advanced) A, B
Seminar on Applied Informatics (Advanced) A, B

Teaching Staff

(K): Institute for Liberal Arts and Sciences (M) : Academic Center for Computing and Media Studies

Professors

Manabu Kano; Toshiyuki Ohtsuka; Toshiyuki Tanaka; Hidetoshi Shimodaira; Hisayuki Hara (K);
Naonori Ueda (NTT, Adjunct); Jun Morimoto; Shin Ishii; Mitsuo Kawato (ATR, Adjunct); Kenji Doya (OIST, Adjunct)

Associate Professors

Kazunori Sakurama; Osamu Nishihara; Tomoyuki Obuchi; Junya Honda; Takuya Isomura (RIKEN, Adjunct);
Louis Kang (RIKEN, Adjunct); Keiichiro Fukazawa (M)

Assistant Professors

Shota Kato; Kenta Hoshino; Takahiro Nemoto; Yugo Nakayama; Satoshi Yagi; Hiroshi Higashi; Hirohiko Imai

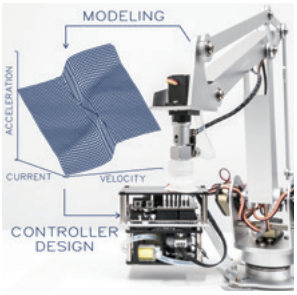
Human Machine Symbiosis

As computer networks spread and information systems become more sophisticated, the interrelationship between manmade systems (typified by machines) and humankind and the environment (including the natural environment and our social environment) is becoming ever more complicated and diverse. So we aim at making the relationships between machines, humankind, and nature harmonious and stable, while being able to cope with complexity and diversity. To this aim, we clarify both the principles and the methodologies of relationship building theoretically, by taking a wide range of approaches that encompass systems theory, control engineering, artificial intelligence, cognitive science, human interface technology, robotic engineering, and reliability engineering. Based on these studies, we build various types of concrete systems.

Mechanical Systems Control

Aiming to design robust and flexible mechanical systems

Advanced control methods that can operate mechanical systems properly under adverse conditions are necessary in order to built systems that have the flexibility to adapt to, and the robustness to withstand, environmental change. Our group focuses on developing this kind of advanced control theory. We also conduct education and research regarding the application of such theory in mechatronics and robotic engineering. More concretely, our theoretical research topics include robust control, system modeling, saturated systems, nonlinear systems, and hybrid systems. Application examples of our research include magnetic levitation systems, crane systems, inverted pendulums, airship control, snake-like robots, and biological systems.



A robot arm with 7 degrees of freedom

Human Systems

Aiming to develop human-centered system design methodology

The society that values humankind is called for now. The situation is similar in the latest industrial science and technology, thus novel system design methodology is required from various positions such as those who develop technology and those who use technology. We perform basic research on developing human-centered system design methodology through understanding the mechanism of human recognition and action. In order to contribute our results to our society, we also perform applied research in various industries such as semiconductor, pharmaceutical, steel, chemical, and automobile. Furthermore, through these studies, we conduct the education that aims at training talented people to take a broad view of things and have high aims.

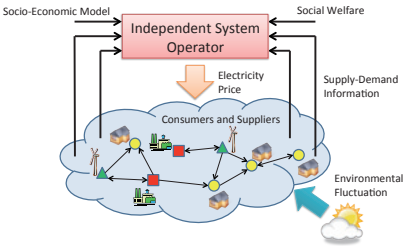
[Professor: Manabu Kano; Assistant Professor: Shota Kato]

Integrated Dynamical Systems

Toward harmonious coexistence of a diversity of systems

For analysis and design of novel systems to realize symbiosis and synergy of various objects including humans, machines, societies, and environments, it is essential to find out universal principles in modeling, analysis, design, and control of dynamical systems. To this end, we conduct researches on novel methodologies to deal with nonlinearities, uncertainties, dynamic optimization, and distributed control, which are often fundamental difficulties in various problems. We also apply our methodologies to a wide range of fields, aiming practical as well as theoretical education and research.

[Professor: Toshiyuki Ohtsuka; Associate Professor: Kazunori Sakurama; Assistant Professor: Kenta Hoshino]



A system consisting of humans, machines, societies, and environments

Mobility Research

Optimizations for design and operation

The research interest of this group mostly lies in mobility technologies, such as vehicle stability controls, which have found practical applications in active safety systems for reducing car accidents, energy efficiency improvements, and collision avoidance systems. These research topics are being investigated with a view toward precise optimization within the constraints of their dynamical properties.

[Associate Professor: Osamu Nishihara]

Outline

System Synthesis

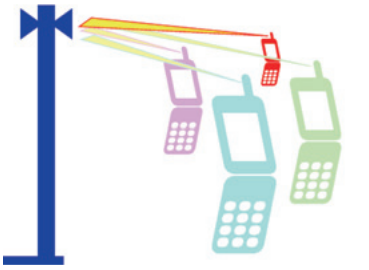
For intelligent systems, acquisition of information about themselves and their surroundings is prerequisite to attainment of their self-stabilization and enhancement of their own functions. The division performs education and research from the standpoint of applied mathematics for solving a variety of problems in Systems Synthesis: artificial realization of adaptive and learning abilities in humans and the living things as well, and modeling and information processing for exploring systems' advanced functions.

Mathematical Information Systems

The mathematics of large-scale probability models

We aim to develop a mathematical, cross-sectional understanding of a diversity of problems relating to information processing in environments of uncertainty. Many problems in information processing today can be formulized with large-scale probability modeling, and using the regularities that come into view thanks to the scale of these probability models is the key to achieving advanced information processing. We are working on topics in areas including the statistical mechanics of information, which addresses information mathematics of large-scale probability models through analogy with statistical mechanics, and theoretical problems related to statistical machine learning, deep learning, and data science.

[Professor: Toshiyuki Tanaka; Associate Professor: Tomoyuki Obuchi; Assistant Professor: Takahiro Nemoto]



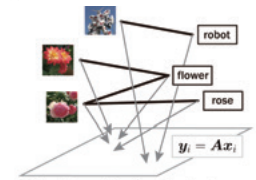
Digital communications as data science: the key to realizing high-performance digital communications lies in extracting the required information from "data" in which numerous signals intermingle.

Statistical Intelligence

Statistics and machine learning: Theory and applications

Statistics is playing important roles as a theoretical framework for fast-moving fields such as big data, data mining, and artificial intelligence. Statistics provide methodologies for inductive inference from data with consideration of randomness. Recent years have seen rapid progress in machine learning, from information extraction from a massive quantity of data to decision-making with a small quantity of data, on the basis of this approach. Through addressing real-world data, we are developing new statistical methods with emphasis on mathematics and programming skills.

[Professors: Hidetoshi Shimodaira, Hisayuki Hara; Associate Professor: Junya Honda; Assistant Professor: Yugo Nakayama]



Multivariate analysis of multiple domains
Dimensionality reduction via graph-embeddings
and bidirectional search between images and tags.

Computational Intelligence Systems Adjunct Unit

Data mining & pattern recognition based on statistical machine learning

Data mining is the technology which discovers significant latent relationships, rule, patterns from huge amount of data like Web contents. It has been widely used in many recommendation systems for products already. We are pursuing statistical machine learning approach to provide highly sophisticated data mining technologies to extract, classify, organize, visualize, and predict latent information hidden in the data. We will offer education and research opportunities in this field.

[Professors: Naonori Ueda, Toshiyuki Tanaka]

Latent information extraction, classification, organization, visualization, and prediction from huge amount of data

Systems Informatics

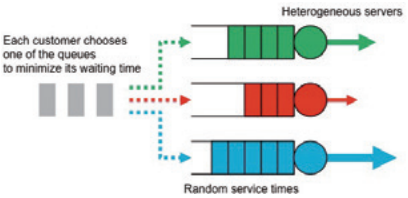
The division performs the education and research from the standpoints of systems science and information science for solving a variety of problems in various kinds of practical systems. Current education and research program is concerned with communication systems, brain and neural systems, and systems in biomedical engineering. We have concerns about practical systems but also theoretical approaches.

Learning Machines

Toward the realization of learning machines with bodies

The fusion field of artificial intelligence and robotics is expected to be a field that will produce the basic industrial technologies of the future. We will explore methodologies to enable machines with bodies to learn skillfully and produce desired behaviors from limited experience and data, just like humans. In order to realize learning machines that can operate in a dynamically changing open environment, we conduct education and research on basic technologies for robot motion learning methods, mathematical models of multi-degree-of-freedom robots, and human motion intention estimation.

[Professor: Jun Morimoto; Assistant Professor: Satoshi Yagi]



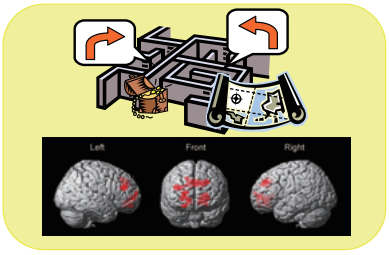
Strategic multiple queueing model

Integrated Systems Biology

Constructing models of information processing in life and intelligent systems

Intelligence (the brain) and life are complex systems that adapt to uncertain and changing environments. Aiming at elucidating the principles of information processing in those complicated systems, we are focusing on researches in the areas of computational neuroscience, systems biology, and bioinformatics, while conducting applied research, such as the application of these principles in the building of robots that have adaptive information processing mechanisms that we have learned about through our studies of living organisms. We conduct interdisciplinary education and research on life systems.

[Professor: Shin Ishii;
Assistant Professor: Hiroshi Higashi]



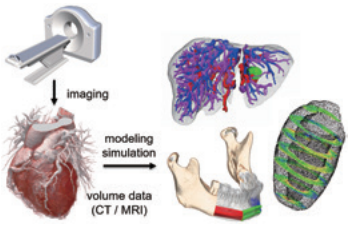
A model of the decision-making process in an uncertain environment, and images of information processing within the brain

Biomedical Engineering

Learning about the functions and physical characteristics of human bodies

Information systems such as data processing systems used in genetic analysis, diagnostic imaging systems are key technologies of modern medicine. Interdisciplinary collaboration is essential to further progress of medical systems' research that combines the two keywords of "bio" and "information." We carry out joint research projects with other research organizations in different fields including the Faculty of Medicine to develop surgical navigation systems, medical imaging techniques, and innovative methods to measure biological characteristics of human bodies.

[Assistant Professor: Hirohiko Imai]



Medical image processing and modeling for diagnosis and treatment

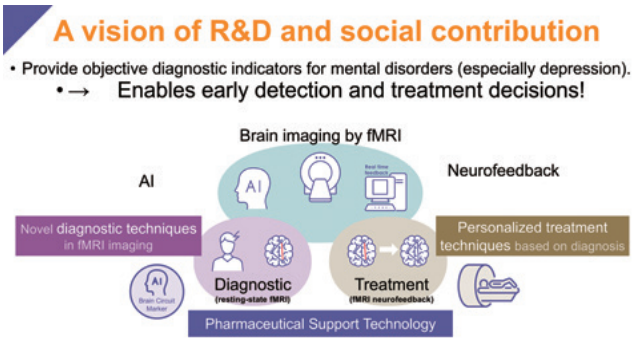
Outline

Computational Neuroscience Adjunct Unit

Knowing the brain by building the brain

(a) Connecting the brain and artificial intelligence

Humans and other animals are known to be capable of learning from a small sample. On the other hand, deep neural networks and other forms of current artificial intelligence today require learning samples around the same size as that of the parameters. Metacognition, multilayered generative and analytical models, and synchronization of neural activity are thought to be some of the secrets the brain holds. We aim to comprehend these and other characteristics of the brain and apply them in the development of the next generation of artificial intelligence.



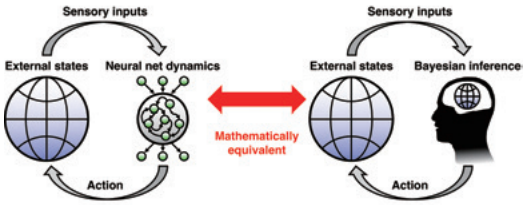
(b) Brain-machine interface

Brain-machine interface technology that directly connects the human brain with machines is attracting attention as a type of "brain tech" that can improve the capabilities not only of people with impaired sensory, mobility, and central nervous functions, but also the ablebodied. Specifically, it involves a process of applying decoding techniques to non-invasively measured brain activity data, and in return providing the subject with decoded neuro-feedback that induces activity patterns in specific parts of the brain in response to certain information. The goal is to utilize this method in the treatment of psychiatric disorders and establishment of a causal approach to neuroscience.

[Professors: Mitsuo Kawato, Shin Ishii]

Exploring the mechanism for emergence of intelligence from neural circuits

How do the neural cells and synaptic couplings that constitute the brain achieve the kind of superior intelligence we find in living creatures? With a view to solving this mystery, we apply mathematical approaches such as dynamic theory, Bayesian statistics, machine learning, and the free energy principle to construct a universal theory of the brain. We focus particularly on topics such as internal model learning in the cerebral cortex and the mechanisms of memory and spatial awareness in the hippocampus. We aim to apply our findings in the development of new artificial intelligence algorithms, psychiatric disorder models and the like.

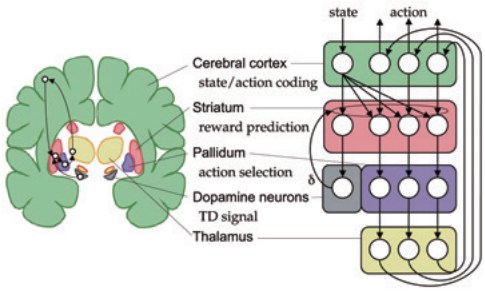


Neural circuit dynamics and plasticity potentially apply Bayesian inference

[Professor: Shin Ishii;
Associate Professors: Takuya Isomura, Louis Kang]

Shedding light on the computational theories of action learning and the learning systems of the brain

Humans and other animals can acquire new behaviors in line with various environments. What workings of the brain enable such acquisition? Answering this question requires a complementary approach to developing computational theories and algorithms on action learning in diverse environments and explicating the mechanisms of neural cells and molecular networks in the brain. Our lab brings researchers from a variety of different fields and countries together on a campus adjacent to the ocean in Okinawa to pursue research on topics including development of new algorithms for reinforcement learning and Bayesian inference, using those algorithms in action learning by robots and applications to bioinformatics, experiments in measurement and control of activity in the cerebral cortex, basal ganglia, and serotonin neurons of rats and mice, explication of human action learning and brain activity, and evolution of group behavior objectives and learning processes in robots.



The neural circuit of the basal ganglia and its functions in reinforcement learning

[Professors: Kenji Doya, Shin Ishii]

Applied Informatics (Affiliated)

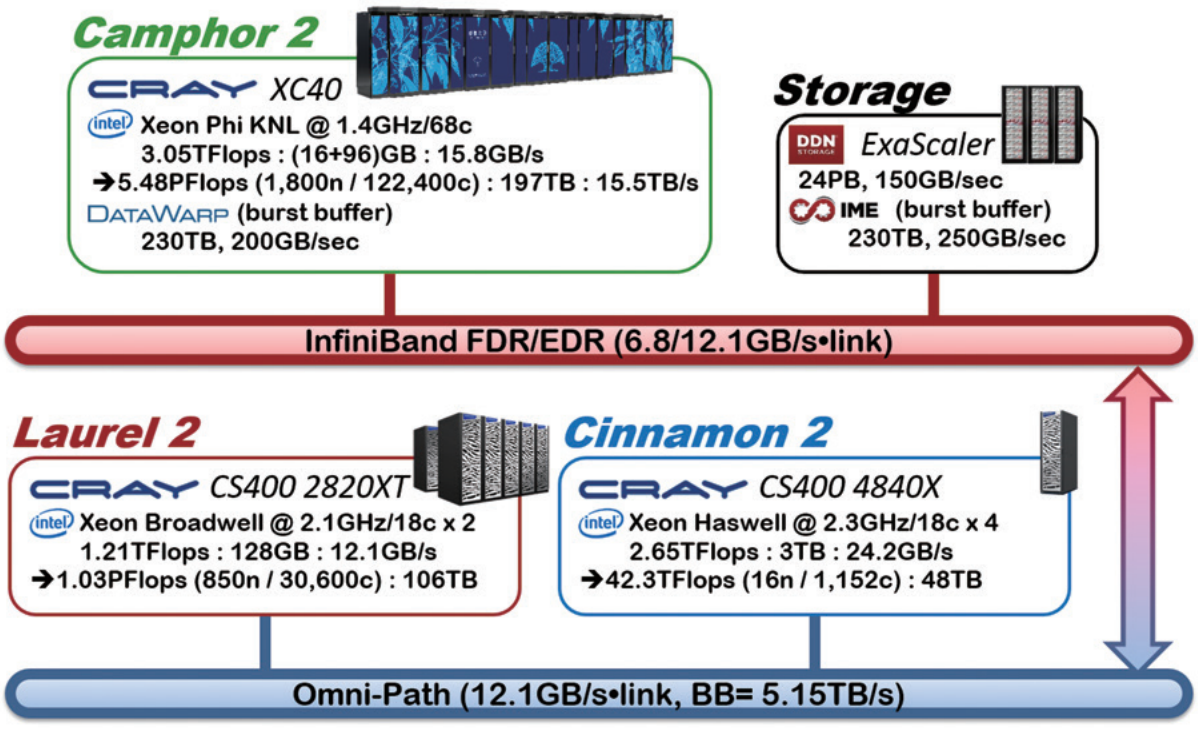
(Academic Center for Computing and Media Studies)

We carry out fundamental and applied research regarding parallelization and high-performance computing technologies that hold great promise for supercomputing at the frontiers of science. We also look at ways to put this research into practical use. We work on research projects with researchers from various scientific fields that need large-scale simulations and scientific computation, as well as with researchers involved in supercomputer technology within the university and in the wider scientific community. Our students are learning a wide range of high-performance computing technologies, from the design of software for parallelized applications to high-performance hardware.

[Associate Professor: Keiichiro Fukazawa]

Aiming to be at the forefront of computing performance

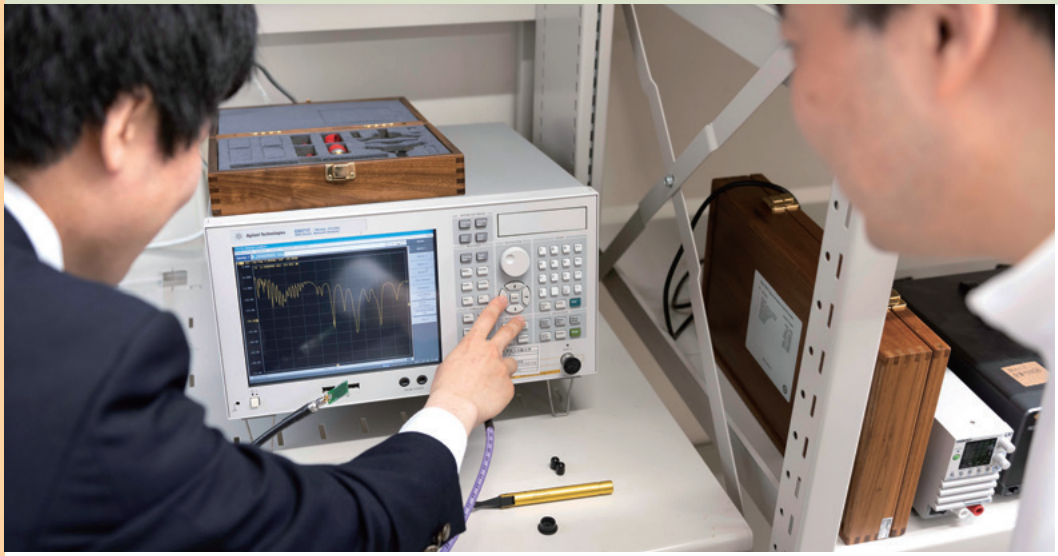
We are involved in research into supercomputers, their software, and systems that are thousands or tens of thousands of times more powerful than ordinary personal computers. We are studying the basic technologies for high-performance parallel processing, such as parallel systems that link together many computers, languages that simplify parallel processing, and software libraries that can be widely used in a range of fields. Much of this research is in the form of joint research projects that extend beyond the field of computer science to involve researchers in the fields of medicine, physics, engineering, and other areas.

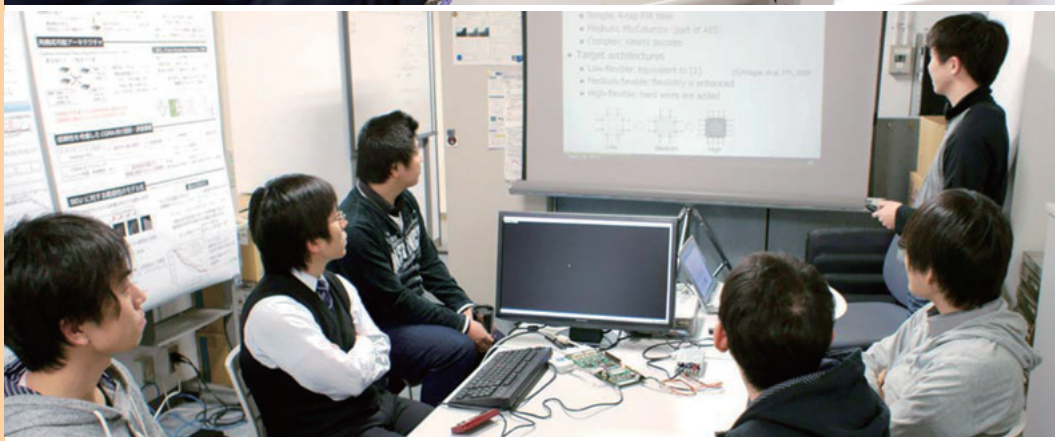


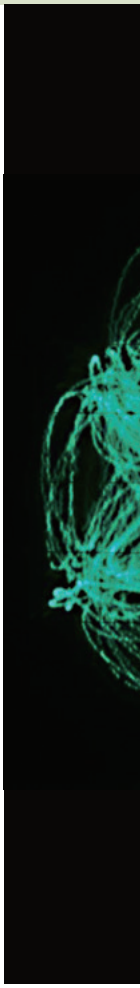
Supercomputer System in ACCMS

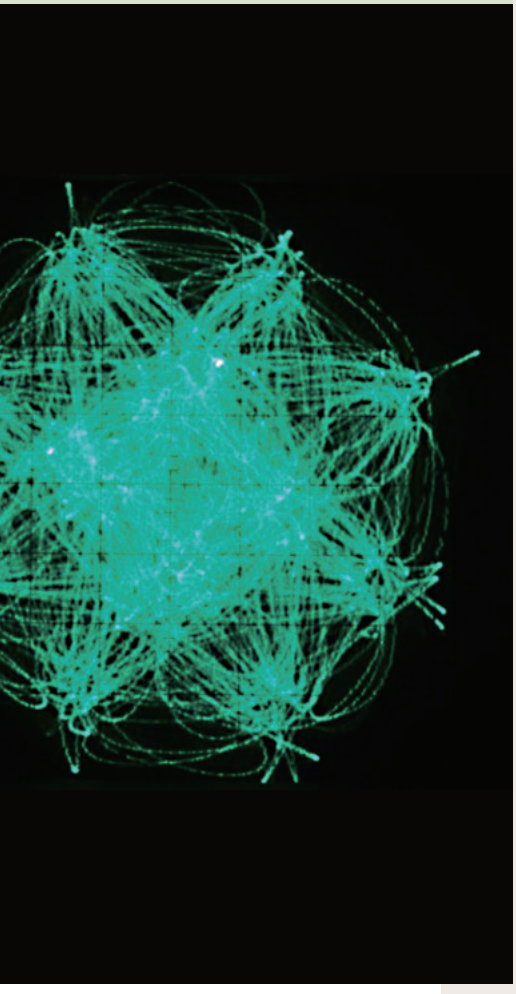
Towards the Establishment of Fundamental Technologies in the Information Age

Advanced information processing and communications are indispensable for our society to prosper in the 21st century.
Information processing devices typified by computers are called upon to achieve high performance and be highly functional and compact.
In communications, we should be able to enjoy high-speed, reliable transmission of a vast amount of multimedia data anytime, anywhere.
The Department of Communications and Computer Engineering supports the development of future technologies in the fields of information processing devices and digital communications.









"Invisiblizing" software

Some people say "Software weighs nothing." What do you think? Here is an anecdote from 1960s, at the dawn of the computer age: "How much does the software on this airplane weigh?" "Nothing." "That's ridiculous. It costs a million dollars and doesn't weigh anything? What about that deck of punched cards? It does weigh something." "See those holes on the cards? Those holes are the only part of the software that actually goes into the plane."

Some people say "Software is invisible." What do you think? Well, even if it is holes, it's very questionable that software is really invisible. Indeed, software bugs frequently annoy us, making software "visible". Software---especially one that works as part of social infrastructure---should be so invisible that we don't even notice its existence.

Our research group conducts a wide range of research to contribute to improving safety and dependability of software, thereby "invisiblizing" software. We develop new programming languages and automated program verification techniques based on theory of computer programs, which we also study.

The Department of Communications and Computer Engineering focuses on education and research in areas such as future computer systems, communications, and integrated systems, which are also "invisible" infrastructure technology. Broad topics ranging from academic research to cutting-edge industrial problems are waiting to challenge you. Why don't you aim for being a "world-visible" researcher at our Department?

Atsushi Igarashi
Department of Communications and Computer Engineering

He received his B.S., M.S., and Ph.D degrees from Department of Information Science, University of Tokyo in 1995, 1997, and 2000, respectively. He joined the faculty of Graduate School of Informatics, Kyoto University in 2002 as a Lecturer after two years as a Research Associate at Graduate School of Arts and Sciences, University of Tokyo. He became an Associate Professor in 2006 and a Professor in 2012. His main research interest is in principles of programming languages. He received the 20th Japan IBM Science Prize in Computer Science in 2006, the Young Scientists' Prize, the Commendation for Science and Technology by the Japan Minister of Education, Culture, Sports, Science and Technology in 2009, the 1st Microsoft Research Japan New Faculty Award in 2009, and the Dahl-Nygaard Junior Prize in 2011.

Department of Communications and Computer Engineering

Outline

Divisions and Groups

Division	Group	Research and Education Topics	Professor
Computer Engineering	Computer Algorithms	Algorithms, Discrete Structures, Complexity, and Logic Circuits	Shin-ichi Minato
	Computer Architecture	Reconfigurable computing, parallel computing, superconductive digital circuits	Naofumi Takagi
	Computer Software	Theory of Programs, Program Verification, Programming Languages	Atsushi Igarashi
Communications Systems Engineering	Digital Communications	Highly Reliable and Secure Broadband Digital Communication Systems	Hiroshi Harada
	Integrated-Media Communications	Integrated Transmission System and Applications	
	Intelligent Communication Networks	Design and Performance Analysis of Information and Communication Networks	Eiji Oki
Integrated Systems Engineering	Processor Architecture and Systems Synthesis	Large-scale, High-performance Information Circuit Architecture, and Design Technology	Takashi Sato
	Ultrafast Signal Processing	Design and application of integrated systems	Masanori Hashimoto
Radio Atmospheric Sciences (Affiliated)	Remote Sensing Engineering	Atmospheric Measurement and Geophysical Environmental Information by Radio Waves, Light, and Acoustic Waves Using Electronic Engineering	Mamoru Yamamoto
	Atmospheric Observations		Hiroyuki Hashiguchi

Graduate Curriculum

Courses for the Master's Program

Courses for the Master's Program
Theory of Discrete Algorithms
Digital Communications Engineering
Information Networks
Integrated Circuits Engineering (Advanced)
Theory of Computational Complexity
Parallel Computer Architecture
Parallel and Distributed Systems
Digital Signal Processing (Advanced)
Formal Semantics of Computer Programs
Advanced Study in Communications and Computer Engineering I
Advanced Study in Communications and Computer Engineering II
Introduction to Algorithms and Informatics
Hardware Algorithm
Transmission Media Engineering (Advanced)
Integrated System Architecture and Synthesis
System-Level Design Methodology for SoCs
Atmospheric Measurement Techniques
Remote Sensing Engineering

Courses for the Doctoral Program

Seminar on Computer Engineering, (Advanced)
Seminar on Communication Systems Engineering, (Advanced)
Seminar on Integrated Systems Engineering, (Advanced)
Seminar on Radio Atmospheric Science, (Advanced)
Seminar on Communications and Computer Engineering, (Advanced)

Teaching Staff

(S): Research Institute for Sustainable Humanosphere

Professors

Shin-ichi Minato; Naofumi Takagi; Atsushi Igarashi; Hiroshi Harada; Eiji Oki; Takashi Sato; Masatoshi Hashimoto; Mamoru Yamamoto (S); Hiroyuki Hashiguchi (S)

Associate Professors

Jun Kawahara; Jesper Jansson; Kohei Suenaga; Koji Yamamoto; Takehiro Sato; Hiromitsu Awano; Tatsuhiro Yokoyama (S); Koji Nishimura (S)

Assistant Professors

Yuni Iwamasa; Ryota Yasudo; Masaki Waga; Ryo Shirai

Computer Engineering

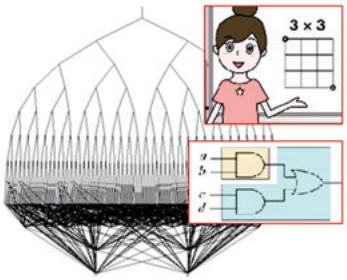
Enhancing the performance of computers is a clear challenge for the age of advanced information. Our goal is to respond to this challenge by conducting research and education on advanced technology for computer systems, including computer architectures for massively parallel information processing, the theory and art of algorithms, and fundamental software such as operating systems, and programming language systems.

Computer Algorithms

The theory and art of algorithms, with real-life applications

A computer system consists of hardware and software. Both parts work according to a logical procedure: "algorithm." The art of algorithms and complexity theory are core areas in computer science, and needless to say have a multitude of applications. We investigate fundamental theory, state-of-the-art techniques, and real-life applications of "algorithms," a keyword of our laboratory. We aim to enable computers to make increasingly significant contributions to society.

[Professor: Shin-ichi Minato;
Associate Professors: Jun Kawahara, Jesper Jansson;
Assistant Professor: Yuni Iwamasa]

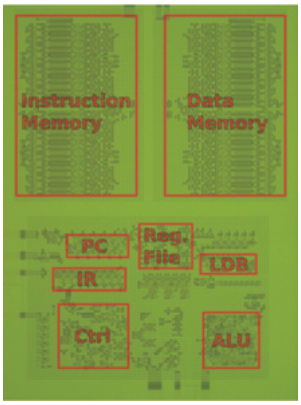


Computer Architecture

Advanced computing mechanisms and design technologies

We conduct education and research on new computing mechanisms and their design technologies for the post-Moore era in which exponential improvement in computer performance is difficult to achieve. Our main research topics include computing methods utilizing FPGA which is a reconfigurable hardware and GPU which enables high-speed parallel computing, high-capacity memory systems based on packet transfer, systems for uniform handling of combinational optimization, and design of superconductive digital circuits and development of their design support technologies.

[Professor: Naofumi Takagi; Assistant Professor: Ryota Yasudo]



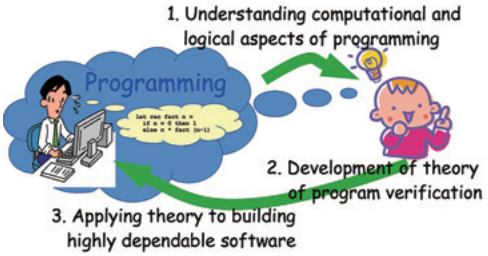
CORE e4: the world's first superconducting RSFQ stored-program microprocessor

Computer Software

Theory and practice for efficient and dependable software

Centering around programming languages, we conduct research and education on theory and practice for building highly efficient and dependable software. Our main focuses are on theory of program verification techniques based on mathematical logic, such as type theory and model checking, and the design and implementation of high-level programming languages, backed by rigorous foundations.

[Professor: Atsushi Igarashi; Associate Professor: Kohei Suenaga;
Assistant Professor: Masaki Waga]



Outline

Communications Systems Engineering

This division aims to conduct education and research on state-of-the-art technology with the goal of developing highly advanced information communication networks for handling multimedia information without network awareness. Topics include fundamental technologies for information communication networks such as the building of integrated wired and wireless digital information communication networks as well as adaptive digital signal processing and transmission technologies, information transmission media, network design and control technologies, and communication protocols that support them.

Digital Communications

Toward ubiquitous wireless information networks

Wireless communication networks, accelerated by cellular radio together with short-range wireless communications and RFID tag technologies, for instance, have been advancing significantly towards the goal of so-called ubiquitous networks. That is, we are on the verge of an era when people can enjoy various benefits unconsciously from totally connected network where various equipments, devices, and sensors are closely connected each other and linked to the Internet via wireless technologies. With wireless distributed self-organizing information networks which will be expected to play core roles in such a next generation information networks in mind, we are actively working to conduct education and research on highly efficient radio resource management techniques including spectrum sharing among multiple wireless systems, and highly spectrum- efficient signal processing techniques for broadband wireless transmission, etc.

[Professor: Hiroshi Harada]

Integrated-Media Communications

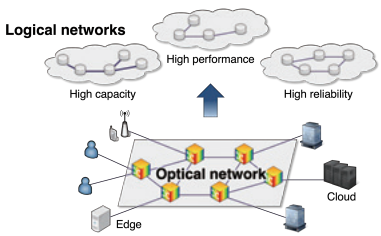
Towards an integrated wireless platform leveraging emerging technologies in different fields

The millimeter wave communications will be a key part of the next-generation radio access system and it will enable high-speed and large capacity wireless networks. However, there are many open issues such as a human blockage problem, where the received signal strength seriously decreases when pedestrians block line-of-sight paths. To solve the problems, we research on an integrated wireless platform leveraging emerging technologies in different fields such as computer vision and machine learning.

[Associate Professor: Koji Yamamoto]

Intelligent Communication Networks

Exploring information and communication network paradigms



The advancement of the Internet of Things (IoT) and big data technologies has enabled the networking of all types of devices around us and the provision of a diverse variety of services through data processing on cloud and edge platforms. Establishing these types of systems as social infrastructure will require technologies for the sophisticated design and control of networks for the transmission and reception of large volumes of traffic and computer resources to collect and analyze data. Our laboratory conducts research on high-speed, reliable, and flexible information communication networks using a broad range of theoretical and practical approaches.

[Professor: Eiji Oki; Associate Professor: Takehiro Sato]

Integrated Systems Engineering

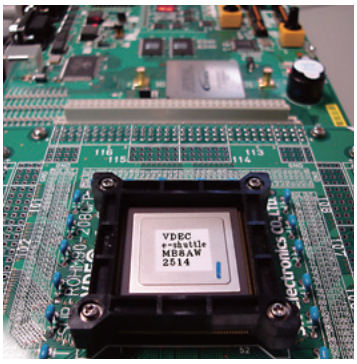
We conduct lectures and researches on high-performance, multifunctional, and highly-reliable large-scale integrated circuits and systems, which are fundamental infrastructures of future multimedia devices, computers, and communication systems. The research area includes processor architecture, algorithms for fast signal processing, massively parallel computing, and design methodologies for their circuit realization on advanced device technologies.

Processor Architecture and Systems Synthesis

Architecture design methodology for system LSIs

Architecture design of integrated circuits is a key enabler for exploiting full potential of advance semiconductor technologies. Real-time signal processing on media data, extremely low power operation to prolong battery lifetime, and maximizing reliability of the system are of utmost importance. We conduct researches on the following areas: (1) methodologies for circuit analysis, circuit design techniques, and circuit-performance optimization, (2) architectural design for processors and reconfigurable devices for system LSI, and (3) hardware and embedded software algorithms for codecs, digital communications, image recognition, and their design methodologies.

[Professor: Takashi Sato; Associate Professor: Hiromitsu Awano]



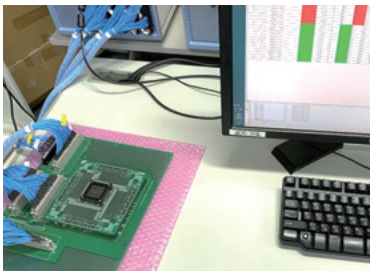
A reconfigurable LSI fabricated using 65nm process technology and its evaluation board

Ultrafast Signal Processing

Design and application of integrated systems

Our society is increasingly dependent on information system infrastructures, such as AI and Internet of Things (IoT). As they deal with human lives and property, information systems are required to offer high reliability. Ultra-low power, ultra-small volume semiconductor devices have been made possible by miniaturized transistors, and are realizing ambient computing that blends in with the environment. On the other hand, as the miniaturization of transistors seems to have reached its limit, efforts are underway to seek computing based on new principles. Under the banner of "creating computing infrastructure," this group is seeking ways to design reliable, high-performance computers, realize next-generation computing based on new principles, and define a computing system that changes our lifestyles.

[Professor: Masanori Hashimoto; Assistant Professor: Ryo Shirai]



Measuring a newly designed and fabricated FPGA chip with novel nano devices

Outline

Radio Atmospheric Sciences (Affiliated)

The Division of Radio Atmospheric Sciences conducts research and education regarding radio science, radio engineering, and information communication engineering related to the expansive atmospheric environment from the surface to the ionosphere. Our research focuses on the fields of applied radio engineering and information processing such as the development of different kinds of radar systems using sophisticated electronic circuit and computer technology, radar signal processing, radar observations of atmospheric waves, and remote-sensing systems.

Remote Sensing Engineering

Exploration of the Earth's atmosphere through radars

We aim to elucidate various phenomena observed in the Earth's atmosphere, through the development of radio remote sensing and computer modeling. We are developing radar technology and/or simulation codes for studying various atmospheric phenomena (e.g., turbulence, rain, clouds, plasma) over a wide altitude range -- from phenomena that occur near the surface and hence are directly related to human activities, to phenomena that occur at the ionosphere above 100km altitude, which is the boundary between the atmosphere and space. We study phenomena over Japan by the MU radar, and focus on the atmospheric and space weather phenomena. In addition to an atmospheric radar located in Indonesia (Equatorial Atmosphere Radar; EAR), we deploy an observation network in Southeast Asia under international collaboration in order to understand the atmospheric/ionospheric phenomena near the equator, where deep cumulus convection is more prevalent there than anywhere else.

[Professor: Mamoru Yamamoto;
Associate Professor: Tatsuhiro Yokoyama]

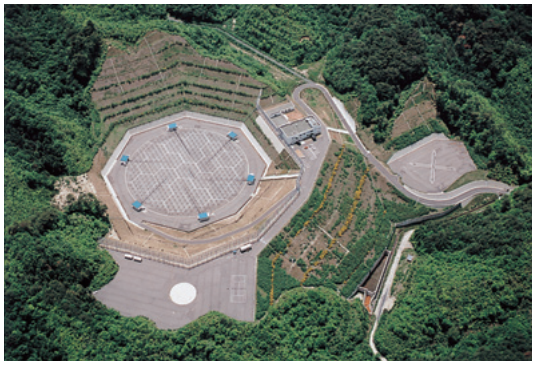
Equatorial Atmosphere Radar in West Sumatra, Indonesia. Its size is about the same as that of the MU radar.

Atmospheric Observations

Towards developing new observation techniques to obtain atmospheric environmental information

We are developing new techniques to observe the atmosphere using radio waves, light, and acoustic waves, and conduct research and education to collect, process, and disseminate global observational atmospheric data. More specifically, our research topics include profiling of atmospheric temperature and humidity by using radio-acoustic sounding and laser-radar techniques, development of radar digital receivers using software-defined radio for radar imaging observations of atmospheric turbulence, and development of adaptive clutter suppression techniques using the MU radar. We also carry out atmospheric observations around the world and combine a variety of techniques such as satellite data analysis and numerical modeling in order to elucidate various phenomena of the Earth's atmosphere, which is a protective coat of the humanosphere.

[Professor: Hiroyuki Hashiguchi;
Associate Professor: Koji Nishimura]

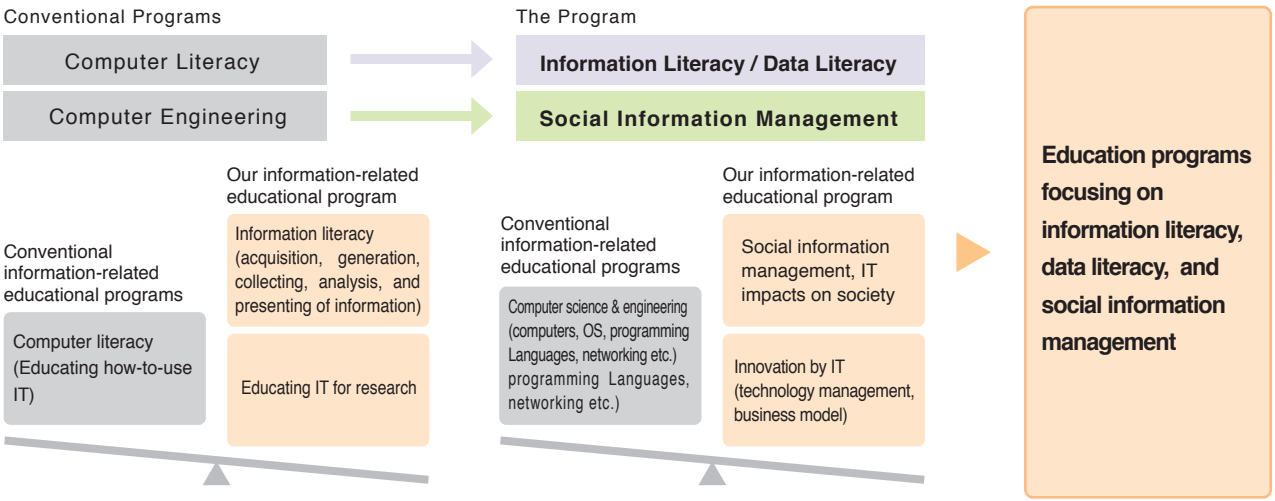


MU radar in Shigaraki, Koka City, Shiga Prefecture.
The diameter of the antenna is 103 m.

Advanced Information-Related Education & Digital Education Infrastructure Unit (Center for the Promotion of Interdisciplinary Education and Research (C-PiER))

The Advanced Information-Related Education & Digital Education Infrastructure Unit was established in Kyoto University C-PiER to implement the budget request project: Fostering Global Human Resources by Innovating Undergraduate/Graduate-level Information-related Education & Digitized Education of the graduate school of informatics, Kyoto University. It is our hope that students who will shape the future of our society will acquire essential skills to utilize information regardless of their areas of expertise so that they can enhance their information and communication skills as well as their global mindset.

Innovative Educational Programs



Digitized Education Environment

BYOD Classroom Learning

- Usage of tablets & note PCs in usual classrooms
- Active learning classrooms

Conventional classroom learning

Learning using tablets
Active learning

Online Lectures

- Online Lectures

Online Lectures

Faculties

Akihiro Yamamoto
Unit Leader / Professor
Graduate School of Informatcis

Yoshikazu Maegawa
Professor
Graduate School of Management

Satoshi Shimada
Senior Lecturer
Graduate School of Management

Nobuo Yamashita
Professor
Graduate School of Informatics

Hiroyuki Sato
Associate Professor
Graduate School of Informatics

Keishi Tajima
Professor
Institute for Liberal Arts and Sciences

Kazunari Sugiyama
Associate Professor
Graduate School of Informatics

Courses

[Liberal Arts Courses]

- Fundamentals of Informatics
- Fundamentals & Practice of Informatics
- Introduction to Information & Intellectual Property
- Innovation and Information
- Information and Enterprises

[Graduate Courses]

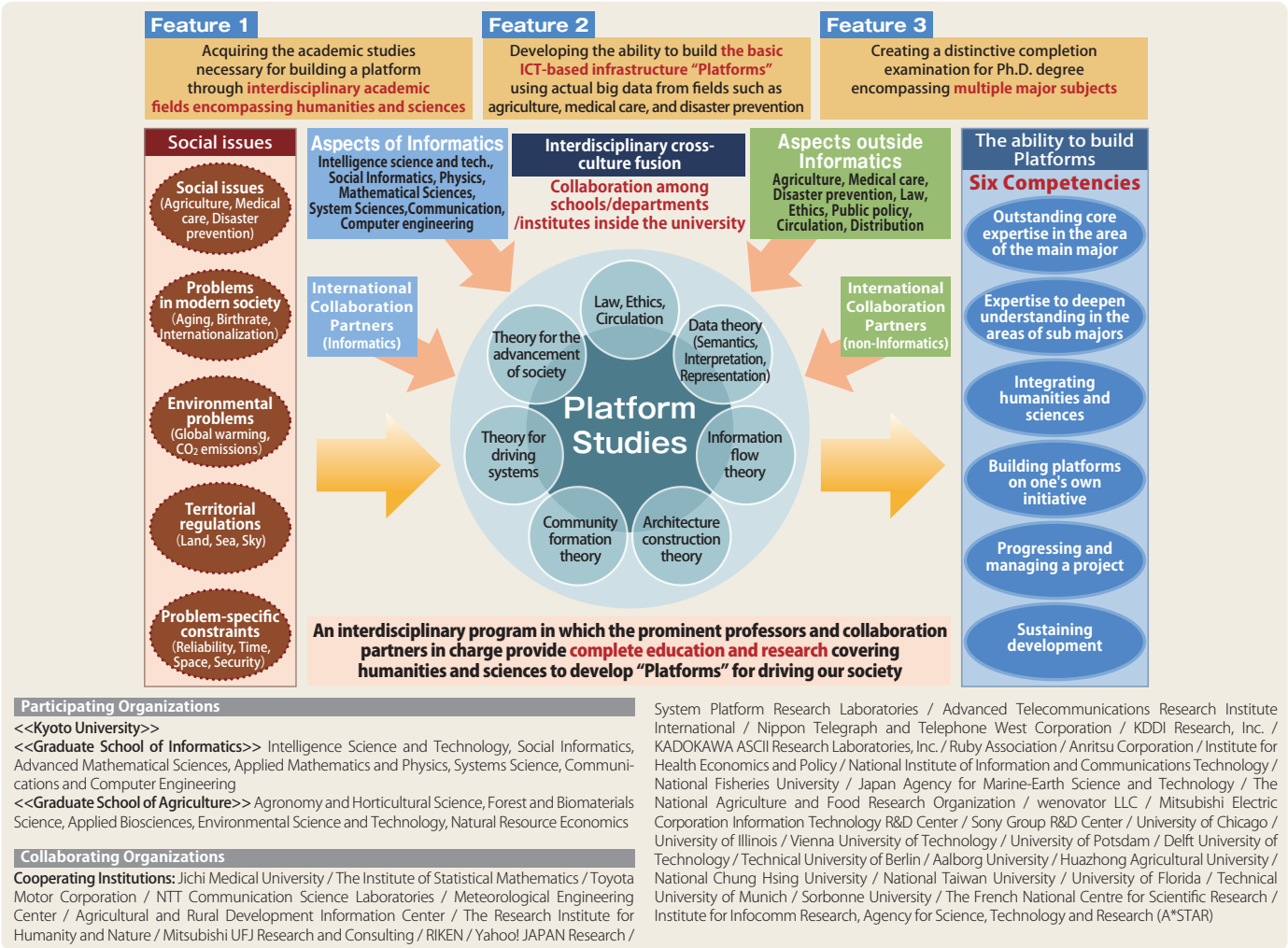
- Information Analysis and Management
- Practice of Information Analysis & Management
- Service Modeling
- Computation Science for Big Data
- Introduction to Computational Science
- Information and Intellectual Property
- Practice of Computational Science A
- Innovation and Information
- Information Security

Contact

Yoshida Honmachi, Sakyo, Kyoto 606-8501 Research Building #12, Rooms 110, 112 E-mail : iedu@i.kyoto-u.ac.jp

Kyoto University School of Platforms (KUSP)

The Kyoto University School of Platforms (KUSP) is a five-year doctoral program designed to cultivate students capable of creating a "platform that activates society." By making full use of interdisciplinary expertise that encompasses information and telecommunications network technology, big data analysis/utilization technology, and the humanities, the program aims to reduce social risks involved in various fields such as agriculture, medical science, and disaster management. KUSP was selected as a FY2020 WISE Program (Doctoral Program for World-leading Innovative & Smart Education) by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).



Participating Organizations

<<Kyoto University>>
<<Graduate School of Informatics>> Intelligence Science and Technology, Social Informatics, Advanced Mathematical Sciences, Applied Mathematics and Physics, Systems Science, Communications and Computer Engineering
<<Graduate School of Agriculture>> Agronomy and Horticultural Science, Forest and Biomaterials Science, Applied Biosciences, Environmental Science and Technology, Natural Resource Economics

Collaborating Organizations

Cooperating Institutions: Jichi Medical University / The Institute of Statistical Mathematics / Toyota Motor Corporation / NTT Communication Science Laboratories / Meteorological Engineering Center / Agricultural and Rural Development Information Center / The Research Institute for Humanity and Nature / Mitsubishi UFJ Research and Consulting / RIKEN / Yahoo! JAPAN Research / System Platform Research Laboratories / Advanced Telecommunications Research Institute International / Nippon Telegraph and Telephone West Corporation / KDDI Research, Inc. / KADOKAWA ASCII Research Laboratories, Inc. / Ruby Association / Anritsu Corporation / Institute for Health Economics and Policy / National Institute of Information and Communications Technology / National Fisheries University / Japan Agency for Marine-Earth Science and Technology / The National Agriculture and Food Research Organization / wenovator LLC / Mitsubishi Electric Corporation Information Technology R&D Center / Sony Group R&D Center / University of Chicago / University of Illinois / Vienna University of Technology / University of Potsdam / Delft University of Technology / Technical University of Berlin / Aalborg University / Huazhong Agricultural University / National Chung Hsing University / National Taiwan University / University of Florida / Technical University of Munich / Sorbonne University / The French National Centre for Scientific Research / Institute for Infocomm Research, Agency for Science, Technology and Research (A*STAR)

Platform Studies for Activating Society

Currently, efforts are fast underway to develop and utilize "platforms" that use telecommunications technology to collect information that is non-uniformly spread throughout our society. This information is digitally stored in the form of big data, which is then categorized, analyzed, and shared so that any outcome of the process may be fed back to society. The present platforms need a considerable amount of electric power and computational capability to collect and process big data. However, we can reduce the power consumption and costs if we consider the processes involved in decentralization, safety, and speed in the data generation and collection process. This requires exceptional informatics knowledge, which has as its focal point information and communication technologies. Meanwhile, deep learning and machine learning have become standard techniques and are often used in black boxes. Yet, it is possible to improve the output while reducing costs by correctly understanding and interpreting the data's meaning in each specific field and optimizing it. To achieve this, informatics must be combined with knowledge of different disciplines such as agriculture, medical science, disaster management, and other scientific studies.

The markets for cloud computing and communication networks are swiftly forming, but the reality is that Japan is failing to make its presence felt sufficiently in the process. One of the reasons for this is that only engineers are involved in platform development, which results in a lack of international perspectives in the standardization process and business undertakings. For Japan to increase its presence in this all-important field, in addition to knowledge on informatics and non-informatics science studies, we need to amalgamate the knowledge of laws, ethics, public policies, data distribution, and other humanities studies that are required to implement new collective decision-making mechanisms, such as Japan's unique outlook on social ethics and fairness. With this combination of studies thus achieved, it must be applied to platforms and deployed globally. In this doctoral program, we call this interdisciplinary academic

field "platform studies," which is essential in building platforms, and we propose to develop the required skills for this new academic discipline.

The Six Competencies Required of Platform Builders

To successfully complete this doctoral program on platform studies, one must acquire the following six competencies:
① Outstanding core expertise (advanced expert knowledge in the area of the primary major);
② Expertise to deepen understanding in core fields (expertise to explore core fields and the ability to foster sub-fields that complement them);
③ The ability to build platforms on one's own initiative (the ability to design/build platforms that offer solutions to social issues);
④ The ability to get things done (the ability to drive/manage large projects and expand their results globally);
⑤ The ability to sustain momentum (the ability to standardize results and develop social implementation in a sustainable manner); and
⑥ The ability to integrate humanities and sciences (knowledge on humanities required to build platforms, entrepreneurship, and the ability to create communities).

To ensure that students acquire "outstanding core expertise" in the areas of their primary major, the program provides students with lectures and seminars on such fields as informatics, agriculture, medical science, and disaster management, which are expected to help them deepen understanding of sub-fields while paying due regard to the curriculum of individual students' majors. Also provided are lectures and seminars on laws, ethics, data distribution, and other humanities studies needed to build platforms, which are designed to cultivate the ability to integrate humanities and sciences. Based on these inputs and research outcomes, students are expected to develop the skills to build platforms on their own initiatives, to promote/manage projects and implement and expand their results globally, and to standardize and socially implement the results so that they can develop the results in a sustainable manner. To assist them in doing so, the program offers guidance from instructors in multiple fields, research grants, research internships, research outcome matching events, international symposia, and other opportunities. Students will also be given access to state-of-the-art communication environments and various types of big data. These opportunities will be provided through industry-university-government cooperation among 41 institutions both within and outside of Kyoto University, including the Graduate School of Informatics, Graduate School of Agriculture, Graduate School of Medicine, School of Governance, and Disaster Prevention Research Institute.

- Website：https://www.platforms.ceppings.kyoto-u.ac.jp/
- E-mail：platforms_contact@mail2.adm.kyoto-u.ac.jp

Kyoto University Collaborative Graduate Program in Design

To respond to the complex needs of our modern society, Kyoto University Collaborative Graduate Program in Design is Japan's first program featuring an integrated, five-year curriculum for "Design" which seeks solutions by calling on knowledge from a variety of academic disciplines. This program aims at cultivating students who deepen their expertise in their own disciplines while working together with specialists in other disciplines as well as with stakeholders to deal with society's variegated issues and create a new structure for the society of tomorrow.
Students enrolled in this program conduct their studies around the six core disciplines of informatics,mechanical engineering, architecture, management, and psychology, while also engaging in a variety of training and field work aimed at acquiring the ability to design society. In order to participate in the program, a student must first be admitted into one of the five departments in the Graduate School of Informatics: Department of Intelligence Science and Technology, Department of Social Informatics, Department of Applied Mathematics and Physics, Department of Systems Science, and Department of Communications and Computer Engineering, and then can be considered for selection as a Preparatory Course student and Regular student in this program. Upon completing the program, students of the Doctorate Program of Graduate School of Informatics will earn either a Doctorate degree (Ph.D.) or a Doctoral Degree in informatics. As for the latter degree,certificate of the completion of the Program for Leading Graduate Schools 'Collaborative Graduate Program in Design' is specified in the diploma.

Participant Organizations

Graduate School of Education (Division of Educational Studies), Graduate School of Engineering (Department of Architecture and Architectural Engineering, Department of Mechanical Engineering and Science, Department of Micro Engineering, and Department of Aeronautics and Astronautics), Graduate School of Informatics (Department of Intelligence Science and Technology, Department of Social Informatics, Department of Applied Mathematics and Physics, Department of Systems Science, and Department of Communications and Computer Engineering), and Graduate School of Management (Department of Business Administration, Department of Management Science)

Partner Organizations

NEC Corporation, Nippon Telegraph and Telephone Corporation (NTT), Nomura Research Institute, Panasonic Corporation, Mitsubishi Electric Corporation, Mori Building, and about 70 members in Design Innovation Consortium (OMRON Corporation, Sony Corporation, Takenaka Corporation, DMG Mori Corporation, DENTSU Inc., Toray Industries Inc., Nikken Sekkei, The Japan Research Institute, Nippon Telegraph and Telephone West Corporation (NTT WEST), HAKUHODO Inc., Yamaha Motor, Yokogawa Electric Corporation, etc.)

- Website：http://www.design.kyoto-u.ac.jp
- E-mail：contact@design.kyoto-u.ac.jp

University Fellowship in Informatics

If you wish to be a proficient researcher who leads research and development in informatics, you should enroll in a doctoral program. To lower the financial obstacles in obtaining a doctoral degree, the Kyoto University Science and Technology Innovation Fellowship has been established with support from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) under its University Fellowship Program for the Creation of Innovation in Science and Technology starting in 2021. Responsible for the fields of information science and AI, the Graduate School of Informatics facilitates financial support for students in doctoral programs, who would lead research in their respective areas of specialty.

- Number of fellowship recipients: 25/grade
- Stipends: JPY1.8 million per year (in monthly installments of JPY150,000)
- Research fund: JPY300,000 per year (under management by supervisors)
- Selection: Applicants submit a statement of past research and research plan, as well as a letter of recommendation by their supervisors, based on which their past academic and research achievements and research perspectives after enrollment will be screened.

Recipients of the fellowship are requested to participate in programs, etc., organized by Kyoto University and the Graduate School of Informatics, so that they can enhance their research prowess and build a career path in diverse academic and industrial fields after completing the program. Some of the programs include presentation of research at the Kyoto University ICT Innovation, participation in a research internship, or being a teaching assistant in data science.

● Website：http://www.i.kyoto-u.ac.jp/fellowship/

International Course at the Graduate School of Informatics

Three departments of the Graduate School of Informatics, namely, the Department of Intelligence Science and Technology, Department of Social Informatics, and Department of Communications and Computer Engineering, have an International Course in their curriculum.

Students of the International Course are taught in English, receive guidance in English from their supervisors, and acquire Master's and Doctoral degrees exclusively in English.

These programs are open both to international and domestic students.

The curriculum was established at the Graduate School of Informatics after Kyoto University was designated as one of the hub university for the Project for Establishing Core Universities for Internationalization (Global 30/G30), which was launched in 2009 by MEXT.

The purpose of the G30 program was to cultivate top-notch individuals who would play an active role in the global arena by providing development opportunities through friendly competition with international students. Participating universities were called upon to provide quality education according to their respective functions and to create an environment that makes it easier for international students to study in Japan. To this end, the G30 program assisted Japan's leading universities in their efforts to create a hub of internationalization, including the development of a system in which degree courses can be offered entirely in English, improvement of the environment to accept international students, and promotion of strategic international cooperation.

● International Courses website：
http://www.i.kyoto-u.ac.jp/en/introduction/g30.html
● Contact：jyoho-kyomu@mail2.adm.kyoto-u.ac.jp
(Student Affairs Division)

Academic Programs

The Graduate School of Informatics provides graduate study programs that lead to Master's and Doctoral degrees. Taking into account the many different aspects of Informatics, students are required to take several compulsory credits outside their own department as a way to encourage interdepartmental education.

Requirements for the Master's Program

To receive a Master's Degree, every student is required to earn at least 30 credits from the courses specified by the departments; to receive the appropriate instructions through the classes; and to pass the course examinations and the assessment of Master's thesis. To encourage a well-rounded curriculum of study, students are asked to take subjects offered not only by one's own department but by other departments as well.

Requirements for the Doctoral Program

A Doctoral degree requires original, high-quality research in an individual field. To receive a Doctoral Degree, students are required to earn at least 6 credits from the courses specified by the departments; to receive the appropriate instructions through the classes; and to pass the course examinations and the assessment of Doctoral thesis.

Entrance Examination

The academic year begins in April. In general, a Master's degree requires two academic years of study, and a Doctoral degree three years. Admission to graduate programs is granted to those individuals who have passed the entrance examination of the Graduate School of Informatics conducted by the relevant departments. The examination is held in July and August. Supplementary examinations may be held in December and February.

Applications for the International Course, in which the degree will be earned in a solely English language medium, are also accepted in the departments of Intelligence Science and Technology; Social Informatics; Communications and Computer Engineering.

The Number of Students to be Admitted by Department

	Master's Program	Doctoral Program
Department of Intelligence Science and Technology	37	15
Department of Social Informatics	36	14
Department of Advanced Mathematical Sciences	20	6
Department of Applied Mathematics and Physics	22	6
Department of Systems Science	32	8
Department of Communications and Computer Engineering	42	11
Total	**189**	**60**

Both non-Japanese and working professionals are eligible for admission into the graduate program. Students may enroll in this graduate school concurrently with their professional responsibilities.

For further information, please contact:

Graduate School of Informatics
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Yoshida-Honmachi, Sakyo-ku,
Kyoto 606-8501 JAPAN
Tel. +81 75-753-4894,5500
http://www.i.kyoto-u.ac.jp

Definition of Informatics

Informatics in Kyoto University is the study of information in natural and artificial systems.

Informatics studies the creation, recognition, representation, collection, organization, optimization, transformation, communication, evaluation and control of information in complex and dynamic systems.

Informatics has human, social, cognitive, biological, linguistic, computational, mathematical and engineering aspects. It includes systems science and communications engineering.

Informatics has close relations with a number of disciplines in the natural and human sciences.
It is developed employing contributions from many different areas :in turn, it can contribute to their further development.

Interfaces to human and social areas, mathematical modeling and information systems are the three pillars of Informatics in Kyoto University.

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