Department of Intelligence Science and Technology

Department of Intelligence Science and Technology

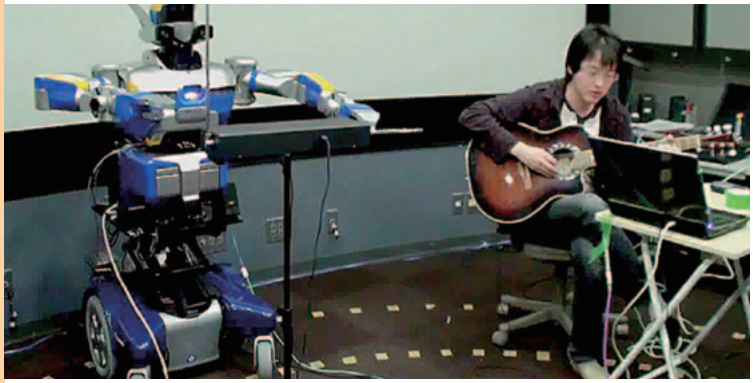
Construction and Elucidation of Intelligence Realization of Flexible, Human-like Information Processing.

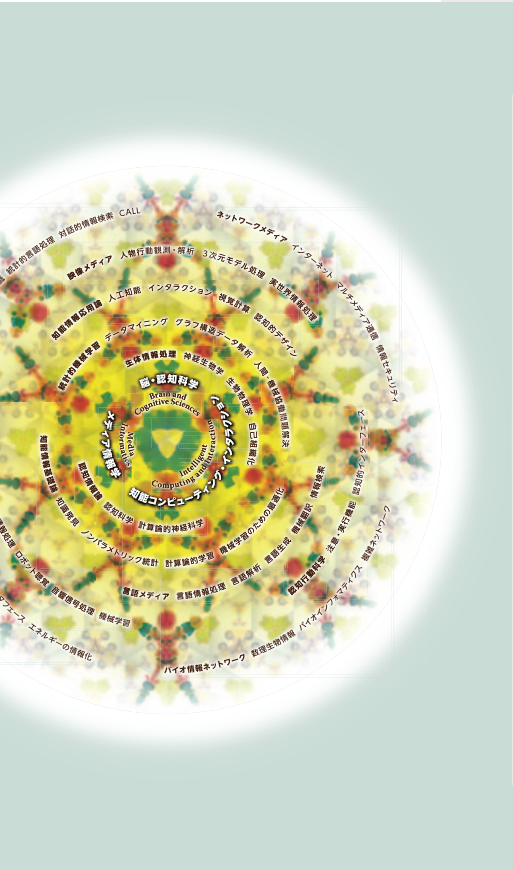
In an advanced information-oriented society, we require information processing with flexible, human-like information capabilities.

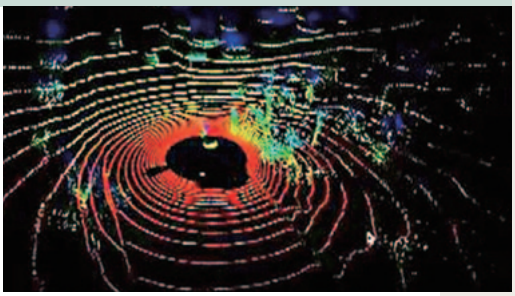
Information processing in human and animal organic systems has developed by means of structural and functional adaptation to the environment through a long process of evolution; there is no other high-level processing capacity quite like it.

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

Welcome to the World of Intelligence Science and Technology Department of Intelligence Science and Technology is a research field, in which we learn sophisticated human information processing and develop new technology on the basis of understanding of human functions. We do not simply mean “intelligence” as “artificial intelligence”, rather as a wider scope of intelligent aspect of human, systems, and information technology. More specifically, our research and educational activities include (i) basic human mechanism, such as life, brain, cognition and behavior, (ii) information media related to language, speech/ auditory, and visual information, and (iii) interaction between human and intelligent systems, such as artificial intelligence, machine learning, beg data, and network. These activity covers a broad range of topics related to intelligence and informatics. Although these topics have been mainly investigated in separate research fields, such as neuroscience, psychology, engineering and so on, our distinguished features are to integrate these topics under a unique discipline, namely, “intelligence science and technology”. Faculty members and students, with a wide variety of academic background, devote themselves to a new and common research field under free discussion and flexible collaboration. We hope that many young students join our department, and tackle mystery of complex human brain functions and develop new ideas to solve problems on intelligent media and computation under unique an academic atmosphere. We are really happy if we can share real pleasure and excitement to archive them with all of you.

Our department welcomes outstanding students graduated not only from engineering, but also from other undergraduate programs. We provide interdisciplinary curricula and research projects. Join us, and an enjoy academic life with us!

KUMADA Takatsune
Department of Intelligence Sience and Technology
Professor, Department of Intelligence Science and Technology
1991 Graduated from Institute of Psychology, University of Tsukuba, PhD.
1992 Research Scientist, National Institute of Advanced Industrial Science and technology (AIST).
2001 Group Leader, AIST.
2012 Unit Leader, Brain Science Institute, RIKEN.
2013 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	KAMITANI Yukiyasu
	Psychoinformatics	Human Attention and Executive Function, and Cognitive Interface	KUMADA Taketsune
	Cognitive communication	Information Processing Mechanisms in Human Cognitive Proces	
	Computational cognitive neuroscience (Adjunct unit)	Speech Observation and Signal Processing Techniques	MASAKI Shinobu
Cognitive System	Computational intelligence	Information Modeling for Intelligent Information Processing Mechanism	YAMAMOTO Akihiro
	Collective intelligence	Machine Learning and Data Mining	KASHIMA Hisashi
	Conversational Informatics	Understanding and Designing Interaction, Human Computer Interaction Using Visual Information	NISHIDA Toyoaki
Intelligent media informatics	Language media processing	Natural Language Processing, Knowledge Engineering	KUROHASHI Sadao
	Speech and audio processing	Recognition and understanding of speech, audio and music	KAWAHARA Tatsuya
	Visual information processing	Image Recognition and Understanding	MATSUYAMA Takashi
Application of Multimedia (Affiliated)	Video Media	Human-Computer Interaction through Video Images	MINOH Michihiko
	Network Media	Techniques to Realize Multimedia Information Network	OKABE Yasuo
	Media Archiving Research	Advanced Digital Archiving via Speech and Language Processing	
Bio-system Informatics (Affiliated)	Biological Information Networks	Bioinformatics, Computational Systems Biology	AKUTSU Tatsuya
i-Energy: Smart Energy Management (Joint Research Chair)	i-Energy: Smart Energy Management		MATSUYAMA Takashi

Graduate Curriculum

Courses for the Master's Program

Introduction to Information Science
Seminar on Biological Information Processing
Foundation of Software Science
Artificial Intelligence (Advanced)
Multimedia Communication
Language Information Processing (Advanced)
Visual Interaction
Advanced Research in Intelligence Science and Technology
Advanced Study in Intelligence Science and Technology I
Advanced Study in Intelligence Science and Technology II
Introduction to Cognitive Science
Introduction to Bioinformatics
Seminar on Cognitive Science
Pattern Recognition (Advanced)
Foundations of Intelligent Systems
Speech Information Processing (Advanced)
Computer Vision
Bioinformatics Advanced

Courses for the Doctoral Program

Advanced Seminar on Biological and Cognitive Processing
Advanced Seminar on Intelligence Information Processing
Advanced Seminar on Intelligence Media Advanced Seminar on Application of Multimedia
Advanced Seminar on Gene Informatics Advanced Seminar on Intelligence Science and Technology
Advanced Seminar on Application of Multimedia
Advanced Seminar on Intelligence Science and Technology

Teaching Staff

(M) : Academic Center for Computing and Media Studies

Professors

KAMITANI Yukiyasu; KUMADA Takatsune; MASAKI Shinobu (ATR, Adjunct); KASHIMA Hisashi; YAMAMOTO Akihiro; NISHIDA Toyoaki; KUROHASHI Sadao; KAWAHARA Tatsuya; MATSUYAMA Takashi; MINOH Michihiko (M); OKABE Yasuo (M); AKUTSU Tatsuya (Institute for Chemical Research)

Associate Professors

TSUJIMOTO Satoshi; LIANG, Xuefeng; CUTURI, Marco; NAKAZAWA Atsuhi; KAWAHARA Daisuke; KAWASHIMA Hiroaki; IIYAMA Masaaki; MIYAZAKI Shuichi (M); MORI Shinsuke (M); KATO Takekazu

Senior Lecturers

HOSOKAWA Hiroshi; MIZUHARA Hiroaki; SHIBATA Tomohide; YOSHII Kazuyoshi; NOBUHARA Shohei

Assistant Professors

MAEGAWA Shingo; MAJIMA Kei; ICHINOSE Natsuhiro; BABA Yukino; YOSHINAKA Ryo; OHMOTO Yoshimasa; NITSCHKE, Christian; MURAWAKI Yugo; ITOYAMA Katsutoshi; KOTANI Daisuke (M); HAYASHIDA Morihiro (Institute for Chemical Research); TAMURA Takeyuki (Institute for Chemical Research); JAVAID Saher; VERSCHAE, Rodrigo

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: KAMITANI Yukiyasu,
Senior Lecturer: HOSOKAWA Hiroshi,
Assistant Professor: MAEGAWA Shingo,
Assistant Professor: Kei Majima]

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: KUMADA Takatsune,
Associate professor: TSUJIMOTO Satoshi,
Assistant professor: ICHINOSE Natsuhiro]

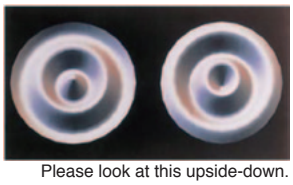
An experiment examining eye and action coordination

Cognitive communication

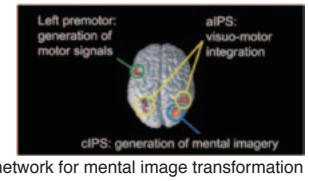
Towards a systematic understanding of the human brain

In order to obtain a systematic understanding of the human brain, we will conduct both experimental and theoretical research and instruction on how higher human cognitive functions are carried out. Specifically, we will undertake studies involving both psychological experiments and neural network simulations to determine how various higher-level functions, such as visual pattern recognition, the integration of sensory information from various modalities, verbal and nonverbal communication, and motor control are carried out in the brain. We will also measure human brain activity using brainimaging techniques.

[Senior Lecturer: MIZUHARA Hiroaki]



Please look at this upside-down.



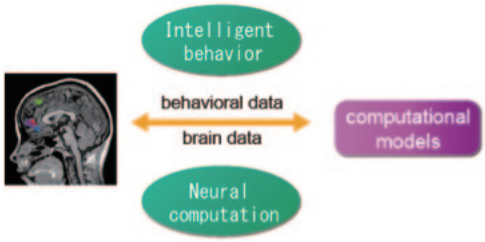
Cortical network for mental image transformation

Outline

Computational cognitive neuroscience (Adjunct unit)

Neural computations of human minds

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.



Cognitive system

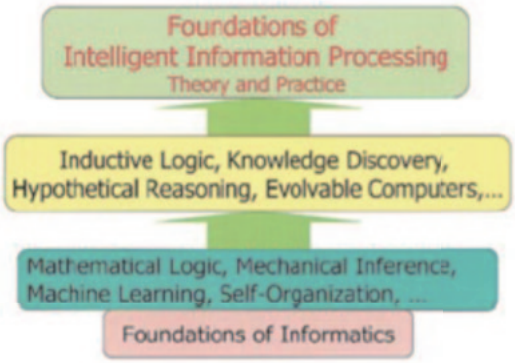
Our goal is to develop flexible and intelligent information processing. We will identify the basic components and structures of information, as well as study extraction, recognition, understanding, and representation of information. We are developing new approaches of intelligence information research 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: YAMAMOTO Akihiro,
Assistant Professor: YOSHINAKA Ryo]

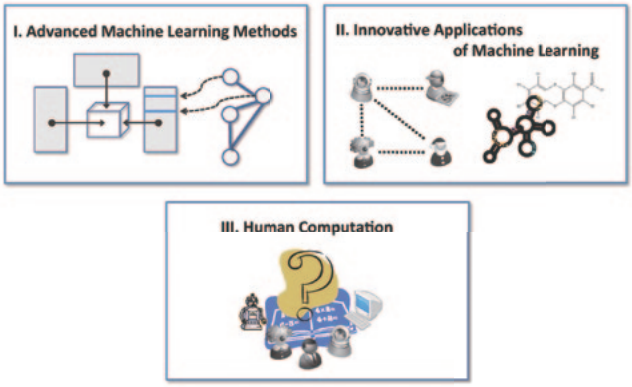


Collective intelligence

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: KASHIMA Hisashi,
Assistant Professor: BABA Yukino]

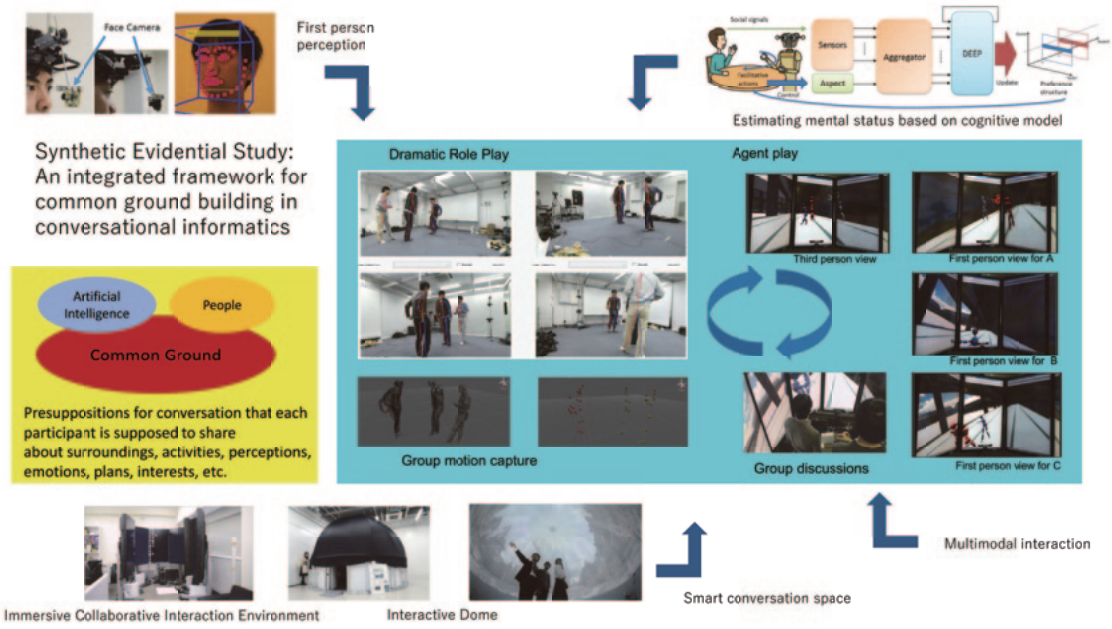


Conversational Informatics

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.

[Professor: NISHIDA Toyoaki,
Associate Professor: NAKAZAWA Atsushi,
Assisitant Professor: OHMOTO Yoshimasa]



Outline

Intelligent media informatics

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. These include the following research areas.

—Fundamental Studies on Text Understanding—

We have been developing a method for automatically acquiring linguistic patterns of predicate-argument structures. By utilizing such knowledge, we study text understanding, i.e., recognizing the relationships between words and phrases in text.

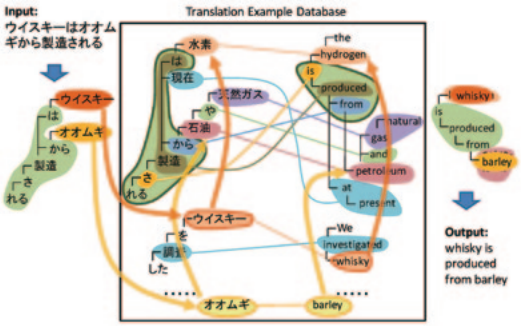
—Development of Search Engine Infrastructure based on Deep Natural Language Processing—

We have been developing a next-generation infrastructure of information retrieval on the basis of the following techniques of deep natural language processing: precise processing based not on words but on predicate-argument structures, identifying the variety of linguistic expressions and providing a bird's-eye view of search results.

—Studies on Improving Machine Translation—

To bring automatic translation by computers to the level of human translation, we have been studying next-generation methodology of machine translation on the basis of text understanding and a large collection of translation examples.

[Professor: KUROHASHI Sadao,
Associate Professor: KAWAHARA Daisuke,
Senior Lecturer: SHIBATA Tomohide,
Assistant Professor: MURAWAKI Yugo]

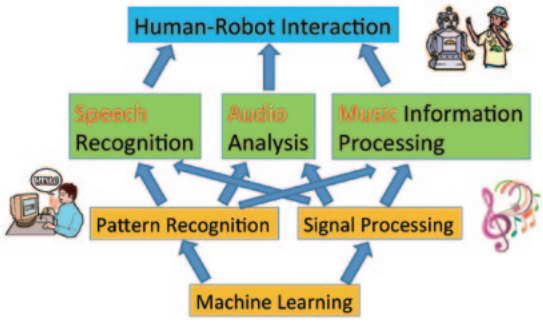


Speech and Audio Processing

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
Senior Lecturer: Kazuyoshi Yoshii
Assistant Professor: Katsutoshi Itoyama]



Visual Information Processing

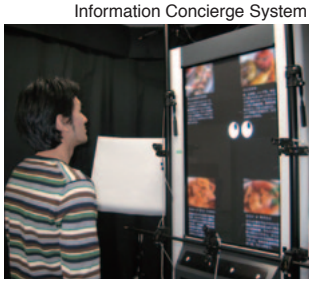
Towards systems that understand visual information

We humans are endowed with highly advanced visual perception capable of recognizing and understanding object appearances and behaviors. The goal of our education and research is to develop hardware and software technologies for systems that recognize and understand visual information as humans do. We study a 3D video technology for capturing dynamic 3D shapes and textures of people as is, a human communication system for understanding human intent and meaning behind human behavior to provide suitable information guidance, and a smart energy management system for realizing energy-efficient homes, offices, factories, and communities.

[Professor: MATSUYAMA Takashi,
Associate Professor: KAWASHIMA Hiroaki,
Senior Lecturer: NOBUHARA Shohei]

3D video technology

Information Concierge System



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

Human-computer interaction through video media

Computers convey information as "information media," which facilitate human communication. We are exploring “information media” technology for facilitating smooth communication through computers and aim to observe, archive and recognize human communication in intellectual activities. More specifically, we aim to achieve the following:

- a telepresence system for supporting human multimedia communica tion in the classroom;
- recognition of human activities in the kitchen to assist cooking;
- extracting 'real world information' for the protection of privacy against observation by various sensory devices;
- acquisition of shapes, motion, and colors of various objects to create virtual environments; and
- interaction between an actor and virtual objects in a virtual studio system.

[Professor: MINOH Michihiko, Associate Professor: IIYAMA Masaaki]

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. For this purpose, we are working on fundamental research issues pertaining to the next-generation Internet, including IPv6 architecture, quality-aware transfer of multimedia data, mobility, zero configuration, and security. We are also working on integration technology of information, communication, and energy. We study how to apply Internet protocols and algorithms, such as routing, matching, reservation, and interruption, to power management.

[Professor: OKABE Yasuo,
Associate Professor: MIYAZAKI Shuichi,
Assistant Professor:KOTANI Daisuke]

Demonstration of on-demand power network

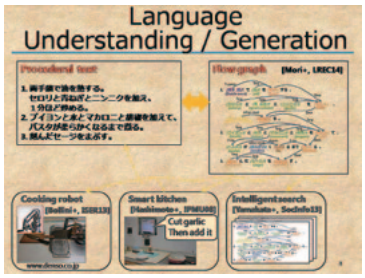
Media Archiving Research

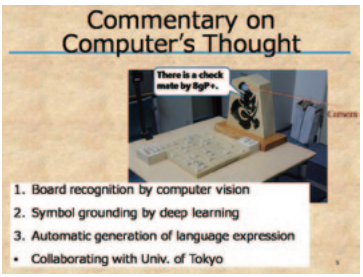
Speech and Natural Language Processing for Multi-media Archives

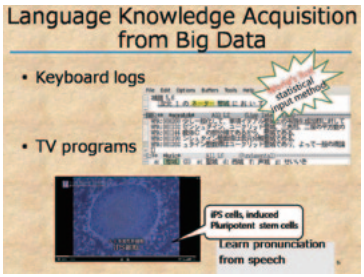
Since time immemorial human knowledge has been recorded as text. The research activities of this group focus on computers capable of understanding these texts and describing new knowledge. As a basis we are studying fundamental natural language processing. And we are studying natural language generation 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.

[Associate Professor: MORI Shinsuke]







Bio-system Informatics (Affiliated)

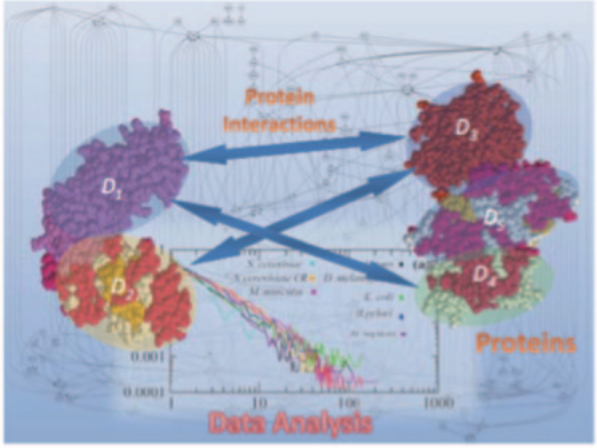
Biological systems and creatures are ineffably complex systems in which many kinds of chemical structures, proteins, genes and other objects interact with one another. We examine these as interactive networks to implement education and research aimed at elucidating and understanding the system, mainly 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: AKUTSU Tatsuya,
Assistant Professors: HAYASHIDA Morihiro,
TAMURA Takeyuki]



Analysis of three-dimensional structures and interactions of protein

i-Energy: Smart Energy management (Joint Research Chair)

Using internet technologies to improve the management of the electric power network has become a popular [idea][notion]. We propose the concept of i-Energy for smart demand-side energy management. This differs significantly from the Smart Grid. The former aims at energy management from the consumer's viewpoint, and the latter from the supplier's viewpoint. We have been studying the following four realization methods for the i-Energy concept: 1) Smart Tap Network for monitoring detailed power consumption patterns of individual appliances and the dynamic activities of people in homes, offices, and factories, 2) Energy on Demand Protocol to realize a priority-based best-effort power supply mechanism as well as an automatic ceiling enforcement mechanism for power consumption in both Watts (W) and Watt hours (Wh), 3) Power Flow Coloring to allow versatile power flow controls depending on the type and cost of power sources, and 4) Smart Community for bi-directional energy trading among households, offices, and factories in a local community.