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

In an advanced information-oriented society, information processing with flexible, human-like information capabilities becomes essential. Information processing in human and animal organic systems is unparalleled in nature which has developed through structural and functional adaptation to the environment in the long process of evolution. Intelligence Science and Technology is a multidisciplinary field that aims to elucidate the mechanisms of biological-, particularly, human-information processing for the development of higher-level information processing.

Welcome to Intelligence Science and Technology Course

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, foci of 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 course 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!
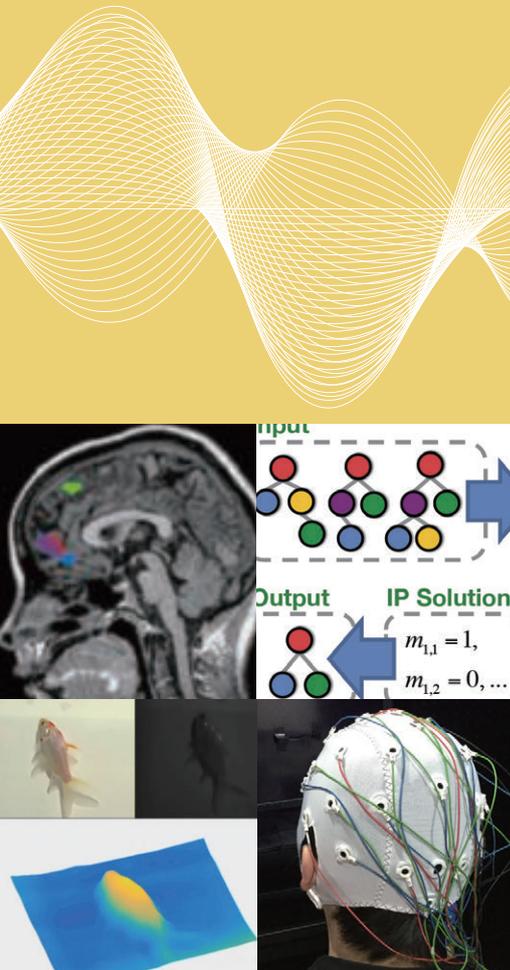
Tadahiro Taniguchi

Professor, Intelligence Science and Technology Course

Received a Ph.D. in Engineering from the Graduate School of Engineering, Kyoto University in 2006.
After serving as Professor at the College of Information Science and Engineering, Ritsumeikan University, and as Visiting General Chief Scientist at Panasonic Holdings Corporation, he assumed his current position in 2024.

Outline

Group and Teaching Staff

Group	Teaching Staff
Neuroinformatics	Yukiyasu Kamitani/Professor Yukiori Goto/Associate Professor Hiroshi Hosokawa/Senior Lecturer Yoshihiro Nagano/Assistant Professor Shingo Maegawa/Assistant Professor
Psychoinformatics	Takatsune Kumada/Professor Ryoichi Nakashima/Associate Professor
Cognitive Informatics	Shin'ya Nishida/Professor Kiyofumi Miyoshi/Assistant Professor
Computational Cognitive Neuroscience (Adjunct Unit)	Hiroyuki Nakahara/Adjunct Professor Wataru Sato/Adjunct Professor(RIKEN)
Computational Intelligence	Akihiro Yamamoto/Professor Nozomi Akashi/Assistant Professor
Collective Intelligence	Hisashi Kashima/Professor Koh Takeuchi/Senior Lecturer Kyohei Atarashi/Assistant Professor
Symbol Emergence Systems	Tadahiro Taniguchi/Professor Masatoshi Nagano/Assistant Professor
Language Media Processing	Sadao Kurohashi/Program-Specific Professor Yugo Murawaki/Associate Professor Chenhui Chu/Program-Specific Associate Professor Fei Cheng/Program-Specific Senior Lecturer Huang Yin Jou /Program-Specific Assistant Professor
Speech and Audio Processing	Tatsuya Kawahara/Professor Keisuke Imoto/Associate Professor Koji Inoue/Assistant Professor Keiko Ochi/Program-Specific Assistant Professor
Computer Vision	Ko Nishino/Professor Ken Sakurada/Associate Professor Ryo Kawahara/Associate Professor
Human Sensing	Yuichi Nakamura/Professor Kazuaki Kondo /Associate Professor Kei Shimonishi/Assistant Professor
Text Media	Shinsuke Mori/Professor Hirotaka Kameko/Assistant Professor
Biological Information Networks	Tatsuya Akutsu/Professor Takeyuki Tamura/Associate Professor Motomu Matsui/Assistant Professor

Curriculum of Intelligence Science and Technology Course

Doctoral Program (Informatics)

3rd	Doctoral Thesis	
2nd	**Subjects provided by the Course (total 6 credits including 4 credits from seminars)** Seminar on Intelligence Science and Technology, Adv. *E* (Mandatory, 2 credits) Seminar on Brain and Cognitive Sciences, Adv. A, B *E,*　　　Seminar on Cognitive System, Adv. A, B *E,* Seminar on Intelligence Media, Adv. A, B *E,*　　　Seminar on Application of Multimedia, A, B Adv. *E,* Seminar on Bio-system Informatics, A, B Adv. *E*　　　　　　　　　　　　　　　(2 credits each)	**Research Guidance**
1st		

Master's Program (Informatics)

Master's Thesis

Subjects provided by the Course (optional 6 credits or more)

| 2nd | **Advanced Subjects**
Seminar on Cognitive Science, Computational Cognitive Neuroscience, Pattern Recognition Adv. *E,* Speech Processing Adv. *E,* Language Information Processing Adv., Computer Vision E, Visual Interface, Bioinformatics Adv. (2 credits each) | **Seminars** (4 credits, Mandatory)
Seminar on Intelligence Science and Technology II *E*
Seminar on Intelligence Science and Technology IV *E*
　　　　　　　　　　(Assigned to M2, 2 credits each)
Seminar on Intelligence Science and Technology I *E,*
Seminar on Intelligence Science and Technology III *E*
　　　　　　　　　　(Assigned to M1, 2 credits each) | **Seminars and exercises for Master's thesis**
(Mandatory 8 credits)

Advanced Study in Intelligence Science and Technology 2*E*
(Assigned to M2, 6 credits)

Advanced Study in Intelligence Science and Technology 1 *E*
(Assigned to M1, 2 credits) |
| 1st | **Basic Subjects**
Introduction to Cognitive Science, Introduction to Information Science, Introduction to Bioinformatics　　　　　　(2 credits each) | **Recommended Subjects Provided by Other Courses**
Computational learning theory
Statistical learning theory | |

General subjects provided by the School

Interdisciplinary subjects of the Perspectives in Informatics (Mandatory 2 credits or more, up to 4 credits) Perspectives in Informatics 1　　Perspectives in Informatics 2 Perspectives in Informatics 3*E*　　Perspectives in Informatics 4*E* Perspectives in Informatics 5*E*　　　　　　(2 credits each)	Perspectives in Platform Studies (2 credits), Computational Science, Introduction (2 credits), Computational Science, Exercise A (1 credit), Information and Intellectual Property (2 credits), Innovation and Information (2 credits), Information Analysis and Management (2 credits), Information Analysis and Management, Exercise (1 credit), Social Contributions through Informatics *E* (1 credit) Internship in the Field of Informatics *E* (1 credit)	Specific subjects provided by the school

| Prior to admission	Bioinformatics	Psychology	Computational Science	Electrical and Electronic Engineering	Required basic background of either subject on the left

Note: Courses marked with the letter "E" will be provided in English.

Brain and Cognitive Sciences

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.

[Yukiyasu Kamitani , Yukiori Goto , Hiroshi Hosokawa , Yoshihiro Nagano, Shingo Maegawa]
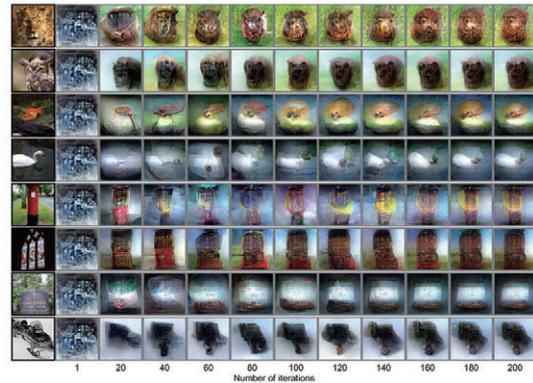
Psychoinformatics

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.

[Takatsune Kumada , Ryoichi Nakashima]

An experiment examining eye and action coordination

Cognitive Informatics

*Understanding Human Sensory and Cognitive Information Processing*

Our lab aims to understand the principles of human information processing related to sensation, perception, and metacognition and their underlying neural mechanisms by means such as psychophysics and computer simulations. By comparing human brains with artificial intelligence systems, we attempt to reveal the characteristics of human information processing. We also work on developing information technology that leverages human characteristics.

[Shin'ya Nishida , Kiyofumi Miyoshi]

Material perception is one of our research topics.
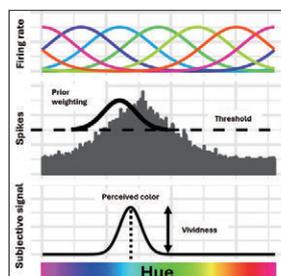
Neural coding model for subjective color experience

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.

[RIKEN: Hiroyuki Nakahara , Wataru Sato]
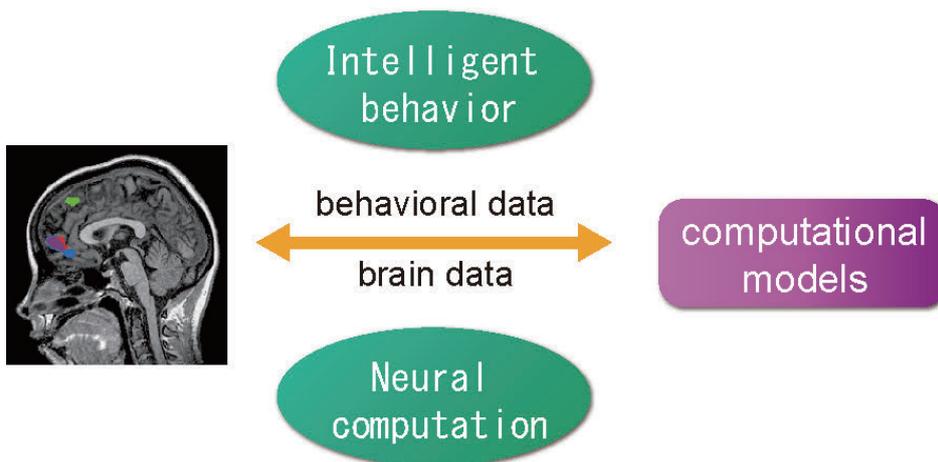
Computational Intelligence

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.

[Akihiro Yamamoto , Nozomi Akashi]
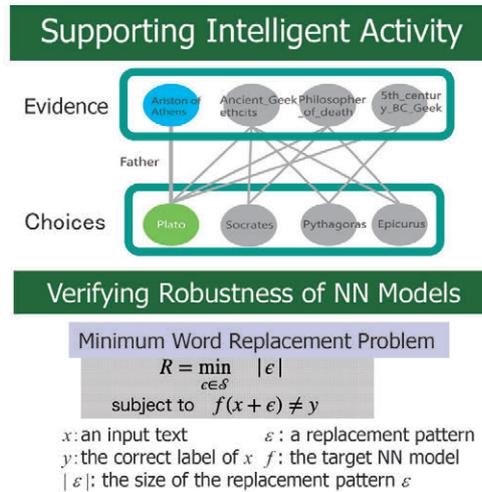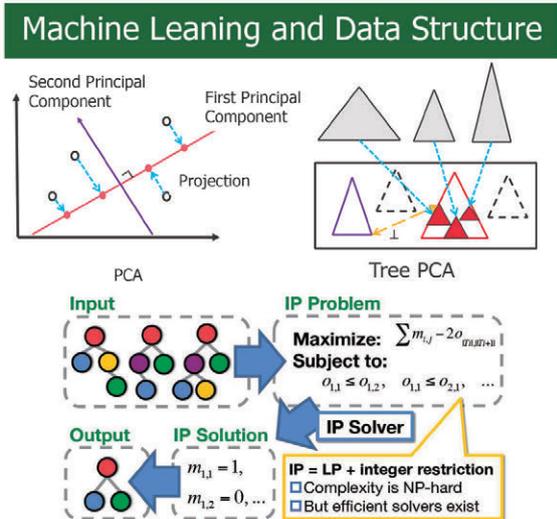
Collective Intelligence

Machine Learning That Matters

Our research focus is on the development of fundamental technologies for intelligent information technology, with a focus on machine learning, and their real-world applications. While pursuing R&D on new problems and methods of machine learning and data analysis, we also tackle various challenges in science and business. At the same time, we conduct research on methodologies for solving challenging problems that are difficult to address by AI or humans alone, by combining AI with human power.

[Hisashi Kashima , Koh Takeuchi , Kyohei Atarashi]
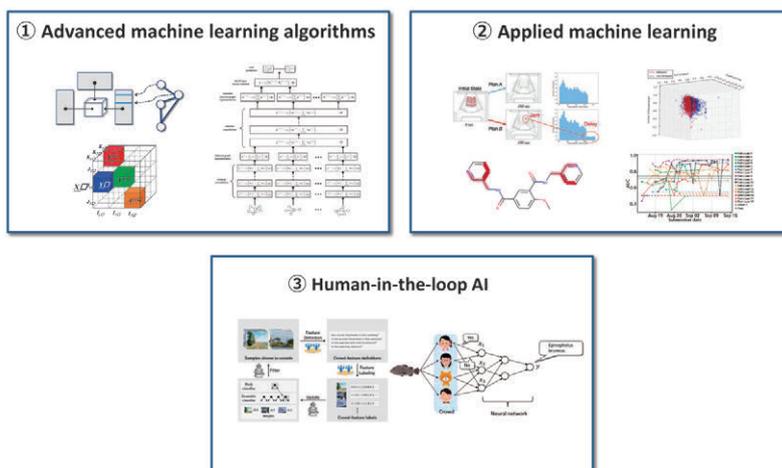
Symbol Emergence Systems

Pursuing AI and robots that can act based on understanding the meaning of language in the real world

Humans adapt in real-world environments and behave intellectually using their bodies. The language used by humans and the conversations based on that language are, in that sense, intellectual functions we, as part of society, have acquired as a result of evolution and development. This group conducts a wide range of research using theory-based computer experiments, simulations, and robotics, with the view that the emergence of language and symbols based on real-world cognition forms the core of intelligence. Research topics include symbol emergence in robotics, communication emergence, multimodal linguistic understanding, cognitive architecture, and systems that include humans. The aim of our research is to create AI and robots that coexist with humans.
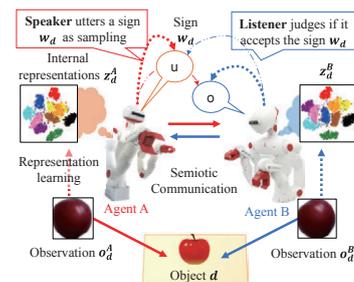
[Tadahiro Taniguchi , Masatoshi Nagano]

Robotics based on a world model and free energy principle and multimodal linguistic understanding
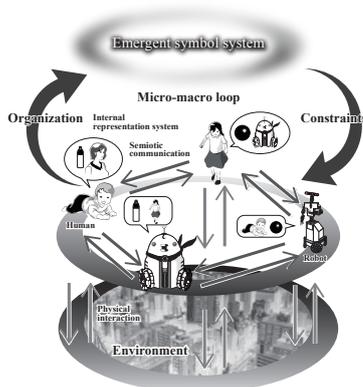

Symbol emergence systems that include people and AI

Synthesis of communication emergence and understanding and utilization of large-scale language models

Language Media Processing

Making computers that can understand language

Since language lies at the core of human intellectual activity, the emergence of computers capable of freely manipulating language will significantly impact society in a broad variety of ways. With this goal, we are engaged in research to shed light on how humans utilize language and to enable computers to communicate using language in human-like ways. We are pursuing both pure research on language understanding based on large-scale language models and applied research for useful real-world purposes, such as translation, dialogue, and knowledge structuring.
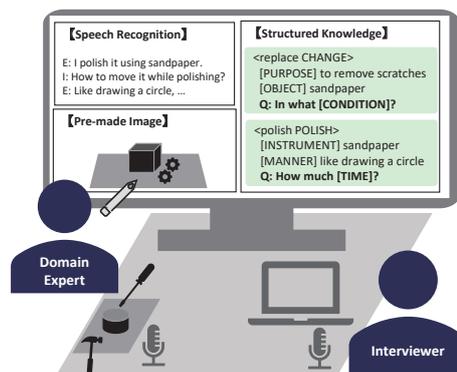
[Sadao Kurohashi , Yugo Murawaki , Chenhui Chu , Fei Cheng , Huang Yin Jou]

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.

[Tatsuya Kawahara , Keisuke Imoto , Koji Inoue , Keiko Ochi]

Overview of Speech and Audio Processing Lab.
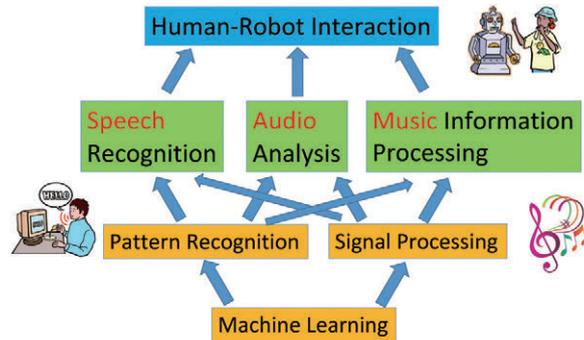
Computer Vision

Making Computers See

Neural substrates dedicated to vision are 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.
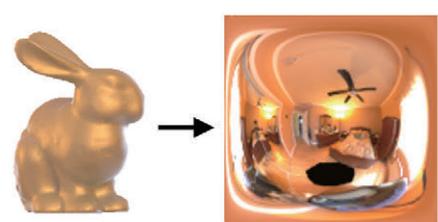
[Ko Nishino , Ken Sakurada , Ryo Kawahara]

Pointing Estimation

Human Body Reconstruction

Illumination and Reflectance Estimation

Human Sensing

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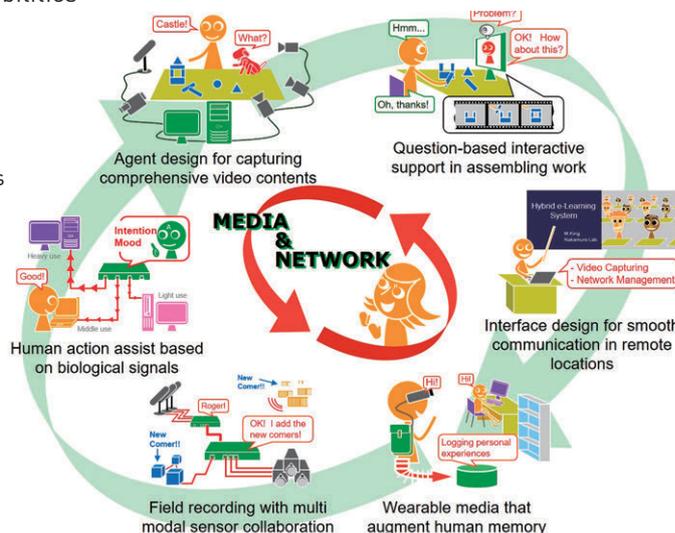
A common approach in all of these media is that information or mechanical systems notice human's intention and augment their abilities for meeting what they want to do.

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

[Yuichi Nakamura , Kazuaki Kondo, Kei Shimonishi]

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.

[Shinsuke Mori , Hirotaka Kameko]

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.

[Tatsuya Akutsu , Takeyuki Tamura , Motomu Matsui]
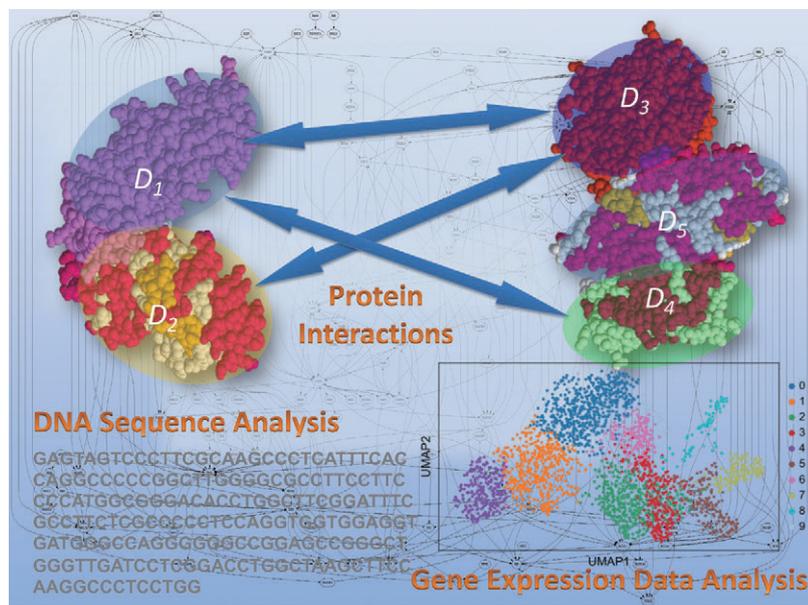
Analysis of three-dimensional structures and interactions of protein