Faculty Members and Labs in Department of Computer Science

Kobayashi Lab	Professor Naoki Kobayashi

Our research group is studying theoretical foundations for software and their applications such as program verification. On the one hand, an increasing number of important systems such as transportation systems, medical devices, and banking systems are now controlled by computer software, and a bug of such software can cause a serious disaster. On the other hand, such software is becoming more and more complex and larger, and it is difficult to maintain the quality of software by using traditional software engineering technologies like testing. In view of these situations, we aim to improve the reliability and efficiency of software by developing automated techniques for program verification and transformation based on rigorous mathematical methods. To achieve the goal, we also need to study and advance many research topics in theoretical computer science, such as type theory, formal languages and automata, and automated theorem proving. It is a pleasure of our research to find out that deep mathematical results, which initially seem to be only of theoretical interests, are actually quite useful for the practically-motivated research mentioned above. See https://www.kb.is.s.u-tokyo.ac.jp for details.

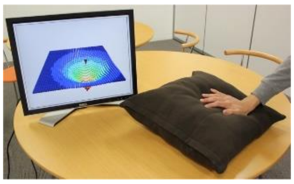
Recent research topics include:

1. Higher-order model checking: This is an extension of traditional model checking that has been successfully applied to system verification. We have constructed the first higher-order model checker in the world.
2. Automated program verification: By applying the higher-order model checking mentioned above and type theory, we are developing fully-automated program verification tools for programming languages like OCaml, Rust, and C.
3. Data compression: String and tree data can be compressed in the form of programs that generate them. The higher-order model checking above can be used to transform such compressed data without decompression.
4. Programming language and formal language theories: We are studying type theory, lambda-calculus, higher-order fixpoint logic, etc. as theoretical foundations for the studies 1-3 mentioned above.
5. Protocol verification: Cryptographic communication protocols are used, for example in Internet shopping, for safely exchanging confidential data. We are developing a method for automated verification of such protocols.

Igarashi Lab	Professor Takeo Igarashi

(1) User Interface: We are working on user interfaces for information appliances ranging from personal computers, smartphone, robots, and self-driving automobiles. We not only develop techniques to improve efficiency but also propose new ways of interaction.

- User interfaces for machine learning and artificial intelligence. We focus on the preparation of training data and interactive learning.
- Interaction techniques for novel appliances such as smartphone, smart watches, AI speakers and smart glasses.
- Interaction techniques for giving directions and controlling real-world systems such as robots and self-driving automobiles.



(2) Graphics: We mainly work on interactive shape modeling. We work on content creation for digital media such as movies and games. We also work on interaction techniques for digital fabrication using 3D printers and laser cutters.

- Content creation such as 3D modeling and 2D animation using recent technologies such as sketching and machine learning. We also work on interaction techniques for medical imaging.
- Shape modeling for real world objects such as musical instruments, clothes, and toys leveraging real-time physical simulation.
- Novel techniques for 3D scanning and 3D printing to support personal fabrication.

We can provide opportunity for students to collaborate with research groups in other countries and productions. http://www-ui.is.s.u-tokyo.ac.jp/

Miyao Lab	Professor Yusuke Miyao

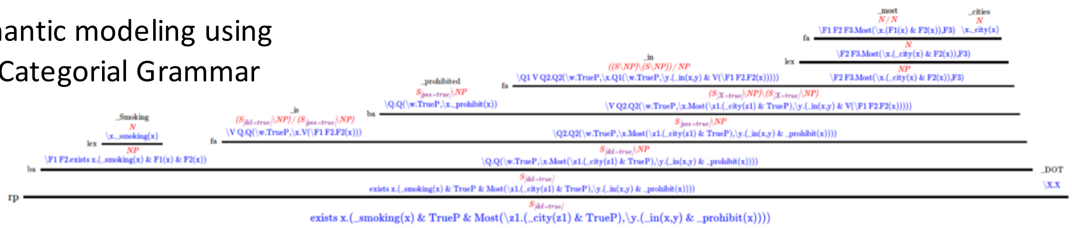
Natural Language Processing, Computational Linguistics, and Human Cognition

The goal of our research group is to enable computers to understand natural language. Humans communicate with each other using language, while its mechanism is still largely mysterious. We apply theories and technologies from computer science and linguistics to model the process of understanding and generating natural language. Specific research themes include: syntactic/semantic modeling to compute the latent structures of sentences and the analysis and evaluation of language understanding capabilities of large language models.

Our group is also engaged in developing real-world applications of natural language processing, focusing on applying the abovementioned fundamental technologies. Examples include dialogue systems for communicating with computers using natural language and data-to-text conversion to describe various types of non-linguistic information in the world, such as images and numerical data, in natural language.

Refer to our homepage for the details of the research: https://mynlp.is.s.u-tokyo.ac.jp/en/

Syntactic/semantic modeling using
Combinatory Categorial Grammar



Issei Sato Lab	Professor Issei Sato

We humans decide our behaviors on the basis of knowledge learned and abstracted from past experiences and current situations. Machine learning is a field of artificial intelligence for improving the performance and behaviors of a machine through the use of data accumulated from past human experiences and current human interaction.

Currently, we are working on the following four main research themes.

1. Generalization and memorization: Generalization is the property of predicting unknown data that does not exist in the training data. Memorization refers to storing the training data in the memory in learning algorithms; however, simply memorizing the training data does not lead to generalization, and over-abstracting the training data reduces the prediction performance. Analyzing the relationship between generalization and memorization is the most fundamental problem in machine learning research.
2. Perturbation and uncertainty. How perturbations to training data and model parameters, as well as uncertainty in predictions, affect learning algorithms.
3. Representation learning. What kind of abstract representation of training data leads to generalization.
4. Robustness. Property that is necessary for learning appropriately even when the training data or the data to be predicted are different from what is expected.

Required knowledge.
We use probability & statistics, linear algebra, functional analysis, and optimization as tools to construct the theory of machine learning. Our lab. assumes that the students are familiar with these mathematics. In addition, programming skills, primarily in Python, are also needed, because we perform exhaustive empirical analysis of the theory.
See https://www.ml.is.s.u-tokyo.ac.jp/ for details.

Kawarabayashi lab	Professor Ken-ichi Kawarabayashi

Our laboratory focuses on "algorithms", "discrete mathematics", and their applications. In particular, we plan to study the following topics, focusing mainly on "graphs".

1. Develop theoretically fast and accurate algorithms for graph problems or prove NP-hardness for them

2. Develop scalable and accurate algorithms that can be implemented, using theoretical tools such as discrete mathematics, for graph datasets in the real world.

3. Develop algorithms that can run theoretically (or practically) quite fast (and accurate), when limiting graph family (for example, planar graphs or social networks).

4. Apply knowledge and implementation techniques of graph algorithms to machine learning, especially online learning and deep learning

5. Research on graphs that appear in the fields of natural language processing, machine learning, databases, data mining, programming languages, etc.

6. Combinatorial optimization and/or discrete mathematics

In our laboratory, we plan to interact with top researchers for theory in overseas for the above "theoretical" research, and jointly work with researchers in Japan and overseas, including industries, for other research topics.

Algorithm innovations such as current information retrieval technology (Google's PageRank) and security technology (Apple's (Local) Different Privacy) have led to the creation of national-scale businesses. What is important here is that both PageRank and Differential Privacy are basic and theoretical researches of algorithms and discrete mathematics, not application-oriented work from the beginning. In our laboratory as well, we plan to focus on basic and theoretical research, rather than conducting research with applications in mind from the beginning. E-mail: k_keniti@nii.ac.jp

Shinagawa Lab	Professor Takahiro Shinagawa

The research field of our laboratory is **System Software**, with a focus on operating systems (OS) and virtualization software. System software plays an important role in connecting computer hardware and applications, and its capabilities greatly affect the overall system performance. In particular, OS kernels and hypervisors have special privileges to control the entire computer systems and have different capabilities from other software. Moreover, while system software research has a scientific aspect of providing abstract and generalized concepts of computers for applications, it also has an engineering aspect of designing, implementing, and evaluating the software on actual hardware to demonstrate their usefulness. Therefore, system software is a fascinating field that lies at the boundary of different disciplines.
Specifically, Shinagawa Laboratory has been working on the following topics in recent years.

- Studies on improving security through system software

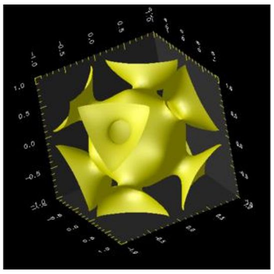
We are working on studies on secure isolated execution environments for applications. Examples include achieving lightweight and robust protection with TEEs, such as AMD SEV-SNP and Intel TDX, lightweight VMs exploiting CHERI researched and developed by Cambridge University, and an FPGA-based RDMA-based OS. We also aim to improve security in various ways, such as finding vulnerabilities in nested virtualization through Fuzzing and use-after-free mitigations that utilize the CPU's address mask function.

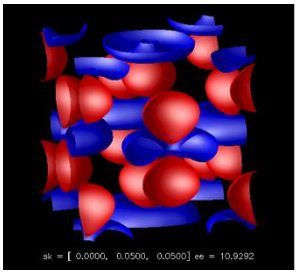
- Studies on improving system software performance and functionality

We are working on various studies to improve the performance and functionality of system software in general, such as OS live migration, container startup acceleration, file systems for non-volatile memory, low-latency cluster schedulers, and OS emulators that run Linux binaries on macOS and Windows.
Shinagawa Lab aims to make research interesting and fun. Students who like and/or are good at low-layer system software (Linux, KVM, BitVisor, etc.) and system programming (C, C++, Rust, etc.) are especially welcome, but if you are interested in system software at any layer, you will enjoy working with us.
Laboratory homepage: https://www.os.is.s.u-tokyo.ac.jp/en/ E-mail: shina@is.s.u-tokyo.ac.jp

Yoshimoto Lab	Associate Professor Yoshihide Yoshimoto

One of the major motivations to invent electronic computers was the application to science and technology. After the invention, the performance of the computers improved dramatically with the exponential development of semiconductor technology: Moore's law. Computational science, which advances science with computation, has benefited greatly from the development. Nowadays, however, because the limitation of semiconductor technology is coming up to the surface, the complexity of computer systems such as parallelization etc. is so increasing that both computational science and computer science have to cooperate once again for the further progress. This laboratory was set up under the above background to perform education and research which connects computational science and computer science. (https:/www.cp.is.s.u-tokyo.ac.jp/)





Yoshimoto himself is specialized in solid-state physics which elucidates the properties of materials such as semiconductors, metals, dielectrics, and magnets. Especially, he is specialized in the first-principles electronic structure calculations which accurately simulates the quantum mechanics of electrons which dominates most of the properties of materials. He has developed and opened to the public a program package xTAPP for this purpose. The right-hand side figures are examples of visualization of an electronic structure calculation. (http://xtapp.cp.is.s.u-tokyo.ac.jp/)

From the electronic structure calculation as a hometown, the aim of the laboratory set up between computational science and computer science is as follows:

1. Perform mutual exchange between wide range of fields in computational science by re-interpretation of the methods developed individually in each field from viewpoints of computer science.
2. Understand needs of computational science from viewpoints of computer science and propose more essential solutions.

Takamaeda Lab	Associate Professor Shinya Takamaeda-Yamazaki

CASYS: Laboratory for Computer Architecture and Systems

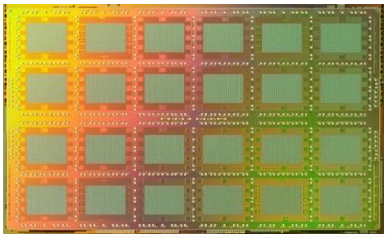
We are pursuing various research on highly efficient and trustworthy next-generation computing technologies, such as custom computing with FPGA and domain-specific hardware, algorithm/system co-design for machine learning, and high-level synthesis compilers for a productive hardware design environment. We are also pursuing software research on compilers, programming models, and frameworks for user/programmer-friendly computers.

Recent research topics:

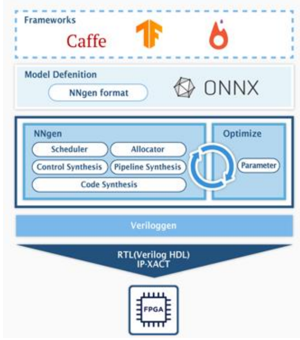
- Computer Architecture
  - Processor Architecture, Memory System
  - Domain-Specific Architecture, FPGA system
  - Secure Processor (TEE)
  - Compute-in-Memory
  - Computing with Emerging Devices
- Hardware Design Technology
  - High-Level Synthesis Compiler
  - Algorithm/Hardware Co-design
- Machine Learning System
  - Distributed Machine Learning, Federated Learning
  - LLM Inference/Serving System
  - AI/LLM Chip

Lab WEB: https://sites.google.com/view/casys/

AI Chip QUEST



DNN-HW Synthesis Compiler NNgen

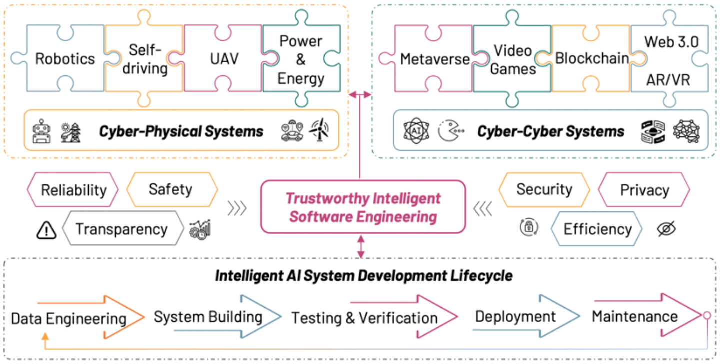


Ma Lab	Associate Professor Lei Ma

Since the past decade, data-driven AI is gradually eating software, which leverages the data-driven programming paradigm to develop software by learning from data. As real-world intelligent systems are often complex that contains both traditional software and AI components, designing fundamental methodology and engineering techniques for building trustworthy intelligent software could be a key challenge and theme for both research community and industries.

(1) Our lab focuses on both sides of software theory and software engineering, to design novel methodology, engineering techniques and toolchains towards building trustworthy intelligent software systems.

(2) We also actively adapt and adopt intelligent software techniques to diverse cyber-physical systems and cyber-cyber systems across industrial domains to solve real-world challenges.



Our lab particularly encourages impactful research, and collaboration with researchers around the world to tackle challenging industrial problems with trustworthy software-driven techniques for social good. More details and concrete topic examples of our research can be found at: https://www.malei.org/lab.html , Email: malei@is.s.u-tokyo.ac.jp

Yanaka Lab	Associate Professor Hitomi Yanaka

Language allows people to communicate with great precision, and most of the information in the world is composed of language. With the development of information technology, natural language processing (NLP) applications based on machine learning models with large corpora, such as information retrieval and machine translation, have been widely used in our daily lives. However, it is not clear to what extent these NLP applications understand the meanings of natural language like humans. We are working on theoretical and empirical research with various domestic and international researchers in diverse fields to realize human-like natural language understanding systems.

(1) Analyzing language models from multiple perspectives of theoretical linguistics, cognitive science, and philosophy
Do current language models understand the various meanings of natural language? Recent work has pointed out trustworthiness issues, where language models learn unexpected biases and heuristics from data. In this laboratory, we analyze language models from multiple perspectives of theoretical linguistics, cognitive science, and philosophy with relevant researchers.

(2) Developing inference systems by integrating machine learning-based approaches and logic-based approaches
Machine learning approaches with large corpora have been used to represent the meanings of sentences and calculate their semantic relatedness. However, whether such end-to-end approaches can handle logical meanings of sentences such as negation and quantifiers remains unclear. By contrast, logic-based approaches have been successful in representing such logical meanings as logical formulas and performing inference in an interpretable way. To have advantages over both logic-based and machine learning-based approaches, we are studying hybrid semantic parsing and inference systems by integrating machine learning-based and logic-based approaches.

(3) NLP applications through interaction between humans and inference systems
Interaction between humans and inference systems is expected to improve the efficiency of data checking, such as medical texts and internal documents, for which quality assurance is required. Through joint research with companies, we are developing methods to convert human tacit knowledge into formal knowledge and store it, as well as applied technologies for inference systems that perform inference based on various data types and usages.

See https://ylab.mystrikingly.com/ for details.

Yamasaki Lab	Associate Professor Hayata Yamasaki

Pushing the Boundaries of Quantum Information Theory

Quantum information science is a field that explores new frameworks for information processing by utilizing the principles of quantum mechanics. Quantum mechanics is a fundamental physical theory that describes microscopic phenomena, such as the behavior of atoms and weak light, and serves as a universal principle governing our world. **Quantum computers**, which fully leverage these principles for information processing, possess fundamentally different characteristics from conventional computers, opening up new possibilities in information processing. For example, quantum computing is expected to achieve **significant speedups for certain computational tasks, such as integer factorization and numerical simulations of quantum mechanical phenomena**. Additionally, quantum communication enables **cryptographic techniques that are inherently resistant to eavesdropping and information-theoretically secure**. Our research explores **the foundational theory of quantum information science—quantum information theory—and its applications**.

For more details about our research, please visit our webpage https://www.hayatayamasaki.com/.

Call for Students

Quantum information science is a rapidly growing field, actively funded by governments worldwide, and there is a high demand for **young scientists with strong theoretical backgrounds**. We provide **full support in training such researchers and assisting them in building successful careers**.

We seek highly motivated students who are eager to tackle **fundamental theoretical challenges**, committed to making **impactful scientific achievements**, and dedicated to advancing quantum technology and science **over the long term**. We collaborate with leading research institutes in Austria, the UK, the US, Canada, South Korea, China, and beyond, and we also encourage students to engage in these **international research efforts**.

If you have any questions, please feel free to contact me at hayata.yamasaki@gmail.com.

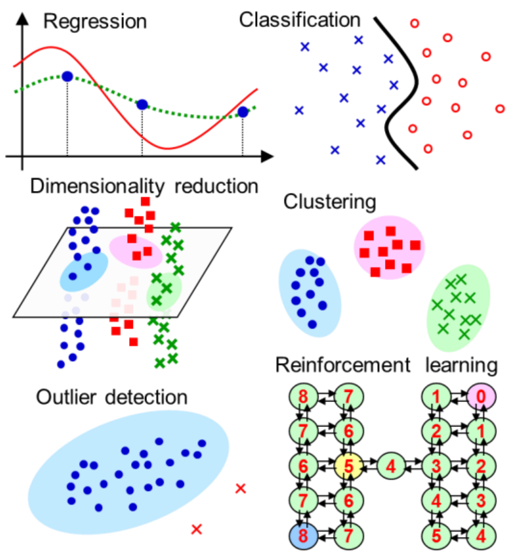
Sugiyama and Ishida Lab	Professor Masashi Sugiyama Associate Professor Takashi Ishida

How Intelligent Can Computers Become? Theory, Algorithm, and Application of Machine Learning

With the rapid advancement of information and communication technology, intellectual activities such as reasoning and creativity, once thought to be exclusive to humans, are now being realized by computers. At the Sugiyama-Ishida Laboratory, we conduct research on intelligent information processing technologies in the field of artificial intelligence, specifically known as machine learning, under the theme of "How intelligent can computers become?"

(1) **Development of Learning Theories**

Generalization refers to the ability to handle unknown situations that have not been encountered during learning, which is essential for computers to behave intelligently. In our laboratory, we mathematically explore the mechanisms by which computers can acquire generalization abilities, based on probability theory and statistics.



(2) **Development of Learning Algorithms**

Machine learning encompasses various challenges, including supervised learning, where computers infer from data paired with inputs and outputs; unsupervised learning, which involves learning from input-only data; and reinforcement learning, which optimizes long-term decision-making through interaction with the environment. Our laboratory develops highly practical machine learning algorithms with a solid theoretical foundation.

(3) **Real-World Applications of Machine Learning Technology**

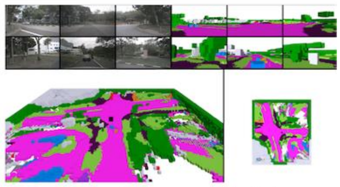
With the development and widespread adoption of artificial intelligence technologies, massive amounts of real-world data---such as text, speech, images, videos, behavior, and economic data---as well as experimental observation data in fields such as physics, chemistry, biology, medicine, astronomy, and robotics, are being collected. Our laboratory collaborates with domestic and international companies and research institutes to tackle real-world problems using cutting-edge machine learning algorithms. http://www.ms.k.u-tokyo.ac.jp/

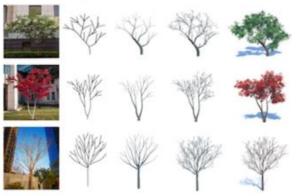
Yokoya Lab	Professor Naoto Yokoya

Our lab works on challenges in the acquisition and understanding of visual information based on image processing and machine learning. In particular, we focus on developing technologies for automatically constructing digital twins of cities from remote sensing data.

(1) **Image Inverse Problem**
By integrating sensing and computation, we can obtain information that cannot be obtained from hardware alone, overcoming limitations such as resolution and noise. We are working to develop mathematical models and algorithms based on machine learning, optimization, and image processing to reconstruct original signals from incomplete observational data.
(2) **Scene Understanding**
We are exploring methods to integrate different types of sensor data, such as optical images and LiDAR data, to comprehensively understand the semantic and 3D information of scenes with greater detail and accuracy. In addition, we are exploring approaches to build machine learning models from limited training data and improve computational efficiency.
(3) **Remote Sensing**
With the goal of automatically constructing digital twins of cities, we are developing techniques to extract map information such as land cover and elevation models from spaceborne and airborne remote sensing data through intelligent information processing.


Multimodal Semantic Segmentation


3D Semantic Occupancy Prediction

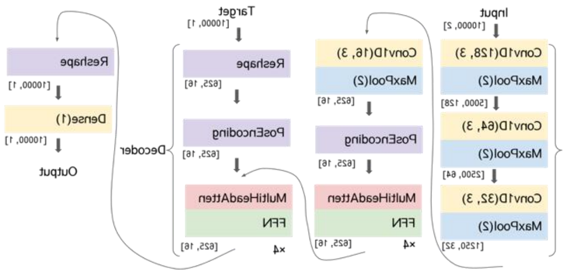

Tree Reconstruction from Single Image


Land Cover Mapping

Nakai Lab	Professor Kenta Nakai

Please note that applicants for the Doctoral program who wish to enroll in October 2026 cannot select Prof. Nakai as a prospective supervisor

Our lab is one of the laboratories specializing in bioinformatics on the Shirokanedai campus (https://fais.hgc.jp/). The basic motivation of our research activities is a naive wish to understand how biological information is encoded as DNA sequences, which are the data type of a simple one-dimensional string. Particularly, we try to understand the regulatory modes of genes that are encoded in the genome with various approaches from computer science. In other words, we aim to understand how the common genome DNA sequence can specify a variety of cell types that constitute our body.


A model for predicting RNA splice sites from given entire pre-RNA sequences, proposed by a lab student (Miyachi, unpublished)

For example, we challenge to characterize the higher-order genome structure that is responsible for the regulation of gene expression, to analyze the temporal and spatial patterns of gene expression at the single-cell resolution, to clarify the mechanism of RNA splicing that occurs post-transcriptionally, and so on. All these studies are designed and performed on the supercomputer system, typically using a combination of natural language models and deep learning techniques. We also pursue collaborations with experimental researchers to verify our *in silico* prediction results and to contribute to finding ways to treat uncurable diseases and boost regenerative medicine. Thus, we not only analyze data and/or develop algorithms but also construct and maintain necessary databases that are open to the public.

Our lab members have a variety of research and international backgrounds, but they all share the common mindset of advanced computational genomics. Although they pursue their own interests and goals, where more emphasis is placed on biological importance, they are interested in the research topics of other members and help each other. Thus, we try to respect each student's research interests and motivation as much as possible when she/he chooses her/his own research topic.

Imoto , Katayama and Zhang Lab	Professor Seiya Imoto Associate Professor Kotoe Katayama Associate Professor Yaozhong Zhang

This is a laboratory of data science in the field of life sciences. We develop statistical data analysis techniques for a wide variety of genome-related big data such as whole genome, transcriptome, epigenome, metagenome of intestinal microflora, and large-scale health and medical data with spatial and temporal axes such as medical images, receipt information, specific health checkups, wearable devices, and so on. In cooperation with various domestic and international companies and researchers in diverse fields, we are promoting social implementation of big data analysis for health and medicine. Our major research themes are listed below (but not limited):
Research Theme 1: Development of Genomic Data Analysis Methods. Rapid advances in DNA analysis technology have produced enormous amounts of data, requiring highly efficient and accurate analysis techniques. However, the successful application of deep learning models in other fields does not directly translate to genomics without careful consideration of the unique properties of genomic data. We are developing data analysis techniques to identify genomic variations in long-read data, single cell data, and other cutting-edge technologies, and constructing genomic language models to represent genomic sequences from fragment level to the whole genome.
Research theme 2: Development of Modeling Technology for Biological Systems. We are developing modeling and simulation technology for biological systems formed by tens of thousands of human and commensal microorganism derived molecules. We are developing mathematical analysis techniques for predicting the effects of drugs and the future progress of diseases.
Research theme 3: Development of Artificial Intelligence for Realizing Genomic Medicine. In the analysis of cancer genomes, thousands to tens of thousands of genomic mutations are found from the whole genome sequence data. To identify cancer-causing (pathogenic) genomic mutations from among these, information published as scientific papers is used. However, the number of papers in the life science field will exceed 36 million now, and it is already beyond the capability of human intelligence to cover all of them. To solve this problem using artificial intelligence, we are conducting research involving medical practice at the Institute of Medical Science Hospital.

Our laboratory's web page (https://www.hm-intelligence.com/) introduces recent activities and research topics (including many themes other than those mentioned above). Please take a look if you are interested.

Shibuya Lab	Professor Tetsuo Shibuya

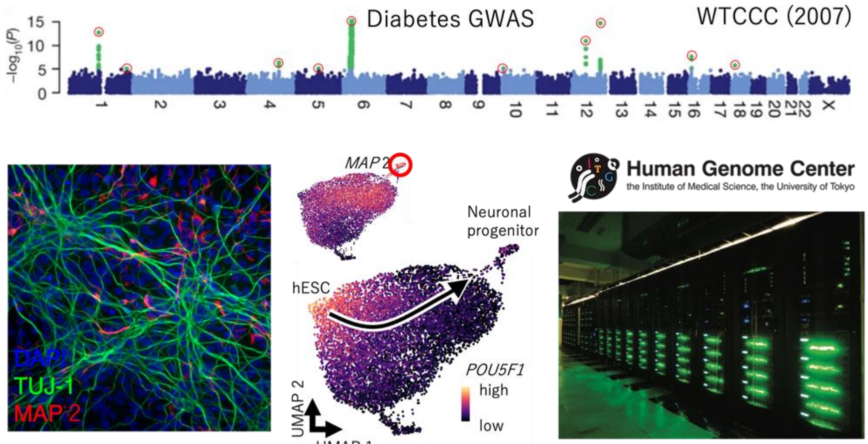
Medical Science is now dramatically changing. It is mainly due to the advent of next generation sequencers that can sequence DNA with incredibly high speed and low cost. State-of-the-art computer science techniques are required to deal with the enormous amount of medical big data. We aim to develop fundamental big data technologies that could drive medical science to the next stage.

Research topics in our lab:
(1) Big data indexing / searching
Development of faster, more accurate, and scalable indexing/searching technologies are highly desired in the era of individual genomic medicine, where we might need to deal with tremendous country-wide individual genomic data.
(2) Privacy preserving computation
Genome is the ultimate individual information to be protected. We need to develop privacy preserving computation technologies, such as differential privacy and secret computation, to meet ethical requirements from genome data.
(3) Machine learning / AI algorithms for medical science data
Development of accurate prediction algorithms for medical big data is always required.
(4) Application to clinical sequencing
We need to apply our results to actual applied medicine, such as clinical sequencing.

Our theme is not restricted to the above. We think we have infinite possibilities to change the world of medical science, molecular biology, drug discovery, etc., by developing novel big data technologies for them.
Home page: http://shibuyalab.hgc.jp

Kumasaka Lab	Professor Natsuhiko Kumasaka

A genome-wide association study (GWAS) is an incredibly powerful method for identifying genetic variants and related genes involved in the molecular mechanisms of common complex traits, such as diabetes (refer to Fig. top panel). Kumasaka Lab is identifying these genetic associations and uncovering their molecular mechanisms using cutting-edge molecular biology assays and integrated mathematical and statistical approaches.



Neuronal progenitor cells from human ES cells

GPLVM

SHIROKANE SuperComputer at Human Genome Center

Currently, we have two major projects underway: (1) discovering the genetic determinants that influence child health and development through GWAS of various child traits; and (2) developing a novel in-vitro approach to validate and elucidate the underlying molecular mechanisms of genetic associations discovered through GWAS.

These projects require the use of cutting-edge statistical and machine-learning approaches to analyze large-scale human omics (genetic, epigenetic and transcriptomic) datasets, consisting of tens of thousands of samples. As an example, we recently generated neuronal progenitor cells from human iPS/ES cells to investigate neuropsychiatric disorders, such as schizophrenia (refer to Fig. bottom-left panel). To extract the target cell differentiation trajectory from single-cell RNA-seq data, we employed a cutting-edge Gaussian Process Latent Variable Model (GPLVM) (refer to Fig. bottom-middle panel), which has been actively developed on the SHIROKANE supercomputer at the Human Genome Center (refer to Fig. bottom-right panel).

Our mission is to contribute to medical science from a computational perspective by generating and analyzing an enormous amount of omics data ahead of the world. Visit our website for more details: https://www.ims.u-tokyo.ac.jp/imsut/en/lab/hgclink/page_00344.html

Aizawa Lab	Professor Akiko Aizawa

Please note that applicants for the Doctoral program cannot select Prof. Aizawa as a prospective supervisor

Our laboratory's research is focused on natural language technologies to assist human intelligent activities. Our major challenges include the following subjects in text and media studies that are based on machine learning including deep learning, statistical modeling and analysis, or annotation and corpus analysis.

(1) Text mining: document structure analysis and information analysis; information identification and entity disambiguation; automatic construction of linguistic resources

(2) Machine reading comprehension: Exploiting the semantic structure of natural language; extracting knowledge and information from natural language

(3) Modeling human language activities: Measuring and analyzing language activities in text media

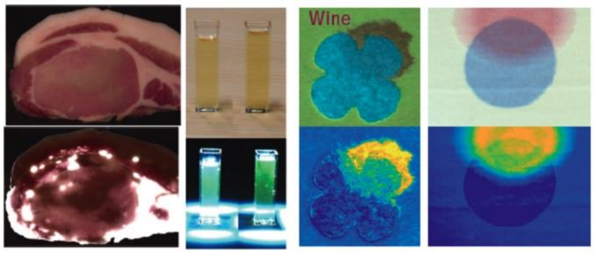
Our recent research topics are as follows: machine reading comprehension, design and analysis of natural language understanding tasks, real document processing, retrieval and understanding of mathematical expressions, information identification and linkage, and recommendation and English writing assistance for academic researchers. We also welcome new research topic proposals related to natural language processing and information retrieval.

Our research facilities include variety of information resources and a large-scale computation platform at NII. Students are encouraged to act as independent researchers/engineers by being allowed to join seminars and discussion groups with interdisciplinary and international researchers and to participate in related joint research activities at NII.

http://www-al.nii.ac.jp/en/

Imari Sato Lab	Professor Imari Sato

Analyzing Light Transport for Scene Understanding



Visualization of bacteria growth (right) and classification of liquids (middle) by the fluorescence excitation-emission characteristics. Recovering the original surface color and the degree of wetness (left).

The appearance of an object changes significantly depending on its shapes, surface reflectance properties, and the lighting condition of the scene in which it is placed. Given an unknown picture, it might not so difficult for us to obtain different kinds of information about the objects in the image. However, it turns out to be an difficult task for a computer to figure out. In the past, techniques for automatically modeling and analyzing the photometric and geometric information of a scene have been studied in the fields of both computer vision and computer graphics research.

Furthermore, some researcher showed that the spectral reflectance and emission of objects provides innate information about material properties that have proven useful in applications such as classification, synthetic relighting, and medical imaging to name a few. In our lab, we analyze different types of optical phenomena including spectral reflectance, absorption, subsurface scattering, and fluorescence emission for modeling and understanding real scenes.

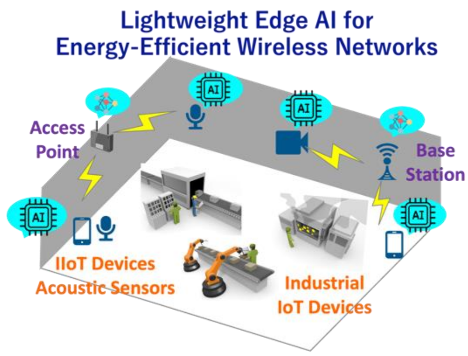
Blood vessels analysis by machine learning.

Message

Seeing is believing: the goal of computer vision is to understand how humans process and use visual information for understanding the surrounding world. There are so much excitement in analyzing real scenes using cutting edge technologies. Please join us and share a feeling of accomplishment with our lab members!
http://research.nii.ac.jp/pbv/index.html

Megumi Kaneko Lab	Professor Megumi Kaneko

With the exponential growth of the amount of IoT mobile data, and given the severe lack of spectrum, current wireless systems are unable to support the demands of future applications. One of the major challenges for next-generation wireless networks (Beyond 5G, 6G, WLAN, IoT, etc.) is to jointly achieve diverse requirements (high data rate, low latency, high reliability, massive connectivity) with low power consumption. In addition, future wireless communications will not only be terrestrial, but will integrate air, space, sea, underwater, providing 3D wide area coverage including isolated areas. Our laboratory is conducting research on the design of future wireless communication systems and networks, for improving spectrum and energy efficiency. We are focusing on low power and smart wireless communication systems, aiming at supporting a sustainable digital society. Our research subjects include:



1. **Wireless access methods for low power and massive IoT connectivity**: design of low power wireless access methods that achieve high network performances even under severe interferences.
2. **Wireless networks exploiting advanced wireless technologies such as RIS (Reconfigurable Intelligent Surface) or THz**: proposal of joint optimization methods for user selection and beamforming in THz band.
3. **Exploiting AI and machine learning for optimizing wireless communications**: design of distributed mobile communication methods exploiting risk-averse reinforcement learning and deep reinforcement learning, tailored to complex mobile environments.

As our laboratory members are international, our group discussions are conducted in English. We have strong collaborations with international entities (ex. CNRS, Paris-Saclay Univ.) and companies (ex. NTT). Motivated students will be able to conduct joint research with companies or to study abroad at overseas institutes.
Laboratory website: https://research.nii.ac.jp/~megkaneko/lab.html