

AY2024 Admission Guide

Department of Information Physics and Computing

Graduate School of Information Science and Technology,

The University of Tokyo

Master's Program

Doctoral Program

Contact [Department Administration Office]

7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656

Department administration office (Department of Information Physics and
Computing), Graduate School of Engineering / Information Science and
Technology Administrative Group,
The University of Tokyo
office@office.keisu.t.u-tokyo.ac.jp

Visit: https://www.i.u-tokyo.ac.jp/edu/course/ipc/index_e.shtml

Note: This guide should be read together with the graduate school's admission guide: "AY2023 Admission Guide: {Master's / Doctoral} Program, Graduate School of Information Science and Technology, The University of Tokyo." The details of this guide may be changed. In that case, it will be posted on the Department's admissions page.

This document is a translation from the official Japanese version. In the case of conflict, the Japanese version shall prevail and be conclusive.

I. Master's Program

Due to the interdisciplinary nature of the Department of Information Physics and Computing, this department seeks applicants from a wide range of fields, both within and outside The University of Tokyo, with a fundamental understanding and knowledge of informatics, mathematics, physics, electrical or mechanical engineering. Written and oral examinations are given to those who pass the document screening, and a comprehensive assessment is used to select applicants for admission. Examination subjects have been selected to allow for fair conditions to be met from a variety of departments outside the university. No priority is given to examinees from within the university.

Select up to nine faculty members to whom you wish to be assigned on the web application system. If there are faculty members to whom you do not wish to be assigned, enter their names in the “Field 1 for Department-Specific Information”. If you cannot be assigned to any of the faculty members depending on the results of the examination and your preference, you will not be accepted. The laboratories in this department conduct research in cooperation with each other, and it is possible for examinees to acquire a cross-sectional study of systems informatics regardless of which faculty member they are assigned to.

a) Document Screening

The screening will be conducted based on the application documents. Please refer to the application guideline of the Graduate School for the notification of the result of the document screening. The document specified below must be submitted.

Describe the reasons for applying to the Department of Information Physics and Computing, with references if necessary, based on what you have learned and experienced. The document should be written either in Japanese or English.

The font size should be around 11 pt. The document should be on three A4-sized or letter-sized pages. Figures and tables can be included. Please put your name on every page. Since the document is used for the document screening and evaluation, it should be well-thought out and of appropriate length and content.

b) Written and Oral Examinations, etc.

Those who passed the document screening should take all of the following examinations.

Those who are absent from one or more of the examinations are considered to have abstained from the entrance examination.

1. Foreign language

TOEFL scores will be used. For details, please refer to the "Guidelines for Submission of TOEFL Scores (for AY2024 Entrance Examinations)."

2. General education subjects

For details, please refer to the Admission Guide of the Graduate School.

3. Specialized subjects

For examinations on specialized subjects, examinees shall choose one subject among the following: "Information Physics and Computing," "Mathematical Informatics," "Computer Science," and "Information and Communication Engineering." Please note that dates, times, and locations differ depending on the subject.

| Specialized Subjects | Examination Dates, Times, and Locations | Scope of Questions |
|---|--|---|
| Information Physics and Computing | August 21, 2023 (Monday) 10:00 – 12:00 Onsite | Examinees will be required to select and solve two among three problems: "signal processing," "electronic circuits," and "control." The total time for answering the problems is 100 minutes. |
| Mathematical Informatics | Please refer to the "Admission Guide" for the Department of Mathematical Informatics. | |
| Computer Science | Please refer to the "Admission Guide" for the Department of Computer Science. | |
| Information and Communication Engineering | Please refer to the "Admission Guide" for the Department of Information and Communication Engineering. | |

In principle, the examination for the specialized subject "Information Physics and Computing" will be administered in person.

The log-in information for the "Website for Examinees (Master & Doctor)" will be sent to applicants. Information on precautions and examination locations will be uploaded to the website, so please check it frequently. For information on the examinations for the Department

This document is a translation from the official Japanese version.

of “Mathematical Informatics,” “Computer Science,” and “Information and Communication Engineering,” please refer to the Admission Guide for the Department in question.

4. Oral examination

The oral examination will be conducted between 9:00 a.m. and 6:00 p.m. on August 22 (Tuesday), 23 (Wednesday), 24 (Thursday), or 25 (Friday), 2023. Detailed schedules will be posted or distributed during the examination period. The Oral Examination schedule for examinees who take specialized subjects other than “Information Physics and Computing” will be adjusted to avoid overlapping with examinations of the specialized subjects.

II. Doctoral Program

At the time of application, please select either the Summer Entrance Examinations or the Winter Entrance Examinations. Please note that the periods for acceptance of applications differ for the summer and winter examinations.

Persons wishing to start school in October 2023 after Summer Entrance Examinations are required to select "October 2023" in the "Entrance Date" field of the web application system. Persons wishing to be included in the “Special Selection for Professionals” must refer to the “AY 2023 Admission Guide: Doctoral Program [Special Selection for Professionals] Graduate School of Information Science and Technology, The University of Tokyo”. As for the "Outline of Work Achievements" of the Application Documents, submit i) b) (1) in the following. For other detailed instructions, please keep checking the “Website for Examinees (Master & Doctor)” carefully.

i) Summer Entrance Examinations

a) Prior Interview

Persons wishing to apply to the Doctoral Program should refer to the “AY 2024 Admission Guide: Doctoral Program, Graduate School of Information Science and Technology,” (“AY 2024 Admission Guide: Doctoral Program [Special Selections for Professionals], Graduate School of Information Science and Technology”, if you are applying for Special Selections for Professionals) and must contact the faculty advisor of your choice for a face-to-face or online interview based on your past history, research history, research capabilities, and research plans.

The interview must be completed between April 21 (Friday) and May 30 (Tuesday), 2023, for Summer Entrance Examinations or between October 12 (Thursday) and November 15 (Wednesday), 2023, for Winter Entrance Examinations. Enter the date of the interview in “Field 1 for Department-Specific Information” in the web application system. Applicants may not be allowed to take the examinations if they fail to complete this procedure.

b) Documents

All of the following documents must be submitted together with the other application documents.

- (1) Describe the content and results of past research as well as the significance of the research in the field in question. The summary should be either in English or Japanese, on no more than four A4-sized or letter-sized pages.
- (2) Provide a specific research plan to be conducted after admission to the Doctoral Program and describe how this research will contribute to the field in question. The summary should be either in English or Japanese, on no more than two A4-sized or letter-sized pages.
- (3) Provide a list of research achievements on A4-sized or letter-sized pages. Achievements should be categorized into original articles, review articles, oral presentations, and others. If there are no research achievements, write “not applicable.”

Since the above documents (1), (2), and (3) will be used as the basis for the Oral Examinations and subject to scoring, they should be well-thought out and of appropriate length and content.

c) Foreign Language

TOEFL scores will be used for evaluation of English ability. For details, refer to "Guidelines for Submission of TOEFL Scores (for AY2024 Entrance Examinations)". Persons who have completed or are expected to complete The University of Tokyo Graduate School Master's Program will not be required to submit TOEFL scores.

d) Oral Examinations

The primary examination consisting of Oral Examinations I and II and the secondary examination are conducted. Persons who have completed, or are expected to complete a Master's Program in The University of Tokyo or persons who have been approved on the basis of the submitted documents will be exempt from Oral Examination I. Examinees who are rejected in Oral Examination I cannot take Oral Examination II. The results of Oral

This document is a translation from the official Japanese version.

Examination I will be posted with the schedules of Oral Examination II.

(Primary Examinations)

| Examination Dates and Locations | Examination Times | Examination Subjects | Notes: |
|---|--|----------------------|--|
| The afternoon of August 21 (Monday) or the morning of August 22 (Tuesday) Online | Detailed schedules will be posted at 10:00 on August 21. | Oral Examination I | Examinees will be required to answer questions related to the fundamentals of Information Physics and Computing and to the applicant's research field. |
| August 23 (Wednesday) Online | Detailed schedules will be posted at 17:00 on August 22. | Oral Examination II | Examinees will be required to answer questions on the results of their past research and research plan submitted beforehand. |

The log-in information for the “Website for Examinees (Master & Doctor)” will be sent to applicants. Information on precautions and online connecting information will be uploaded to the website, so please check it frequently.

(Secondary Examinations)

Secondary examinations consist of an oral examination on the master's thesis. A master's thesis or an alternative document must be submitted.

As a general rule, Secondary Examinations will be conducted between late January and mid-February, 2024. Applicants will be notified of detailed schedules and locations later. For persons wishing to start the school program in October 2023 or for persons having a master's degree by September 30, 2023, the Secondary Examination will be conducted at the same time as Oral Examinations II.

ii) Winter Entrance Examinations

As a general rule, the primary and secondary examinations will be conducted between late January and mid-February, 2024. Acceptance will be limited to a few examinees. Examination methods will be in accordance with those used for Summer Entrance Examinations. Applicants will be notified of detailed schedules and locations after applications have been received.

a) Prior Interview

This document is a translation from the official Japanese version.

See Summer Entrance Examinations.

b) Document

See Summer Entrance Examinations.

c) Foreign Language

See Summer Entrance Examinations.

d) Oral Examinations

See Summer Entrance Examinations. In the Winter Entrance Examinations, the secondary examinations are administered at the same time as the Oral Examination II.

This document is a translation from the official Japanese version.

Department-specific Conditions on Submitted Documents

For other conditions on submitted documents common to all the departments, check the Admission Guide of the Graduate School.

| | Summer Entrance Examination | | Winter Entrance Examination | |
|---|--|----------------|--|----------------|
| | Documents to be Submitted | Who to Submit | Documents to be Submitted | Who to Submit |
| Master's Program | Reason for Application (three A4-sized or letter-sized pages, either in English or Japanese) | All Applicants | | |
| Doctoral Program | (1) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (2) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (3) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.) | All Applicants | | |
| Doctoral Program <Special Selection for Professionals> | (1) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (2) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (3) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.) | All Applicants | (1) Content and results of past research (no more than four A4-sized or letter-sized pages, either in English or Japanese) (2) Research Plan for Doctoral Program (no more than two A4-sized or letter-sized pages, either in English or Japanese) (3) List of research achievements (A4-sized or letter-sized page. If not applicable, please mention.) | All Applicants |

Department-specific Conditions on TOEFL Scores

| | Summer Entrance Examinations | Winter Entrance Examination |
|---|--|--|
| Master's program | All applicants must submit. | |
| Doctoral Program | All applicants must submit, except those who have completed (or are expected to complete) Master's program in the University of Tokyo. | |
| Doctoral Program <Special Selection for Professionals> | All applicants must submit, except those who have completed (or are expected to complete) Master's program in the University of Tokyo. | All applicants must submit, except those who have completed (or are expected to complete) Master's program in the University of Tokyo. |

Conditions for the Transfer to the Online Examinations

Applicants may be transferred to online examinations if they meet one of the conditions below. If you wish to be transferred, fill "Transfer Application Form for the Online Examinations" and submit it.

- A. Those who live outside Japan and are unable to travel to Japan due to border restrictions.
- B. Those who should avoid the on-site examination, having likely contracted an infectious disease (having symptoms such as fever or cough). For details, refer to the conditions for avoiding on-site examinations specified in the document "Examination Guideline for On-site Written Examination", which will be delivered later to applicants.

This document is a translation from the official Japanese version.

Faculty members and laboratories

| Sound Media Informatics Lab. (Saruwatari and Takamichi Lab.) http://www.sp.ipc.i.u-tokyo.ac.jp/ | |
|---|---|
| Professor Hiroshi Saruwatari ¹⁾ Lecturer Shinnosuke Takamichi | <p>This laboratory mainly innovates in new signal processing and information processing systems, focusing our attention on understanding, processing, and controlling sound media (speech, music, etc.). For example, theories on new statistical modeling and machine-learning-based algorithms are of interest for solving optimization problems under acoustical generative models and physical constraints. Through our research, we extend human hearing systems, create new human-machine interface systems, and bring our innovative contribution to music creation.</p> <p>(1) Auditory Communication Augmentation via Unsupervised Learning</p> <p>We realize versatile unsupervised source separation combining statistical estimation theories and low-rank modeling. Also, we address a new combination of deep learning and spatial acoustics, which can be applied to semi-supervised source separation. Thanks to these methods, new human-machine interfaces, auditory communication augmentation systems, and user-oriented music information systems can be developed.</p> <p>(2) Augmented Speech Communication Based on Machine Learning</p> <p>We investigate signal processing and machine learning theories for speech synthesis and conversion for human-human and human-machine communication. We interpret speech from the perspectives of physics and informatics and deal with accurate modeling of speech signals and speech information. We also develop speech-based virtual reality systems by using human-in-the-loop speech modeling that integrate humans into machine learning.</p> <p>(3) Sound Field Analysis and Synthesis, and its Applications</p> <p>We tackle inverse problems related to acoustic fields, such as sound field imaging, analysis, source localization, and estimation of room acoustic parameters, as well as sound field control problems for synthesizing a desired sound space. We explore new methodologies based on wave theory using various approaches (signal processing, optimization, statistical modeling, machine learning, etc.) and develop new systems for telecommunication, virtual reality, etc.</p> |

1) Department of Creative Informatics

| | |
|---|--|
| <p>Biomechanical system Lab. (Kawashima and Miyazaki Lab) http://www.bmc.ipc.i.u-tokyo.ac.jp/</p> | |
| <p>Professor Kenji Kawashima</p> <p>Lecturer Tetsuro Miyazaki</p> | <p>We aim to develop novel medical systems, robotic systems, and human-machine systems useful for a healthy and long-lived society. Our original technique is to combine a measurement control technology based on distributed parameter models of fluid drive systems with a system design that utilizes actuator characteristics. We additionally integrate medical engineering and information science to develop highly smart and functional systems to implement them into our society.</p> <p>(1) Surgical robots</p> <p>We are researching robots that support minimally invasive surgery. We aim to improve system intelligence and function by autonomous control of specific operations using machine learning.</p> <p>(2) Physical assistive systems</p> <p>We realize motion assistive systems that estimate a wearer's motion from control system model and actuator-side control information without mounting sensors directly on the wearer's body by leveraging the advantages of directly driven soft actuators such as pneumatic artificial rubber muscles.</p> <p>(3) Measurement and control of fluid systems</p> <p>We propose applications to state estimation and prediction problems in fluid-driven medical systems by using morphological computation that utilizes non-linearly distributed state quantities of the fluid-driven systems.</p> <p>(4) Status estimation from medical images</p> <p>We develop a system that estimates the state of robots and the pathological conditions of organs for medical images using AI.</p> |

| Physical Informatics & Inverse Problem Lab. (Nara Lab.) http://www.inv.ipc.i.u-tokyo.ac.jp/ | |
|--|--|
| Professor Takaaki Nara | <p>Inverse problems are ubiquitous in science and engineering. In these problems, unknown quantities are inversely estimated from indirect measurements through mathematical reconstruction. Our laboratory develops basic and unified theories, measurement and sensing methods, and applied systems for diverse inverse problems.</p> <ol style="list-style-type: none"> (1) Development of direct reconstruction methods for inverse problems: Based on mathematical physics approaches using complex analysis, potential theories, tensor analysis, and reproducing kernel theories, direct methods that express unknown quantities in a closed form in terms of data are developed for inverse source/coefficient/governing-equation problems. In addition, we clarify the mechanism of instability in machine learning approaches to inverse problems owing to their ill-posed nature and develop methods for stabilization based on the direct methods with physical constraints. (2) Inverse problems in medical imaging: We address magnetoencephalography and electroencephalography inverse problems, in which electrophysiological neuronal activity in the brain is estimated from the magnetic field and electric potential measured outside the head, respectively. Mathematical methods using a novel source model based on physiological information are derived and applied to the identification of epileptic foci. Moreover, methods to determine electrical, mechanical, and thermal properties inside the body using magnetic resonance imaging are being developed for cancerous tissue imaging. (3) Inverse problems in nondestructive inspection: We formulate the identification of cracks in structures as inverse scattering problems for electromagnetic or ultrasonic fields. In addition, stable and efficient mathematical methods and methods that directly measure input quantities for inverse problems are being developed. (4) Inverse problems for disaster prevention: We develop localization methods for victims buried in rubble after an earthquake. Methods for those buried by landslides and avalanches are also developed. We deploy applied systems in which a searcher generates sound/electromagnetic fields including location information that is measured by the victim's smartphone and sent back to the searcher. |

| Real-World Informatics Lab. (Shinoda and Makino Lab.) https://hapislab.org/?lang=en | |
|--|---|
| Professor Hiroyuki Shinoda ²⁾ | <p>We realize a real-world informative environment that goes beyond conventional barriers by introducing new physical phenomena and physical structures into the system. In particular, we propose technologies from hardware to applied systems for sensing humans, environments, and their interactions, and for supporting humans through haptic and other human senses. Research topics include basic and universal discoveries based on novel ideas and the process of solving social problems and using them in practical technologies.</p> |
| Associate Professor Yasutoshi Makino ²⁾ | <ol style="list-style-type: none"> (1) Haptic Interface: A system that supports human life and behavior by stimulating the sense of touch simultaneously with audiovisual information. Clarify the relationship between the tactile sensation and the mind and emotions that support the base of human intelligence, and apply it to real systems. (2) 2D Communication: Information and electricity transmission through a thin sheet using electromagnetic waves to realize wireless power supply and high-speed signal transmission without interfering with conventional wireless LAN. (3) Use of human behavior: Based on the features of human behavior, we predict near-future motion and estimate haptic characteristics of the object in touch. This technology can be used for preventing falls and for sports. (4) Other topics such as physical informatic devices, human-machine interfaces, non-contact measurement of haptic information, artificial robot skin, wearable computing, remote interactions for understanding animal behavior, etc. |

2) Department of Complexity Science and Engineering, Graduate School of Frontier Sciences

| | |
|---|---|
| <p>Control Theory Lab. (Tsumura Lab.) http://www.cyb.ipc.i.u-tokyo.ac.jp/</p> | |
| <p>Associate Professor Koji Tsumura</p> | <p>Control engineering is involved in the design of the behavior of systems and we conduct research related to a broad range of control theories and their applications. Research themes are divided into three categories; cybernetics, control system analysis & synthesis, and modeling/system identification/estimation/learning, which are explained below:</p> <p>(1) Cybernetics: By employing a new fusion of system control theory with information theory/physics/optimization/system biology, we aim to establish theories of analysis and synthesis for large scale complex system/multi-agent system/networked system/networked AI/bio-system/quantum control system.</p> <p>(2) Control System Analysis & Synthesis: We aim to develop advanced control theories including robust control, nonlinear control, hybrid control, learning control, etc.</p> <p>(3) Modeling/System Identification/Estimation/Learning: We aim to establish theories for the modeling of dynamical systems, in particular system identification for uncertain modeling or modeling for large-scale complex systems.</p> |

| Neural Information Lab. (Amano and Sawayama Lab.) https://www.brain.ipc.i.u-tokyo.ac.jp/ | |
|--|--|
| Professor Kaoru Amano Lecturer Masataka Sawayama | <p>We investigate the neural mechanisms underlying human perception and cognition using non-invasive neuroimaging techniques such as magnetoencephalography (MEG), electroencephalography (EEG), functional magnetic resonance imaging (fMRI). Furthermore, we develop methods for non-invasive manipulation of brain information to elucidate the neural process that causally contributes to behaviors. In recent years, we have been focusing on the functional roles of neural oscillations in information integration, the mechanisms of the individual differences in brain activity and perception/cognition, and fusion of machine learning techniques and neuroscience.</p> <p>(1) Development and application of brain information control technology: We are developing techniques for non-invasive manipulation of brain information based on transcranial electrical/magnetic stimulation and neurofeedback. Using these techniques, we investigate the changes in perception, cognition, and behavior associated with the changes in brain information.</p> <p>(2) Neural oscillations as a clock for visual processing: Neural oscillations such as alpha (8-13 Hz) and theta (4-8 Hz) oscillations are thought to work as a clock for information processing in the brain. We investigate this clock function by combining functional brain imaging such as EEG and MEG with non-invasive manipulative techniques.</p> <p>(3) Mechanism of brain state dynamics: Human behavior in response to a certain task is always fluctuating, and one of the reasons for this is the intrinsic fluctuation of brain states. This project analyzes the relationship between fluctuations in brain state measured by fMRI, MEG and EEG, and individual brain network and cognitive task performance. Furthermore, we investigate the mechanism of changes in brain state throughout learning.</p> <p>(4) Hierarchical visual processing of object recognition in humans and machines: Recent machine learning models trained on large-scale datasets have succeeded in solving various real-world tasks. In this project, we will analyze brain activity using machine learning models to clarify information representation in the higher visual cortices.</p> |

| | |
|--|--|
| Systems Information Physics Lab. (Naruse, Horisaki, and Roehm Lab.) http://www.inter.ipc.i.u-tokyo.ac.jp/ | |
| Professor Makoto Naruse Associate Professor Ryoichi Horisaki | <p>Photonics plays a crucial role in the frontiers of innovative computing, imaging, and communications. Our research group is working in frontier research from three complementary perspectives. One is <i>photonics-for-computing</i>, where the aim is to develop novel architectures for computing, including decision making, in which we benefit from the unique physical attributes of photons. The second is <i>computing-for-photonics</i>, such as computational imaging, where novel algorithms and mathematical modeling significantly expand imaging functionalities. The third is the <i>extension</i> of our information physics systems approach to new domains such as beyond 5G communications.</p> <p>(1) AI Photonics — <i>Photonics for Computing</i></p> <p>This project physically resolves decision-making problems in dynamically changing uncertain environments by utilizing the unique nature of light. The topic includes the design of ultrafast decision-making using chaotic lasers and collective decision-making using quantum attributes of photons. Also, we explore novel principles of photonic computing including reservoir computing and photonic approximate computing.</p> <p>(2) Computational Imaging — <i>Computing for Photonics</i></p> <p>Computational imaging aims to provide novel imaging functionalities by unifying optics and computing. For example, we develop novel architectures for imaging through scattering media via insights into physical processes and state-of-the-art signal processing, including machine learning. <i>Computing-for-photonics</i> research plays critical roles in medical, astronomical, and security applications.</p> <p>(3) Novel System Design Utilizing Natural Processes</p> <p>Novel system architecture design is critical to deal with the growing demands for computing and communications. We are developing strictly delay-bounded information networks based on precision time-and-space synchronization technology, which is vital for real-time and reliable communications in the beyond 5G era.</p> |

| Computing System Lab. (Nakamura and Takase Lab.) http://www.hal.ipc.i.u-tokyo.ac.jp/ | |
|---|---|
| Professor Hiroshi Nakamura | <p>Our goal is to establish a design methodology for high-quality computing in which advanced interactions between the physical world and the cyber world are realized. Here, high-quality includes performance, responsiveness, power consumption, reliability, and security. These qualities are in a trade-off relationship, and the system needs to be optimized according to its characteristics and requirements. We are researching the comprehensive system-level design methodology to optimize the entire system, including edge devices, such as sensors and robots, servers, and networks by coordinating device, circuit technology, architecture, and software.</p> |
| Associate Professor Hideki Takase | <p>(1) Cyber-physical systems: Cyber-physical systems connect everything in the physical world to the Internet, process enormous amounts of obtained data in the information or cyber world, and work on the physical world. We are conducting research on optimization of computing to improve performance, responsiveness, power efficiency, reliability, and security by making full use of characteristics of the target processing task.</p> <p>(2) Highly Efficient Accelerated Computing: Significant performance improvements are required in various types of computing, including high-performance computing and machine learning. To meet this demand, we are conducting research to improve the speed of high-efficiency computing by coordinating and linking devices, circuit technology, architecture, and system software across design layers. To this end, we are studying coarse-grain reconfigurable architecture and approximate computing which makes good use of parallelism, locality, and allowed accuracy degradation. We are also working on quantum computing based on new computing principles.</p> <p>(3) Communication technology and design optimization for cloud robotics systems: Based on ROS (Robot Operating System), we are researching a lightweight runtime environment for embedded devices, and a highly autonomous communication library for IoT systems using the functional language Elixir. We are also working on development methodologies that utilize cloud-native technologies and virtual environments for robot applications in large-scale IoT environments.</p> <p>(4) Comprehensive computing technology for IoT systems: We are researching a resource-permeating distributed processing platform based on a functional programming paradigm. Furthermore, we are researching distributed machine learning infrastructures, especially for processing allocation optimization that adapts to changes in resource and geographic information of IoT nodes, and a programming model for comprehensive representation of fairness and diversity in the AI model.</p> |

| <p>Information Somatics Lab. (Inami and Monnai Lab.) https://www.star.rcast.u-tokyo.ac.jp</p> | |
|---|---|
| <p>Professor Masahiko Inami</p> | <p>The Information Somatics Lab conducts research based on psychology, cognitive science, and physics to understand the mechanisms of the human body from a systems perspective. We use the insights gained from the research to augment human capabilities (e.g., sensory, motor, and intellectual/mental processing.)</p> |
| <p>Associate Professor Yasuaki Monnai</p> | <p>(1) Jizai Technology: To enable free (jizai) control of their bodies, including any augmentations, both the user and system require awareness of the world and each other. We integrate biological (e.g., gaze, EMG, facial expression, heart rate) and environmental (e.g., vision, acoustic) sensing, intention interpretation and action prediction (e.g., using machine learning), and actuation (e.g., EMS, mechanisms) to achieve human augmentation.</p> <p>(2) Human Augmentation Engineering: Employing VR, XR, robotics, wearable device, wireless technologies, machine learning, and telexistence, we augment human abilities to achieve novel forms of embodiment (e.g., superhuman, disembodied, transformed, cloned, fused) to address social issues such as “hyperaging” and “diversity and inclusion.”</p> <p>(3) Experience Transferral: We aim to provide experiential "supplements" which improve the quality of everyday life. These supplements are formed and administered by systems capable of recording, replaying, and transferring first-person audio-visual-haptic bodily and spatial experiences. We are working towards applying our work in the areas of entertainment computing, superhuman sports, and skill transferal.</p> <p>(4) Experience Design: Building on a foundation of psychology and physiology, we design methods that make use of information technologies to enable the composition of arbitrary perceptual and emotional experiences and to induce transitions in mental states by transforming a user's self-perception as well as their perception of others.</p> <p>(5) Wireless interaction: We aim to support human activities without compromising physicality and sociality by transmitting information, energy, and materials in a non-contact manner through wireless technology in its broad sense. This includes utilizing various waves and fluids such as microwaves, terahertz waves, and ultrasonic waves.</p> |

| Information Communication System Architecture Laboratory https://www.sekiya-lab.info/ | |
|---|---|
| Professor Yuji Sekiya ³⁾ | <p>In this laboratory, we research communication infrastructure technology and its architecture using software and virtualization, and methods for detection and countermeasures against cybersecurity threats using machine learning.</p> <p>This laboratory cooperates with the Information Technology Center and Security Informatics Education and Research Center at the University of Tokyo. We aim to contribute to improving the system architecture using software technology and cybersecurity measures based on actual operations.</p> <ol style="list-style-type: none">(1) Virtualization and software technologies have been introduced as fundamental technologies for information communication systems (ICT) such as cloud computing and 5G. In recent years, flexibility and promptness are required on ICT systems. Therefore, virtualization and software technology are being introduced into, classically, hardware-based architectures. In this laboratory, we research software technologies for ICT systems and their new architecture.(2) Cybersecurity is a big problem for ICT systems. Attackers steal confidential information and hijack systems through organized and sophisticated attacks. In this laboratory, we research methods to detect cyber threats using machine learning technologies with various types of datasets from communication infrastructure to social trends. This research improves the safety of ICT systems that support society's infrastructures. |

3) Center for Education and Research in Information Science and Technology

| | |
|---|---|
| <p>Systems Pharmacology (Ueda Lab.) http://sys-pharm.m.u-tokyo.ac.jp/</p> | |
| <p>Professor Hiroki Ueda⁴⁾</p> | <p>Our goal: Understanding and controlling sleep and consciousness through the integration of medicine and information science</p> <p><u>Whole-brain & whole-cell analysis</u></p> <p>Our laboratory has developed a whole-brain clearing and imaging method (CUBIC) which can make brain samples look transparent, such that all cells in the brain can be analyzed at a single-cell resolution, including the position of all cells. Aiming at understanding brain functions, we will develop analysis and visualization methods for large image data (14 terabytes per brain) obtained by CUBIC, and apply it to the study of sleep/wake rhythms.</p> <p>Keywords: Cloud computing, Brain function analysis, Image analysis</p> <p><u>Chemoinformatics-driven drug discovery</u></p> <p>Chemoinformatics is becoming more and more widespread such as for drug discovery research, but it still requires development in many aspects, such as activity prediction and structure prediction. In our laboratory, we will develop algorithms to predict drug discovery and experimental reagent candidates by predicting compounds with specific activities, and apply it to the study of sleep/wake rhythms.</p> <p>Keywords: Machine learning, Bayesian optimization, Drug screening</p> <p><u>Development of sleep classification algorithm using biological data</u></p> <p>Accurate sleep classification of humans is performed by measuring brain waves. Based on easily acquired time-series data such as breathing and arm movements, we have developed a simple and high-performance sleep classification algorithm using machine learning. By improving this algorithm, we will carry out a big data analysis of sleep and understand sleep/wake rhythm.</p> <p>Keywords: Machine learning, Time series analysis, Biological data</p> |

4) Department of Systems Pharmacology, Graduate School of Medicine

| Operating System Laboratory (Shinagawa Lab.) https://www.os.ecc.u-tokyo.ac.jp/ | |
|---|---|
| Associate Professor Takahiro Shinagawa ⁵⁾ | <p>Our research is about low-layer (deep) system software located on the boundary between computer hardware (physical world) and software (information world).</p> <p>We primarily focus on core system software such as operating systems (OS) and virtual machine monitors (VMM) as well as system software in general, from middleware to distributed systems. From the perspectives of performance, functionality, security, reliability, manageability, and abstraction, we are conducting leading-edge research and development that contributes to the realization of next-generation system software based on new concepts. We use existing OSes such as Linux, Windows, macOS, iOS, and Android, and our original virtualization software called BitVisor developed in our laboratory. The target hardware is a variety of computer systems from large-scale systems such as servers, clouds, and data centers to small systems such as desktops, smartphones, and embedded devices such as IoT devices.</p> <p>(1) Operating system: we are conducting research to improve the functionality and performance of existing OS kernels through modification. We also aim to research and develop our own OS for next-generation computers.</p> <p>(2) Virtualization software: we have been conducting several kinds of research using “BitVisor,” made in Japan. By exploiting modern virtualization technology, we aim to realize new functionalities, such as security and system management, without depending on specific OSes.</p> <p>(3) Secure computing: we aim to provide a secure computing environment as a whole by organically combining OS kernels, virtualization software, compilers, and applications.</p> |

5) Information Technology Center