IRCN
International Research Center for Neurointelligence

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The University of Tokyo Institutes for Advanced Study

How does human intelligence arise?

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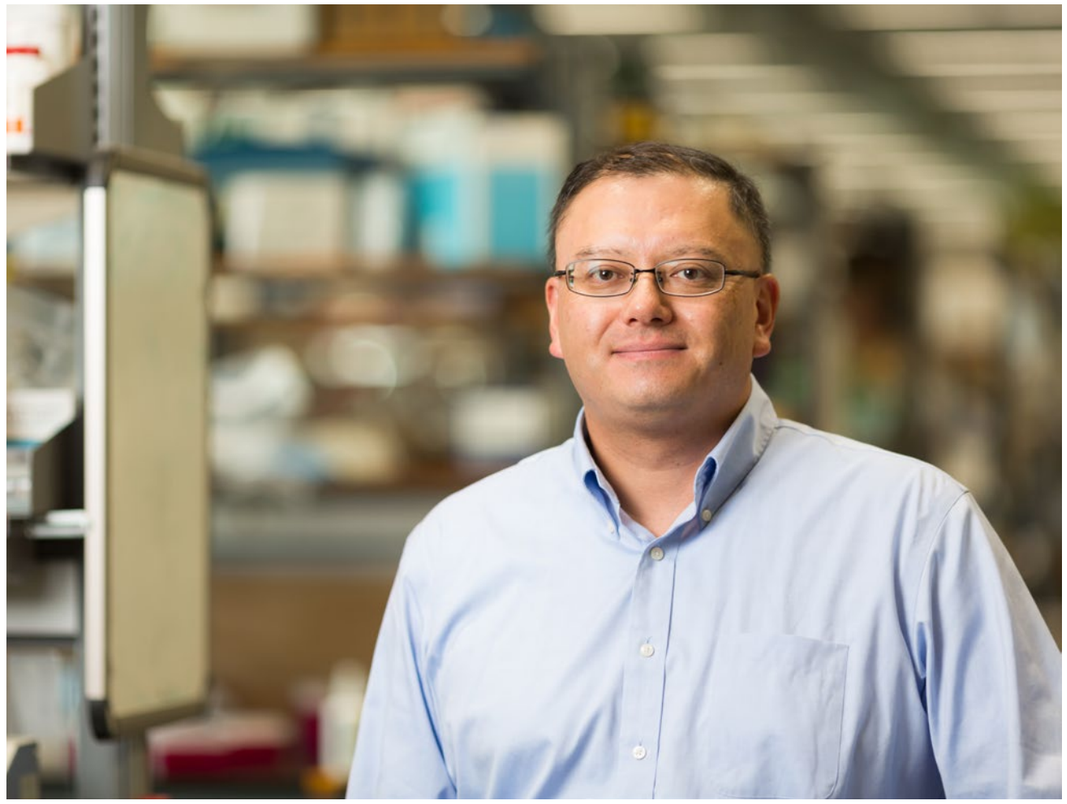


Our brain exhibits a uniquely flexible intelligence; but, it is still largely unknown how we acquired it. Needless to say, the wonder of the brain is a big question for all humans ? one that I too have long pondered through personal experience.

The IRCN (International Research Center for Neurointelligence) was established with the ultimate goal of fundamentally understanding the origins of human intelligence, which to this day remains a black box. Together, we will probe underlying principles of neural circuit development and explore the etiology of brain disorders. Based on this knowledge, we strive to create innovative artificial intelligence (A.I.) and to ultimately approach the key question, “How does human intelligence arise?” by blending developmental neuroscience with novel A.I. perspectives. Our research enterprise will fuse a wide range of academic disciplines, including life science, medicine, humanities, social, mathematical, and information sciences, to create a new field of “neurointelligence.”

Raised in the U.S.A. by a Japanese mother and German father, I was naturally exposed to all three languages at home and felt it was not at all unusual. And so, my childhood was spent without questioning it, until I noticed in elementary school not everyone shared the same experience. I was surprised to find classmates struggling to learn a second language. Switching frequently between three languages from a young age made learning another less onerous. This led me to wonder, “how is my brain different from others?” From there, my own admiration for the brain took root.

The voyage into the inner universe of the human brain is still in its infancy. Now as biology (life science) connects ever more with mathematics (information science), it is becoming possible to address this childhood fascination. Understanding the brain also yields insights into its disorders, bearing enormous potential for the IRCN to contribute to society. The field of neurointelligence should then emerge as a newly applied science as well. We embark on this journey, dreaming of the day when we might finally unravel the origins of human intelligence.

Takao K. Hensch
Director,
International Research Center for Neurointelligence
January 24, 2019

Complementary Research Units

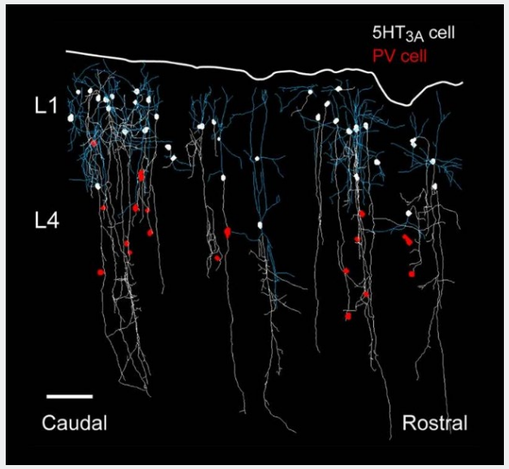
Creating the Field of Neurointelligence

The IRCN is organized into four complementary Research Units whose collective goal is the creation of the research field of neurointelligence. Each Unit is asked to produce new synergistic research outcomes through joint collaborative research with other Units.

Development Unit

Discovering Principles of the Brain's Developmental Programs

The brain consists of neural circuits whose neurons connect via multitudinous synapses. The Development Unit is a basic research group that pursues novel principles in neural circuit and brain development. When a human being is *in utero*, these neural circuits are primarily formed by genetic mechanisms. After birth, brain circuits continue to be customized by exposure to life experience during discrete epochs in the process of brain growth called “critical periods”. The Unit studies the formation of human intelligence from genetic programming in the embryonic and fetal stages and the effects of life experience on neural circuits and brain activity in later developmental stages defined by critical periods. Brain development principles revealed by the Unit will depend on advanced technologies and in turn can serve as guides for advancing clinical research and treatment of disorders in brain development, and for creating detailed mathematical models of the brain to inspire new artificial intelligence. The Unit serves as the biological foundation of the IRCN.

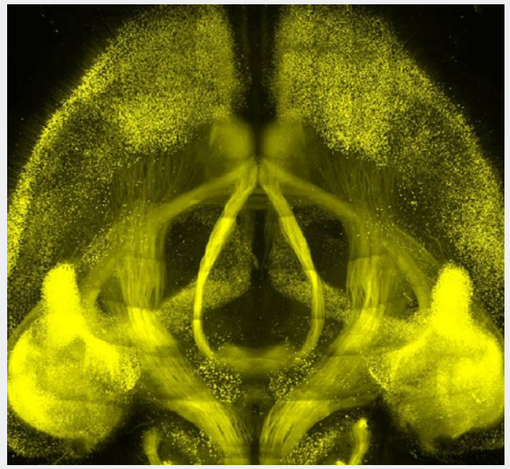


CREDIT: AE Takesian

Technology Unit

Developing Innovative Technologies for Advancing Brain Research

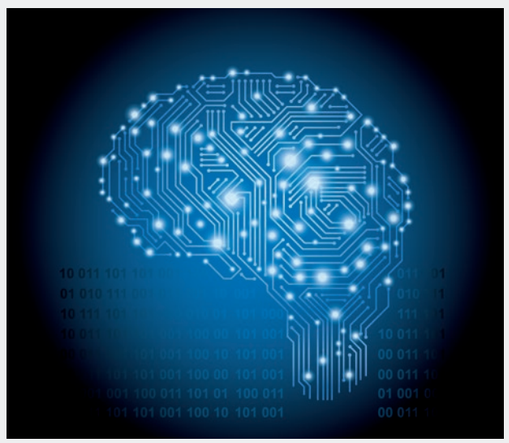
The Technology Unit develops technologies and tools for understanding principles of brain development and function. Driving the fundamental and applied research performed by the other Units, the Technology Unit invents and optimizes innovative, cutting-edge technologies to measure and analyze neural activity from individual neurons to entire brains, including the genetic engineering of animals, new recording methods for physiological data, and human imaging methods for the non-invasive monitoring of brain activity. The Unit will also strive to apply computational models to develop new robots and neuro-feedback devices. The Unit's production of these tools will aid our understanding of human and machine intelligence and their clinical and A.I. applications.



CREDIT: HR Ueda

Computation Unit

Building Computational Brain Models for Neuro-Inspired A.I.



The Computation Unit builds computational brain models and neuro-inspired A.I. based on principles of neural circuit development in cooperation with the Development Unit, and systematically analyzes big data utilizing methods based on mathematical science and A.I.. An additional goal of the Unit is to develop brain models for advancing computational psychiatry approaches to clinical diagnosis and treatments conducted by the Human/Clinical Unit. In the current state of psychiatry, clinicians make a diagnosis based on an examination of a patients' clinical data. In computational psychiatry, computational collection and analytical methods applied to big data can extend diagnostic capabilities that can go beyond a clinician's abilities to recognize. The research addressed by the Computation Unit will contribute to a deeper quantitative understanding of human intelligence that will help to improve Artificial intelligence.

Human/Clinical Unit

Solving Brain Development and Disorders of Human Intelligence

CREDIT: M Dee

Human brain development is powerfully tuned to enable high intelligence capacities such as language and pattern recognition learning. Conversely, several prevalent brain disorders, such as autism and schizophrenia, have their origins in aberrant brain development. The Human/Clinical Unit studies human brain development and its disorders, based on principles discovered or elaborated by the Development Unit. The Human/Clinical Unit additionally works with the Computation Unit to develop frameworks for computational psychiatry based on the analysis of large patient cohorts with brain disorders. Based on this research, the Unit will operate in a highly transdisciplinary workspace to collaborate with other fields including engineering, humanities and social sciences. The Unit will strive to advance research that will allow access to fundamental questions of human intelligence and how this knowledge can help to build healthier human societies in harmony with technology.

Research Core Facilities

Comprehensive Technical Support for the IRCN Research Community

IRCN features five state-of-the-art research core facilities to power the scientific exploration of neurointelligence. The ES-Mouse/Virus Core, Imaging Core, Human fMRI Core, and Data Science Core provide advanced technological platforms for researchers to develop novel reagents, make observations, and collect and analyze data for both hypothesis and discovery-driven research. A unique feature of IRCN, the Science Writing Core, supports and trains global standard communication.

Generating

ES-Mouse/Virus Core

Producing Genetically Modified Reagents with Novel Technologies for Enhancing the Speed and Efficiency of Experiments

The ES-Mouse/Virus Core houses facilities and services for the generation of genetically modified mice, and the production of viruses for studies with genetically modified mice.

The core has developed an efficient, rapid, and simple procedure for the production of genetically-modified mice enabling the production of multiple knock-in ES cells in about 1 month. The core can also create multiple parallel lines of knock-in ES-mice without a need for breeding, thus shortening the production time from a year to 2-3 months. Virus engineering for neural circuit experimental applications is also supported by the core.

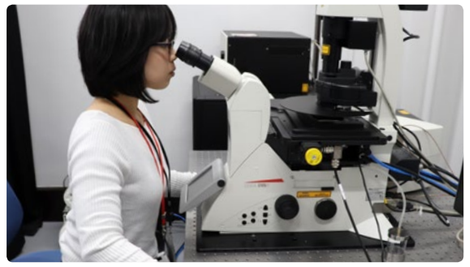
Core Manager: Hideki Ukai, Ph.D.

Observing

Imaging Core

Harnessing an Array of High-Performance Microscopes for Fine-Scale Spatiotemporal Observations and Image Analysis

The Imaging Core enables comprehensive data acquisition on brain structure and function at multiple spatial and temporal resolution with advanced optical equipment.



The Imaging Core houses an advanced array of microscopes and imaging devices for the efficient observation of biological samples, including the visualization of neuronal activity in the mouse brain at single micron or whole brain scale. The facility also offers a wide range of data collection schemes for great versatility in experimental design. New technologies are continuously adopted and refined by the core to serve its users.

Core Manager: Satoru Kondo, Ph.D.

Observing

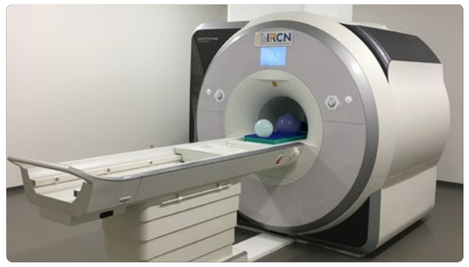
Human fMRI Core

Measuring and Mapping Brain Structure and Activity for Building Models of Brain Cognition and Biomarkers for Disorders

The human fMRI core serves as a research facility for scientists to conduct studies that will probe the origins of intelligence and help to understand pervasive brain disorders.

The core employs a Siemens Prisma 3T MRI allowing flexibility and interoperability with multiple forms of human functional imaging experiments including task-based and resting state measurements. Basic and clinical studies will be conducted to examine brain function in the healthy and disease-impaired state. Coordination with national, regional and global brain imaging projects is emphasized.

Core Manager: Naohiro Okada, Ph.D., M.D.



Analyzing

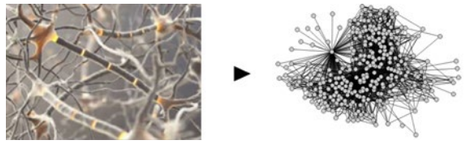
Data Science Core

Conducting Statistical Analyses of Physiological Data with Computational Methods, Mathematical Modeling, and Novel A.I.

The Data Science Core processes and stores data on brain structure and function and uses statistical analyses and mathematical modeling to derive fundamental properties.

The core promotes interactions between numerical and empirical experiments. Data analysis is conducted with mathematical tools and software using observations from IRCN member laboratories, with the aim of deriving fundamental properties of the brain, developing novel data analysis methods, and building mathematical models for a quantitative perspective on brain development, and human and machine intelligence.

Core Manager: Kantaro Fujiwara, Ph.D.



Communicating

Science Writing Core

Supporting and Training Researchers and Students to be International Leaders in Scientific Writing, Communication, and Facilitation

The Science Writing Core provides communications services, consulting, training, and resources for grants and manuscripts supporting world-class interdisciplinary research.

The core provides bilingual support and training for the production of research manuscripts, grants, oral presentations, public/media outreach, web/multimedia, and other forms of science communication., Core staff are also members of the IRCN Office for Research Strategy, whose mission is to power transdisciplinary collaboration, community engagement, internationalization, and advancing a neurointelligence field.

Core Manager: Charles Yokoyama, Ph.D.

IRCN Research Ecosystem:

leveraging the power of transdisciplinary collaboration, communication, and community building to explore human and artificial intelligence.

Global Partners

Building a global network of partner institutions and researchers for international engagement in projects to discover the origins of intelligence and repair brain disorders.

1	Max-Planck Florida Institute for Neuroscience (MPFI)
2	Boston Children's Hospital
3	The Agency for Science, Technology & Research, Singapore
4	Fondazione Istituto Italiano di Tecnologia
5	RIKEN Center for Advanced Intelligence Project
6	NCCR "SYNAPSY – The synaptic bases of mental diseases"
7	Edwin O. Reischauer Institute of Japanese Studies, Harvard University
8	Asian Consortium on MRI studies in Psychosis
9	Okinawa Institute of Science and Technology Graduate University
10	The University of British Columbia
11	The Hong Kong University of Science and Technology
12	The Chair of Morphogenetic Processes of the Collège de France

As of January, 2019

Organization

As of April, 2019

Takao K. Hensch
Director

Executive Board

Masanobu Kano
Deputy Director

Kazuo Emoto
Deputy Director

Charles Yokoyama
Executive Director

Tetsushi Kagawa
Administrative Director

- Principal Investigators
- Affiliated Faculty
- Research Core Facilities
  - Data Science Core
  - ES Mouse/Virus Core
  - Human fMRI Core
  - Imaging Core
  - Science Writing Core
- Satellites/Global Partners
- Office for Research Strategy
- Administrative Office
  - Administrative Manager
    - Financial Section
    - General Section
    - International Section

Researchers

As of April, 2019

Principal Investigators	17
Office for Research Strategy	4
Research Core Facilities	7
Affiliated Faculty	31
Lectuer / Project Lecturer	2
Postdoctoral Fellows	11

Support IRCN

IRCN addresses an ultimate question in science and society - “how does human intelligence arise?”.
By conducting transdisciplinary research, IRCN aims to understand the principles of the developing brain with the ultimate goals of solving mental illness and brain disorders and developing next-generation artificial intelligence (A.I.) technologies for the benefit of humanity. To achieve this ambitious goal, it is necessary for IRCN to have sufficient funding to conduct world-leading research and recruit researchers internationally. We would appreciate any support you can provide to help us achieve our mission. Please contact us for further information on our donor programs and benefits.

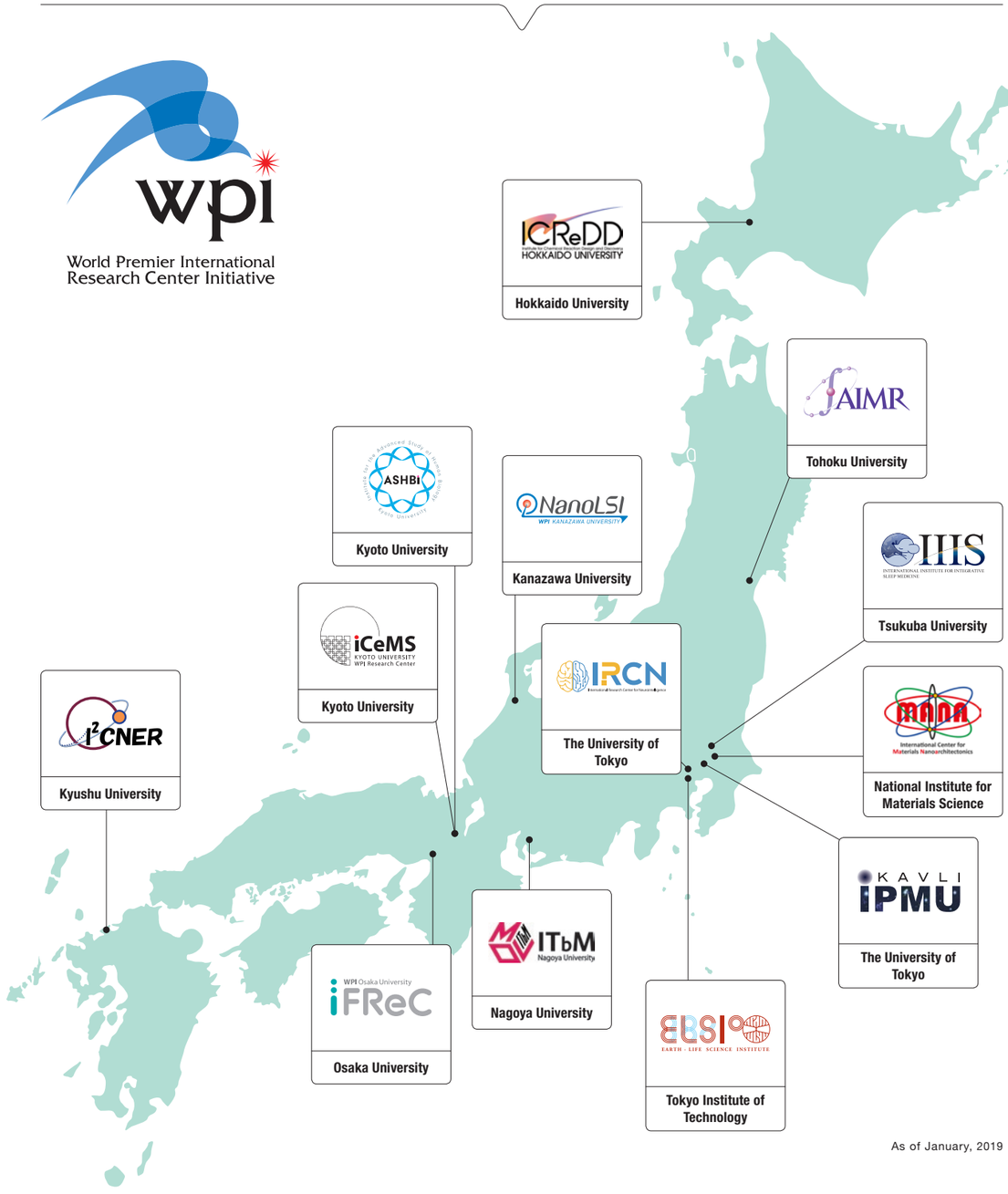
Administrative Office, International Research Center for Neurointelligence,
The University of Tokyo Institutes for Advanced Study
Tel: +81-3-5841-8691
E-mail: donate@ircn.jp

About the WPI

World Premier International Research Center Initiative

The World Premier International Research Center Initiative (WPI) was launched in 2007 by the Japanese Government's Ministry of Education, Culture, Sports, Science and Technology (MEXT) with the aim of building globally visible research centers. WPI research centers have four requirements: achieving the world's highest research standard, establishing an international research environment, reforming the research system, and the creation of interdisciplinary research. The International Research Center for Neurointelligence (IRCN) was founded on November 1, 2017 and is undertaking ambitious reforms including inviting frontline researchers from around the world to establish a global research environment.

World Premier International Research Center Initiative



As of January, 2019

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wpi
World Premier International Research Center Initiative

ACCESS

- 8 minute walk from Hongo-sanchome Station on the Tokyo Metro Marunouchi Line
- 6 minute walk from Hongo-sanchome Station on the Tokyo Metro Toei Oedo Line

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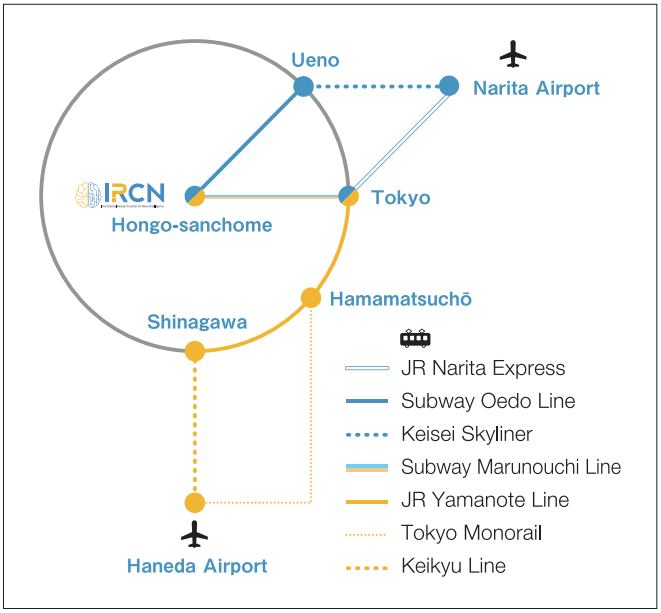

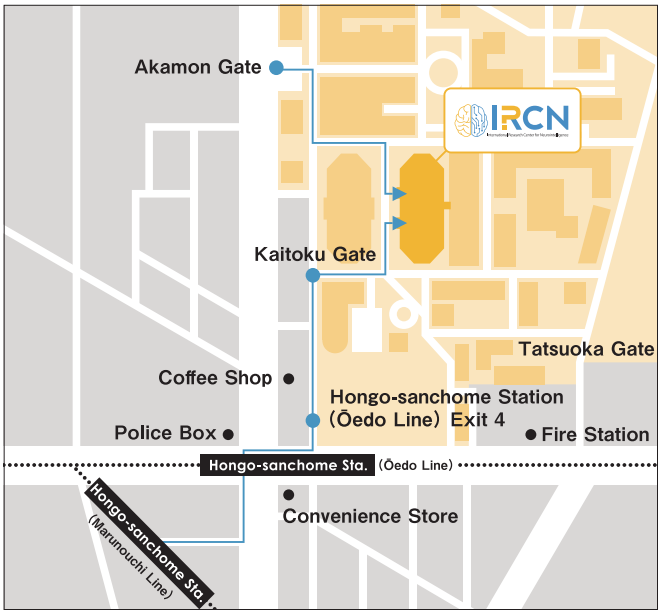

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