The Institute for AI and Beyond conducts research in a range of fields, including neuroscience.

THE SURPRISING NEW IDEAS COMING FROM AI

From powering miniature lab-based brains, to helping humans understand quantum mechanics, CROSS-POLLINATING AI WITH OTHER DISCIPLINES is creating new and surprising research directions.

When Yoshiho Ikeuchi joined The University of Tokyo's Institute for AI and Beyond, he and his colleagues developed an innovative way to build tiny models of brain circuits from neural tissue in the lab.

After completing his PhD at the University of Tokyo in 2007, Ikeuchi worked in a post-doctoral position in cellular neuroscience in the United States. When he returned to the University of Tokyo seven years later, he collaborated with engineering colleagues to grow neural organoids — neural tissue generated from human stem cells — in silicon rubber moulds.

Ikeuchi could see potential in marrying engineering and biology. But it wasn't until he arrived at the Institute for AI and Beyond, in 2020, that his research expanded and evolved in an unexpected direction, resulting in an unprecedentedly rich model of neural function that connects AI with biology.

The model is comprised of two organoids-on-a-chip connected by a narrow channel. Axons, fibres which extend from neuron cells and connect to others, grow through the channel from one organoid to the other, forming a rudimentary version of complex brain circuit architecture.

TRANSFORMATIVE INSTITUTE

This miniature brain model is designed to exist inside a closed AI loop. AI sends signals to one organoid via an electrode array and records and analyses the response of the other. It allows Ikeuchi to exert control over the stimulus and to detect and analyse output that would otherwise be too complex to comprehend.

Ikeuchi attributes this innovative model to the unique interdisciplinary nature of research at the Institute for AI and Beyond. For him, the impact of working at the Institute, has been "professionally transformative," fundamentally changing his sense of what is possible.

Founded in May 2020 by the University of Tokyo and SoftBank, the institute has already proven itself as a centre of excellence and innovation. Dedicated to creating a dynamic exchange between AI research and industry, it supports mid-and long-term research projects that explore all aspects of AI, its industry and research applications, impact on society, and the research horizons of AI itself. The institute also supports more practical research projects, called high-cycle projects, that aim to establish AI companies in a few years and eventually create a business ecosystem consisting of the University of Tokyo, SoftBank and related companies.

The institute's faculty reflects AI's rapid evolution and ability to affect many different parts of society and different fields of research.

Aside from neuroscientists such as Ikeuchi, it is also home to engineers, astrophysicists, quantum mechanics experts and social historians.

Like Ikeuchi, physicist, Eiji Saitoh, also began his research heading in a different direction to his current work. Saitoh trained in spintronics, but over time became increasingly interested in quantum mechanics.

BEYOND HUMAN LIMITS

Quantum mechanics posed a greater challenge to Saitoh, as current scientific understanding cannot fully account for the behaviour of the subatomic world, which is simultaneously wave-like and particle-like. Currently, he says, the quantum realm is "beyond human understanding," which is why AI has great potential for the field.

AI has an enormous capacity to analyse complexity, he explains, meaning it could act as an interpreter to help us decipher the quantum world. To this end Saitoh is focused on building a human and AI collaboration.

He's using this technology to understand the interference caused by small structural defects in the electric conductance of nano-metals, such as copper or aluminium. Previously the effect of such interference was thought to be too random to be analysed, but Saitoh used AI to find and study patterns in the 'noise', creating what he calls a quantum fingerprint.

By using AI in this way, Saitoh says, researchers can build useful generalizations about the quantum world. Such insights have practical applications, such as helping to develop better quantum computers. Furthermore, he believes, human logic combined with AI "leaps of understanding" will make it possible to eventually formulate a new physics that will describe both the subatomic and the ordinary worlds, in a way that humans can comprehend.
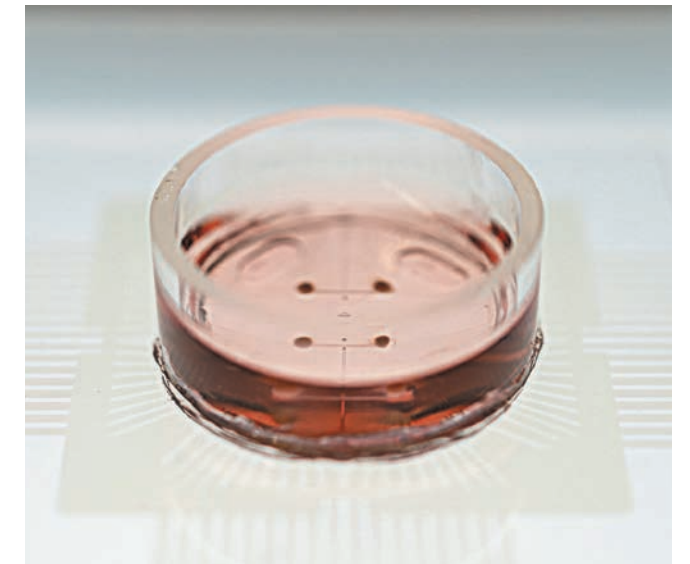
Projects such as Saitoh's and Ikeuchi's may have practical applications, but the research of the Institute for AI and Beyond is not only dictated by business interests. The freedom and collaborative opportunities it has given both researchers has greatly expanded their research horizons. Now because Saitoh's ambitious work is supported by the Institute, he hopes to be able to change not just the way we understand physics, but to push the limits of what AI itself can achieve.

▲ Two pairs of connected organoids on a multi-electrode array (MEA). Neuronal activities are recorded by the electrodes underneath them.

"WE WANT TO SEE HOW AI CAN BE USED IN A POSITIVE WAY."

AI'S GLAMOROUS AURA

Yuko Itatsu, a social and cultural historian, heads up the institute's humanities and social science project. Her goal is to explore both the way in which AI is used within society and the impact that it has on society. There is "a glamorous aura to AI in Japan," she explains, but engaging with colleagues at the institute has helped her to develop a more realistic understanding of the technology.

Part of her project is to monitor the effect of AI and ensure it doesn't exacerbate existing social issues and inequalities based on gender, race, sexuality, disability, and wealth disparity. For example, Itatsu mentions widespread concerns about the way that face-recognition and surveillance technology may replicate the racial biases of society. Even within the AI-research community, Itatsu observes that most researchers are men. The field includes only a small percentage of women, a figure that she says is not expected to change in the next 10 years. She says it is important to monitor how AI research develops and track the potential impact of that skewed representation.

Using the multi-disciplinary resources of the institute, Itatsu has brought together researchers including media specialists, historians, cultural anthropologists, linguists and scientists to collaborate on an international comparative study. Globally, "there is a naive idea that AI exists in a kind of abstract neutral space," she argues, but AI emerges from the society that creates it, and all over the world AI is shaped by distinctly different cultural assumptions and funding contexts, which she believes should be made explicit.

"We are not watchdogs," she clarifies. "But we want to see how AI can be used in a positive way to change stigma and mitigate discrimination".

INTERDISCIPLINARY DIALOGUE

Itatsu's ultimate goal is to create a forum for truly interdisciplinary dialogue about AI. Her lab has already put together a book that is a compilation of essays that will be one of the first of its kind in Japan. True to the spirit of her lab, Itatsu's collection includes work by a wide range of researchers, and equally importantly, it has been written for the public, not for a small, specialized audience.

"The only way to mitigate algorithmic bias is to make sure that dialogue about AI is shared by society in general," she says. When the general public understands what AI can do, they can hold governments and companies accountable.

The work of Itatsu, Saitoh and Ikeuchi, as well as the many different researchers at the Institute for AI and Beyond, promises to continue driving AI research in surprising and exciting directions. ◼

Andriy Onufriyenko/Moment/Getty