Progress report 2024

Empirical research on Pre-disease AI Medicine

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■ Course Outline
The diverse biological and medical information obtained at the Graduate School of Medicine and the UTokyo Hospital will be analyzed using mathematical science and AI technology developed by the IRCN to predict disease onset, creating new linkages with clinical medicine and social medicine and opening up new areas of research. Specifically, to link AI technology based on the DNB theory developed at the IRCN with clinical medicine, the newly established Mebyo AI Center will be utilized to realize personalized medicine at the stage of Mebyo (Pre-disease state). This is expected to prevent major diseases, extend healthy life expectancy, and improve the health of the population, as well as generate economic benefits such as an increase in the working productive population and a reduction in medical costs.

■ Research Content
We have started data analysis and development of mathematical analysis methods to promote research using biological and medical information. Currently, while collecting and organizing data, we are preparing to apply mathematical models and AI techniques based on the DNB theory, and are attempting to extract characteristics of various diseases in the Mebyo stage. Through these efforts, we aim to construct a diagnosis and prediction model of Mebyo for personalized medicine.

■ Future Outlook
In the future, we plan to conduct empirical studies to improve the accuracy of diagnosis of Mebyo and apply it to preventive medicine by detecting Mebyo specific to each disease based on the DNB theory, developing an algorithm for detecting abnormalities, and integrating the algorithm with clinical data..

■ [FY2024 Activity Report]
■ Journal papers
- Takeaki Yajima, Satya Prakash Pati, Yifan Geng, Satoshi Hamasuna, Kantaro Fujiwara, Tetsuya Iizuka, Hisashi Inoue, and Isao Inoue, Real-time Information Processing via Volatile Resistance Change in Scalable Protonic Devices, Communications Materials, 2024
-Suzukaze Kamei, Hideaki Kawaguchi, Shin Nishio, Tatakahiko Satoh. Quantitative Evaluation of Quantum/Classical Neural Network Using a Game Solver Metric. arXiv:2503.21514, 2025 (preprint)
-Yota Maeda, Hideaki Kawaguchi, Hiroyuki Tezuka. Estimation of mutual information via quantum kernel method. Quantum Machine Intelligence, Volume 7, 29, 2025
-Yudai Suzuki, Rei Sakuma, Hideaki Kawaguchi. Light-cone feature selection for quantum machine learning. Advanced Quantum Technologies, 2400647, 2025
-Hakan Doga, Aritra Bose, M Emre Sahin, Joao Bettencourt-Silva, Anh Pham, Eunyoung Kim, Alan Andress, Sudhir Saxena, Laxmi Parida, Jan Lukas Robertus, Hideaki Kawaguchi, Radwa Soliman, Daniel Blankenberg. How can quantum computing be applied in clinical trial design and optimization? Trends in Pharmacological Sciences, Volume 45, Issue 10, p.880-891,

2024
■ Domestic Conference
- Toshimasa Yamauchi, Main Session2 "Activation of adiponectin receptors AdipoRs for type 2 diabetes, metabolic dysfunction associated steatohepatitis and short life in obesity like exercise," 4th Annual Meeting of International Society of Portology, Juntendo University, Tokyo, June 1, 2024 life in obesity like exercise, International Society of Portology 4th Annual Meeting, Juntendo University (June 1, 2024, Tokyo)
- Toshimasa Yamauchi, Chairman Lecture "Elucidation of genetic and environmental factors of obesity and type 2 diabetes and their interaction and application to prevention and treatment methods", The 45th Japan Society for the Study of Obesity and the 42nd The 45th Annual Meeting of the Japan Society for the Study of Obesity and the 42nd Annual Meeting of the Japan Society for the Study of Obesity (October 19-20, 2024, Yokohama), President: Toshimasa Yamauchi
- Toshimasa Yamauchi: Educational Lecture 1 "Molecular mechanisms and therapeutic strategies for type 2 diabetes and its complications - with focus on subtype PRS, complications and pharmacotherapy algorithm", The 62nd Annual Meeting of the Japan Diabetes Society Chugoku-Shikoku Regional Meeting (December 6-7, 2024, Okayama) (Okayama)
- Kantaro Fujiwara, "Complex Mathematical Modeling for Research on Mebyo - From the Viewpoint of Utilization of Research Data Infrastructure," The 17th Symposium on Informatics, Committee on Informatics, Science Council of Japan, Minato-ku, Tokyo, July 2024 (oral, invited)
- Taiki Yamada, Kantaro Fujiwara. Evaluation of learning process of dynamical systems using topological data analysis, Annual Meeting of the Japanese Society for Applied Mathematics 2024, Kyoto, Japan, Sep. 2024 (oral)
- Taiki Yamada, Amit Yaron, Dai Akita, Hirokazu Takahashi, Kantaro Fujiwara. Parameter Estimation of Echo State Network Using Cultured Neuronal Cell Data, Japanese Neural Network Society, Sapporo, Hokkaido, Sep. 2024 (poster)
- Masaharu Hayashi, Yusuke Komiyama, Ikki Fujiwara, Makoto Asaoka, Yasuyuki Minamiyama, Rue Ikeya, Hiroyuki Yasuda, Ken Todoroki, Fumiyuki Fujii, Sanae Kimoto, Kantaro Fujiwara, Kazutsuna Yamaji. Management, Sharing, and Publication of Research Data in the Comprehensive Mebyo Database Project, Information and Knowledge Science Forum, Kanazawa, Ishikawa, November 2024 (oral)
- Kantaro Fujiwara, Practices and Issues Related to Utilization of Mebyo Data in Moonshot Goal 2, The 10th Meeting on Research Ethics, Osaka, Osaka, Japan. March 2025 (oral, invited)
- Ryutaro Sato, Yasuhiro Aota, Takaharu Yoshida, Hideaki Kawaguchi, Yuichiro Mori, Hiroki Kuji, Yuichiro Matsuzaki. Quantum circuit learning using dynamics of non-integrable systems. Proceedings of the 198th Joint Conference on High Performance Computing and Quantum Software, Sapporo, Hokkaido, March 2025. (oral)
- Yusuke Machida, Hiroki Kuji, Yuichiro Mori, Hideaki Kawaguchi, Takashi Imoto, Yuki Takeuchi, Miku Ishizaki, Yuichiro Matsuzaki. Discrimination of phase plate properties by quantum sensor network using photons. The 51st Quantum Information Technology Conference (QIT51), Takamatsu, Kagawa, Nov. 2024. (oral)

■ International Conference
- Anubhav, Kantaro Fujiwara, Across Trials vs Subjects vs Contexts: A Multi-Reservoir Computing Approach for EEG Variations in Emotion Recognition. 26th ACM International Conference on Multimodal Interaction, SanJose,

Costa Rica, Nov. 2024 (oral)

- Taiki Yamada, Kantaro Fujiwara, Approximating Eigenmodes of the Koopman Operator of Dynamical Systems Using Kolmogorov-Arnold Networks. The 2024 International Symposium on Nonlinear Theory and Its Applications (NOLTA), Halong, Vietnam, Dec, 2024 (oral)
- Kantaro Fujiwara, Diabetes treatment by chaos control: potential of Slow Electronics application, Workshop for Slow Electronics in AIST, Tsukuba, Ibaraki, Mar 2025 (oral)
- Rei Kawano, Hideaki Kawaguchi, Takahiko Satoh. Ruleset generation and execution in Quantum Internet applications. Quantum Innovation 2024, Chuo-ku, Tokyo, Oct 2024.（poster）
- -Kisho Sotokawa, Hideaki Kawaguchi, Takahiko Satoh. A hierarchical GUI-based web app for quantum circuit transpilation and qubit Allocation. Quantum Innovation 2024, Chuo-ku, Tokyo, Oct 2024.（poster）
- -Suzukaze Kamei, Hideaki Kawaguchi, Takahiko Satoh. Quantitative analysis of classical and quantum neural networks using a tic-tac-toe engine. Quantum Innovation 2024, Chuo-ku, Tokyo, Oct 2024（poster）
- -Masaki Nagai,Hideaki Kawaguchi, Takahiko Satoh. Uncovering bottlenecks in quantum Internet applications via blind variational quantum computing. Quantum Innovation 2024, Chuo-ku, Tokyo, Oct 2024 (poster)
- -Rei Kawano, Hideaki Kawaguchi, Takahiko Satoh. Resource allocation procedure with Quantum Internet applications. 24th Asian Quantum Information Science Conference, Sapporo, Hokkaido, Aug 2024 (poster)
- -Kishou Sotokawa,Hideaki Kawaguchi, Takahiko Satoh. A GUI-based application to support learning and implementation of quantum applications using entanglement. 24th Asian Quantum Information Science Conference, Sapporo, Hokkaido, Aug 2024 (poster)
- -Masaki Nagai, Hideaki Kawaguchi, Takahiko Satoh. Quantifying Operational Costs of Quantum Internet Applications Through Blind Variational Quantum Computing. 24th Asian Quantum Information Science Conference, Sapporo, Hokkaido, Aug 2024 (poster)
- -Suzukaze Kamei, Hideaki Kawaguchi, Takahiko Satoh. Quantitative evaluation of quantum and classical system performance by board game win/loss ratio. 24th Asian Quantum Information Science Conference, Sapporo, Hokkaido, Aug 2024 (poster)

■ Social Activities

The 9th UTokyo-NTU Joint Conference (November 27-28, 2024, Tokyo)

- Speaker Toshimasa Yamauchi: session 2 "Preventive health concept of "Mebyo".