

OIST Neural Computation Unit Annual Report FY2024

April 2024 – March 2025

Professor: Kenji Doya

Web: <https://www.oist.jp/ncu>

Research Personnel

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PhD Students

Yuji Kanagawa
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David Pere Tomas Cuesta (Co-supervision)

Research Interns

Gaganpreet Singh Jhajj
Ami Maeno
Mehak Bhatia
Aman Altabbaa

Journal Articles

1. Cheng, Yi-Shan. 2025. "Information-Theoretical Analysis of Team Dynamics in Football Matches." *Entropy*, 27:224. <https://doi.org/10.3390/e27030224>
2. Lalande, Florian, Elizabeth Tasker, and Kenji Doya. 2024. "Estimating Exoplanet Mass using Machine Learning on Incomplete Datasets." *Open Journal of Astrophysics* 7. <https://doi.org/10.33232/001c.124538>
3. Kasahara, Kazumi, Keigo Hikishima, Mariko Nakata, Tomokazu Tsurugizawa, Noriyuki Higo, and Kenji Doya. 2024. "A Whole-Brain Analysis of Functional Connectivity and Immediate Early Gene Expression Reveals Functional Network Shifts after Operant Learning." *NeuroImage* 299:120840. <https://doi.org/10.1016/j.neuroimage.2024.120840>
4. Taira, Masakazu, Katsuhiko Miyazaki, Kayoko Miyazaki, Jianning Chen, Shiho Okitsu-Sakurayama, Anupama Chaudhary, Mika Nishio, et al. 2024. "The Differential Effect of Optogenetic Serotonergic Manipulation on Sustained Motor Actions and Waiting for Future Rewards in Mice." *Frontiers in Neuroscience* 18: 1433061. <https://doi.org/10.3389/fnins.2024.1433061>
5. Keshmiri, Soheil, Sutashu Tomonaga, Haruo Mizutani, and Kenji Doya. 2024. "Respiratory Modulation of the Heart Rate: A Potential Biomarker of Cardiorespiratory Function in Human." *Computers in Biology and Medicine* 173: 108335. <https://doi.org/10.1016/j.combiomed.2024.108335>
6. Han, D., K. Doya, D. Li, and J. Tani. 2024. "Synergizing Habits and Goals with Variational Bayes." *Nature Communications* 15:4461. <https://doi.org/10.1038/s41467-024-48577-7>
7. Tinker TJ, Doya K, Tani J. 2024. "Intrinsic Rewards for Exploration Without Harm From Observational Noise: A Simulation Study Based on the Free Energy Principle." *Neural Computation* 36: 1854-1885. https://doi.org/10.1162/neco_a_01690
8. Hamada, Hiro, Yoshifumi Abe, Norio Takata, Masakazu Taira, Kenji Tanaka, and Kenji Doya. 2024. "Optogenetic Activation of Dorsal Raphe Serotonin Neurons Induces Brain-Wide Activation." *Nature Communications* 15:4152. <https://doi.org/10.1038/s41467-024-48489-6>
9. Tanaka SC, Kasai K, Okamoto Y, Koike S, Hayashi T, Yamashita A, Yamashita O, Johnstone T, Pestilli F, Doya K, Okada G, Shinzato H, Itai E, Takahara Y, Takamiya A, Nakamura M, Itahashi T, Aoki R, Koizumi Y, Shimizu M, Miyata J, Son S, Aki M, Okada N, Morita S, Sawamoto N, Abe M, Oi Y, Sajima K, Kamagata K, Hirose M, Aoshima Y, Hamatani S, Nohara N, Funaba M, Noda T, Inoue K, Hirano J, Mimura M, Takahashi H, Hattori N, Sekiguchi A, Kawato M, Hanakawa T. 2024. "The Status of MRI Databases across the World Focused on Psychiatric and Neurological Disorders." *PCN Frontier Review* 78:563–579. <https://doi.org/10.1111/pcn.13717>

Conference Proceedings

1. Kanagawa, Yuji, and Kenji Doya. 2024. "Evolution of Rewards for Food and Motor Action by Simulating Birth and Death." In *Proceedings of the 2024 Artificial Life Conference*, 288–96. https://doi.org/10.1162/isal_a_00753
2. Sangati E, Sangati F, Slors M, Doya K (2024). "The collaborative abilities of ChatGPT agents in a number guessing game." In *Proceedings of the Joint Symposium of AROB-ISBC-SWARM 2024*, 116-121, <https://repository.ubn.ru.nl/bitstream/handle/2066/314022/314022.pdf>
3. Tomonaga S, Mizutani H, Doya K (2025). Training Recurrent Neural Networks with Inherent Missing Data for Wearable Device Applications. In *Proceedings of the AAAI Conference on Artificial Intelligence*, 39:29512-29513. <https://doi.org/10.1609/aaai.v39i28.35307>

Presentation at Conferences

1. Doya, Kenji. 2025. "Reinforcement Learning, Computational Neuropsychiatry, and the Digital Brain." *6th Japan-UK Neuroscience Symposium*. Jan. 23-26, 2025, Awaji Yumebutai.
2. Doya, Kenji. 2025. "脳神経統合プログラムのデジタル脳プロジェクト Digital Brain Project of Brain/MINDS 2.0." 第26回日本正常圧水頭症学会. 26th Annual Meeting of the Japanese Society of NPH. <http://nph2025.umin.jp/>
3. Doya, Kenji. 2025. "「デジタル脳」による精神神経疾患の予測と制御 Prediction and Control of Neuropsychiatric Disorders by Digital Brains." 産総研人間情報インタラクション研究部門シンポジウム: 脳の変化 AIST Human Information Interaction Research Area Symposium: Changing Brain. 2025.2.15, Online. <https://unit.aist.go.jp/hiiri/events/HIIRI-sympo2024.html>
4. Doya, Kenji. 2025. "Reinforcement Learning, Bayesian Inference and the Digital Brain." *2025 5th International Conference on Electrical Engineering and Information Technology (CEEIT 2025)*. <https://www.ceeit.net>
5. Doya, Kenji. 2025. "Reinforcement Learning, Bayesian Inference and the Digital Brain." OIST Machine Learning Workshop. March 3-5, 2025. <http://omlw2025.mlds.jp>
6. Doya, Kenji. 2025. "Bayesian Inference, Reinforcement Learning, and the Canonical Cortical Circuit." *Biological, Artificial, and Quantum Intelligence 2025 (BAQ2025)*, March. <https://groups.oist.jp/qed/event/%E3%80%90international-workshop%E3%80%91biological-artificial-and-quantum-intelligence-2025-baq2025>
7. Doya, Kenji. 2025. "脳と AI、デジタル脳 Brain, AI and Digital Brain." 数理の翼 伊計島セミナー2025 Wings of Mathematics Ikei Island Seminar. 2025.3.24 Ikei Island. <https://seminar.npo-tsubasa.jp/island2025/>
8. Doya, Kenji. 2025. "理論駆動とデータ駆動の脳科学 Theory-driven and Data-driven Brain Sciences." 脳科学若手の会 春の合宿 Spring Camp of Young Researchers in Brain Science, March 15, 2025, Miura. <https://brainsci.jp/blog/2025/03/17/%E7%AC%AC17%E5%9B%9E-%E8>

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E%E4%BC%9A-%E6%98%A5%E3%81%AE%E5%90%88%E5%AE%BF-2/](https://www.softbank.jp/biz/blog/cloud-technology/articles/202412/beyond-ai-brain-science/)
9. Doya, Kenji. 2025. "Digital Brain: Computational Theory Meets Brain Big Data." *Brain Science × AI Community Event*, March 25, 2025, Softbank.
<https://www.softbank.jp/biz/blog/cloud-technology/articles/202412/beyond-ai-brain-science/>
 10. Doya, Kenji. 2024. "楽しい大学のつくり方:OIST で拓く脳と AI 研究 How to Enjoy Making a University: Developing Brain Science and AI in OIST." *トライボロジー会議 2024 秋 名護 Fall 2024 Tribology Meeting in Nago*.
https://www.tribology.jp/conference/tribology_conference/24nago
 11. Doya, Kenji. 2024. "デジタル脳プロジェクトのめざすもの The Aims of the Digital Brain Project." *第1回 日本放射線医療技術学術大会 (JCRTM2024)*.
<https://www.linkage-okinawa.co.jp/jcrtm2024/>
 12. Doya, Kenji. 2024. "デジタル脳は脳構造、脳活動、脳機能をつなげるか Can Digital Brains Bring Together Brain Structures, Activities, and Functions?" *Autumn School for Computational Neuroscience (ASCONE 2024)*. 2024.11.26, Ichinomiya. <http://ascone.brainsci.net>
 13. Doya, Kenji. 2024. "Bayesian Inference, Reinforcement Learning, and the Canonical Cortical Circuit." *RIKEN CBS Summer Program*.
<https://cbs.riken.jp/en/summer/2024/>
 14. Doya, Kenji. 2024. "Endless Questions about Behaviors and Brain." *The EMBO Practical Course - Barcelona Summer School for Advanced Modeling of Behavior (BAMB!)*. <https://www.bambschool.org/previous-editions/bamb-2024>
 15. Doya, Kenji. 2024. "Brain/MINDS 2.0 and the Digital Brain Project." *The 17th International Conference on Brain Informatics (BI2024)*. <https://wi-consortium.org/conferences/bi2024/>
 16. Doya, Kenji. 2024. "Evolution, Reinforcement Learning, and Mental Simulation." *ICRA 2024 Workshop: Cognition across Species: From Nature to Robotic Application*.
https://sites.google.com/view/cognitionacrossspecies/cognition_wsicra2024
 17. Doya, Kenji. 2024. "Bayesian Inference and Model-Based Reinforcement Learning." *FENS 2024 Symposium on Internal World Models*.
<https://forum2024.fensforum.org/>
 18. Doya, Kenji. 2024. "Digital Brain Project of Brain/MINDS 2.0." *The 1st International Whole Brain Architecture Workshop*. <https://wba-initiative.org/en/24158/>
 19. Doya, Kenji. 2024. "Consciousness as Data Assimilation." *CogSci 2024 Invited Symposium: Dynamics Between Minds & The Environment*.
<https://underline.io/events/465/sessions?eventSessionId=18016&searchGroup=lecture>
 20. Doya, Kenji. 2024. "Bayesian Inference, Reinforcement Learning, and the Cortico-Basal Ganglia Circuits." *CogSci 2024 Hong Kong Meetup: Cognitive Science in the Era of AI*. <https://cogsci2024.hkust.edu.hk>
 21. Doya, Kenji. 2024. "Digital Brain Project for Brain/MINDS 2.0." *Digital Brain Workshop, Tokyo, 2024.9.19*. <https://boatneck-weeder->

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22. Doya, Kenji. 2024. "What is the Digital Brain of Brain/MINDS 2.0?" Digital Brain Seminar. April 1, 2024. Online.
<https://digitalbrainproject.github.io/seminar/>
23. Doya, Kenji. 2024. "脳と AI の強みと弱み Strengths and Weaknesses of the Brain and AI." 情報処理学会 連続セミナー「次世代 AI モデルに向けた研究開発動向」4th Seminar Series "Research and Developments for Next-Generation AI Models," Information Processing Society of Japan. August 7, 2024.8.7, Online.
<https://www.ipsj.or.jp/event/seminar/2024/program04.html>
24. Sangati, Ekaterina, Federico Sangati, Marc Slors, and Kenji Doya. 2024. "The Collaborative Abilities of ChatGPT Agents in a Number Guessing Game." *Proceedings of the Joint Symposium of AROB-ISBC-SWARM 2024*.
https://isarob.org/symposium/past_symposia/arob29

Seminars

1. Doya, Kenji . 2024. "神経の高次機能と報酬系 Higher functions of the brain and the reward system." 琉球大学医学部 神経科学特別講義 Special Lecture of University of Ryukyus Medical School, May 27, 2024.
2. Doya, Kenji. 2024. "強化学習と脳内シミュレーションの神経機構 Neural Mechanisms of Reinforcement Learning and Mental Simulation." 計数工学特別講義 Special Lecture at Department of Mathematical Engineering and Information Physics Special Lecture, University of Tokyo, May 28, 2024.
3. Doya, Kenji. 2024. "How the Cerebellum and the Basal Ganglia can Work Together." Seminar at Erasmus MC, 2024.7.20, Rotterdam
4. Doya, Kenji. 2024. "How Can We Build Digital Brains?" 2024 Brain Prize Webinar, Nov. 6, 2024. <https://brainprize.org/winners/computational-and-theoretical-neuroscience-2024/the-brain-prize-webinar-series-2024>
5. Doya, Kenji. 2025. "Reinforcement Learning in Machines and Brains." Lecture at INSTIKI Indonesia, Bali, Feb. 28, 2025.
6. Doya, Kenji. 2024. "ベイズ推定・強化学習と大脳皮質-基底核の神経回路 Bayesian Inference, Reinforcement Learning, and the Cortico-Basal Ganglia Circuit." 獨協神経生理学セミナー Dokkyo Neurophysiology Seminar. 2024.12.20, Online.
7. Doya, Kenji. 2024. "「デジタル脳」による精神神経疾患の予測と制御 Prediction and Control of Neuropsychiatric Disorders by Digital Brain." パーキンソン病-神経科学カンファレンス Parkinson Disease and Neuroscience Conference. 2024.11.15, Naha.
8. Doya, Kenji. 2024. "デジタル脳とは何か、どう作りどう使うのか What is the Digital Brain? How can we Build and Use it?" 応用脳科学アカデミー「脳に学ぶ AI」 Applied Neuroscience Academy "Brain-inspired AI". 2024.11.29, Online.

9. Doya, Kenji. 2024. “強化学習とベイズ推定の脳機構 Brain Mechanisms for Reinforcement Learning and Bayesian Inference.” 大阪大学生命機能研究科 集中講義「計算論的神経科学への招待」Osaka University Graduate School of Frontier Biosciences Special Lecture: Introduction to Computational Neuroscience. 2024.12.19, CiNet.

Scholarly Contributions by Unit Members

Name of Unit Member (Author-Presenter)	Title	Outlet
Yukako Yamane	Adaptation of the inferior temporal neurons and efficient visual processing.	Front Behav Neurosci
Yukako Yamane	Representation of Natural Contours by a Neural Population in Monkey V4	eNeuro
Terezie Sedlinska	Differential effects of dopamine and serotonin on reward and punishment processes in humans: A systematic review and meta-analysis	JAMA Psychiatry
Yukako Yamane	OptiNiSt (Optical Neuroimage Studio) Tutorial	JNNS 2024 satellite symposium
Yukako Yamane	Young Investigators Seminar on AI and Brain 2024	JNSS 2024 satellite symposium
Sutashu Tomonaga	A Novel Recurrent Neural Network Architecture for Modeling Time Series from Wearable Devices	JNNS2024
Sutashu Tomonaga	Training Recurrent Neural Networks with Inherent Missing Data for Wearable Device Applications (Student Abstract)	AAAI25
Anna Chiajung Chang	The efficacy of the synthetic peptide PHDP5 in rescuing cognitive deficits in Alzheimer's disease model mice	SfN 2024
Tojoarisoa Rakotoaritina	Embodied Evolution of Intrinsically Motivated Reinforcement Learning	OIST Machine Learning Workshop 2025
Razvan Gamanut	A computational approach at mesoscopic scale for studying the interaction between claustrum and cortex	JNNS 2024
Shuhei Hara	fMRI study reveals enhanced top-down and bottom-up processes in schizophrenia	COSYNE 2025
Naohiro Yamauchi	Cortical micro circuits reference architecture for dynamic Bayesian inference	1st Digital Brain Workshop

Name of Unit Member (Author-Presenter)	Title	Outlet
Gaganpreet Singh Jhaji	Jack and the BeansTALK: Towards Question Answering in Plant Biology	Eighth Widening NLP Workshop EMNLP 2024
Katushiko-Kayoko Miyazaki	Dorsal raphe serotonin neurons encode probability not value of future rewards	FENS2024
Terezie Sedlinska	Reversal learning under 2-week bupropion or escitalopram treatment in mice	SfN 2024
Yuji Kanagawa	Evolution of Rewards for Food and Motor Action by Simulating Birth and Death	ALIFE 2024
Razvan Gamanut	A computational bottom-up, mesoscale approach for the study of the interaction between claustrum and cortex	SfN 2024
Razvan Gamanut	A bottom-up, mesoscale approach for the study of the claustrum function	NEST conference (Online)
Anna Chiajung Chang	First-in-class peptide drug for the treatment of Alzheimer's Disease (Pitchers)	BioFIT 2024
Yukako Yamane	OptiNiSt (Optical Neuroimage Studio) Tutorial	NEURO 2024 satellite symposium
Yukako Yamane	Young Investigators Seminar on AI and Brain 2024	NEURO 2024 satellite symposium
Naohiro Yamauchi	Encoding of action and action values in the primary motor cortex of mice during a lever-pulling task	NEURO2024 (JNNS 2024)
Razvan Gamanut	A computational bottom-up, mesoscale approach for the study of the interaction between claustrum and cortex	Society for Claustrum annual meeting
Naohiro Yamauchi	Data for Brain Reference Architecture of NY24CanonicalCorticalMicrocircuitsInference and NY24CanonicalCorticalMicrocircuitsDecisionMaking	The Second International Whole Brain Architecture Workshop

Honors, Awards & Fellowships

Term 2 2025 - Term 2 2025	Shuhei Hara, COSYNE presenter travel grant, COSYNE 学会渡航費, 2024, COSYNE, N/A [Fiscal Year: 2025-03-27]
Term 3 2024 - Term 3 2024	Naohiro Yamauchi, Excellence Award for the Training Session for Early-Career Scientists, 若手育成道場 優秀発表賞, 2024, NEURO2024, N/A [Fiscal Year: 2024-07-24]

Workshops and Seminars

Speaker Name(s)	Title
Dr. Atsushi Yokoi	A possible link between autonomic arousal and contextual inference process in human motor learning and control
WCCI 2024 Open Forum on AI Governance	How to harness evolving AI – Dialogue of developers, users, and policy makers –
Dr. Rieko Osu	Well-Being and Communication: Exploring Social Interaction and Neurodiversity
Dr. Jovan Rebolledo	Exponential Data and Better AI for Solving Biological Challenges
Dr. Mehdi Adibi	Neuronal mechanisms of decision making in rodents and humans
Dr. Andres Hernandez-Matamoros	Enhancing Biomedical Data Utility and Privacy Through Synthetic Data Generation and Local Differential Privacy