FY 2025 Annual Report

Unit Name

Biological Nonlinear Dynamics Data Science Unit

Assistant Professor Gerald Pao

Collaborations

Misha Ahrens, Janelia HHMI, Ashburn, Virginia, USA, Zebrafish whole brain EDM

George Sugihara, Scripps Institution of Oceanography, UC San Diego, La, Jolla, California, USA, EDM in ecology

Sarah Luo, Astar, Singapore, EDM for Aging

Hiroaki Natsukawa, Osaka Seikei University, Japan, Visualization for EDM

Weiping Han, Astar, Singapore, EDM for Aging

William Frost, Rosalind Franklin University, North Chicago, Illinois, USA, Tritonia and Aplysia EDM analysis

Jun Wu, UT Southewestern, Dallas, Texas, USA, the early human embryo pluripotency

Yonkeun Paul Park, KAIST, South Korea, reflectin proteins and EDM for quantitative phase microscopy

Stanislav Smirnov, University of Geneva, Switzerland, mathematics of neuroscience

Masahito Ikawa, Osaka University, Japan, mammalian spermatogenesis epigenetics

Terrence Sejnowski, Salk Institute, UC San Diego, La, Jolla, California, USA, low dimensional manifolds and AI

Keichi Takahashi, Osaka University, Japan, High perfomance computing EDM algorithms

Jingwen Li, UCSD, La, Jolla, California, USA, EDM for Marmosets

Yoko Iwata, U of Tokyo, Japan, Cephalopod biology

Nicholas Friedman, Museum of Nature Hamburg, Hamburg, Germany, OKEON soundscape analysis

Michael Yoo, CNIR, Institute for Basic Science, Suwon, South Korea, EDM for monkey electrophysiology

Jack Gallant, UC Berkeley, Berekeley, California, USA, fMRI of human driving

Yu Mu, ION, CAS, Shanghai, China, experimental verification of EDM in whole brains

Loren Frank, UCSF, San Francisco, California, USA, embeddings of rat decision making

Rosa So, Astar, Singapore, EDM for Aging

Caroline Wee, Astar, Singapore, EDM for Aging

Quan Zhu, UCSD, La, Jolla, California, USA, EDM from MERFISH

Won Mok Shim, CNIR, Institute for Basic Science, Suwon, South Korea, EDM for fMRI of videogames

Hakwan Lau, CNIR, Institute for Basic Science, Suwon, South Korea, EDM for fMRI

Xiaomei Lu, NASA, USA, Antarctic Sea Ice LIDAR and temperature satellite observations

Students Supervised:

- Temma Fujishige (PhD Student)
- Amirhossein Naseri Golestani (PhD Student)
- Iaroslav Korobov (PhD Student)
- Mizumo Yamanokuchi (Research Intern)
- Bach Nguyen (Research Intern)
- Mizumo Yamanokuchi (Visiting Research Student)

Scholarly Contributions and Creative Productions (by Faculty)

Conference Proceedings

1. Hu, M.; Zhang, N. a.; Lam, Z. Y.; Keng, A., Kai; Yue, S.; Xinwei, L., Sarah; Wee, C. L.; Pao, G.; Han, W.
   Empirical Dynamic Modeling for Accurate Prediction and Detection of State Transition in Physiological and Behavioral Time Series of Mice*. In 2025 47th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC); 2025.

Journal Article

1. Deyle, E. R.; Pao, G.; Sugihara, G.
   Extending Empirical Dynamic Modeling to Cross-Sectional Data beyond Traditional Time Series. bioRxiv 2025.
2. Park, J.; Sugihara, G.; Pao, G.
   Control of Complex Systems with Generalized Embedding and Empirical Dynamic Modeling. PLoS ONE 2024, 19.

Other Scholarly Work

1. Pao, G.
   Toyota KONPON UC San Diego Days, Insight from the Ocean. TOYOTA KONPON UC San Diego Days, Scripps Institute of Oceanography panel 2025.

Poster Presentation at Conference

1. Pao, G.
   Experimentally Testable Mapping of Brain Activity to Behavior. SfN 2024.
2. Pao, G.
   Decoding Human Behavior from fMRI Using Dynamical Manifold Embeddings. SfN 2025.

Presentation at Conference

1. Pao, G.
   Manifolds of Brain Activity That Predict Behavior without Latent Variables. Singapore NeuroAI 2025.
2. Pao, G.
   Manifolds for Explainable Data Science. Mathematical foundations of Biological organization 2025.
3. Pao, G.
   Decoding Brain Activity into Behavior on Low Dimensional Manifolds. JNS Integrating Neuroscience with Complex Systems Science: From Single Neurons to Whole-Brain symposium 2025.
4. Pao, G.

Decoding Brain Activity into Behavior on Low Dimensimoal Manifolds. Biological Artificial and Quantum intelligence 2026.

5. Pao, G.
   Finding Biological Integration on the Surface of Low Dimensional Manifolds. Winter QBIO 2025 2025.
6. Pao, G.
   Data Driven Science with Time. Developmental Neuroscience conference (OIST) 2025.
7. Pao, G.
   Generic Decoding of Behavior from Brain Activity. OIST neuroscience symposium 2025.
8. Pao, G.
   When Causes and Effects Exist without Correlation. Tsukuba Humanics 2025.
9. Pao, G.
   Manifold Dimensional Expansion. Manifolds in nature 2025.
10. Pao, G.
    AIST/OIST. AIST OIST 2025.
11. Pao, G.
    Manifolds for Explainable Data Driven Science. APPW 2025.
12. Pao, G.
    How Nature Computes with Geometry. Biological Artificial and Quantum intelligence 2025.

Seminars

1. Pao, G.
   Manifolds for Explainable Data Science. 2025.
2. Pao, G.
   When Causes and Efffects Exist without Correlation. 2026.
3. Pao, G.
   Finding Biological Signal Integration on Low Dimensional Manifolds. 2026.
4. Pao, G.
   Data Driven Science with Empirical Dynamic Modeling. 2026.
5. Pao, G.
   Causation without Correlation in Biology (NIBB/National Institute for Basic Biology, Aichi, Japan). 2025.
6. Pao, G.
   Manifolds for Explainable Data Science. 2025.
7. Pao, G.
   Algorithms to Map Brain Activity to Behavior. 2025.

Scholarly Contributions (by Unit Members)

Name of Unit Member	Type	Title	Outlet
Yang Shen	Poster Presentation at Conference	Geometry of the temporal embeddings for neuronal spiketimes	SfN Neuroscience 2025
Yang Shen	Presentation at Conference	TBD	Biological, Artificial, and Quantum Intelligence 2026 International Workshop

External Service

Term 3 2024 - Ongoing	NeurIPS Neuro-AI workshop program committee, NeurIPS foundation, program committee member for the Neuro AI Workshop 2024, Vancouver [Fiscal Year: 2024-12-21]
Term 1 2023 - Ongoing	PNAS, USA NAS, reviewer for Proceedings of the National Academy of Sciences [Fiscal Year: 2023-03-01]
Term 1 2023 - Ongoing	Neural Computation reviewer, Neural Computation Jounral [Fiscal Year: 2023-03-01]

Other Institutional Service

Term 2 2025 - Term 2 2026	External member review of Earth Sciences/Oceanograpnhy search, (University) [Fiscal Year: 2025]
Term 3 2024 - Ongoing	Mathematics Faculty Search commitee, (University) [Fiscal Year: 2024]
Term 2 2024 - Ongoing	Information Security Committee , (University) [Fiscal Year: 2024]
Term 2 2023 - Ongoing	Biosafety committee, (University) [Fiscal Year: 2024]
Term 2 2023 - Ongoing	Animal care and use committee, (University) [Fiscal Year: 2024]

Workshops and Seminars [Organized and Hosted by Faculty/Units]

Speaker Name(s)	Title	Location	Co-Organizers	Date
Barry C Sanders / Thiparat Chotibut / Nana Liu / Nuttida Rungratsameetaweemana / Taro Toyoizumi / Mahito Sugiyama / Patricia Churchland / Yasuhiro Yamada / Takuya Isomura / Tomoki Fukai / Makoto Yamada / Akitada Sakurai	Biological, Artificial, and Quantum Intelligence 2026 (BAQ2026)	Banquet Hall Mahina, The Moon Beach Museum Resort, Onna, Okinawa, Japan	Prof.Kae Nemoto / Prof.William John Munro	2026-03-03
Jean-Pierre Eckmann	A mysterious blowup in cosmological effective field theories	Seminar Room C210, OIST		2025-10-10
Jean-Pierre Eckmann	Rolling stones reveal new structures in SO(3)	Seminar Room C210, OIST		2025-10-07
Terrence Sejnowski / Gerald Pao / Stanislav Smirnov / Raphy Coifman / Jean Pierre Eckmann / Tsvi Tlusty / Alex Pouget / George Sugihara / Timothy Sauer / Joseph Park / Yu Mu	Manifolds in Nature 2025	La Villa Boninchi (Meeting facilty of University of Geneva), Switzerland	Prof.Stanislav Smirnov (University of Geneva)	2025-05-12
Thiparat Chotibut, Kenji Doya, Tomoki Fukai, Kunio Kashino, Yu Mu, Yoshifumi Nishi, Barry C Sanders, Mahito Sugiyama, Ryousei Takano, Hiroki Takesue, Taro Toyoizumi, Junichi Tsujii	Biological, Artificial, and Quantum Intelligence 2025 (BAQ2025)	OIST (Lab4, E48 Seminar Room)	Prof.Kae Nemoto and Prof.Bill Munro	2025-03-12
Cepaholopod International Advisory committee CIAC 2025		OIST	Dan Rokhsar, Ryuta Nakajima, Sam Reiter, Jonathan Miller, Yoko Iwata	2025

Speaker Name(s)	Title	Location	Co-Organizers	Date
Ronald Coifman, George Sugihara, Timothy Sauer, Jean Pierre Eckmann, Alex Pouget, Tsvi Tlusty, Stanislav Smirnov, Gerald Pao, Yu Mu, Joseph Park	Manifolds in Nature 2	University of Geneva, Geneva, Switzerland	Stanislav Smirnov	2025
Michael Stryker	Presidential lecture	Sydney Brenner hall		2024-08-02