Janne K. Lappalainen, Ph.D.

Seattle, WA

Machine Learning & AI for Science · Shanahan Foundation Postdoctoral Fellow, Allen Institute & UW

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Machine learning scientist building **mechanistic, structured deep learning models of biological neural networks**—combining task-driven deep learning, differentiable simulation (PyTorch/JAX), graph neural networks, and simulation-based inference. First-author *Nature*, senior-author **NeurIPS Spotlight**, and *summa cum laude* Ph.D. (University of Tübingen & Max Planck Institute for Intelligent Systems).

SELECTED PUBLICATIONS & PREPRINTS

Measuring Robustness and Efficiency in a Connectome-Constrained Fly Visual System Model: Linking an Adversarial and a Perceptual Illusion — **NeurIPS 2026 (Spotlight) · Senior author**

A. García-Durán, A. Rodríguez-García, M. Molano-Mazón, A. Hyafil, S. Ramaswamy, **J. K. Lappalainen** [arXiv]

Benchmarked a connectome-constrained continuous-time RNN in a differentiable 3D pipeline: model leads in noise corruption robustness at up to $10^5\times$ fewer FLOPs than RAFT, and its adversarial failures share the same low-level motion mechanism as biological reverse-phi illusions.

Connectome-constrained networks predict neural activity across the fly visual system — **Nature 2024 · First author**

J. K. Lappalainen, F. D. Tschopp, S. Prakhya, M. McGill, A. Nern, K. Shinomiya, S. Takemura, E. Gruntman, J. H. Macke, S. C. Turaga [Paper] [Code]

Built a PyTorch deep mechanistic network of 45,669 neurons (64 cell types, 1.51M synapses) constrained strictly by the Drosophila optic-lobe connectome graph. Task optimization for optic flow predicts single-neuron responses zero-shot across dozens of experimental studies.

JAXLEY: Differentiable simulation enables large-scale training of detailed biophysical models of neural dynamics — Nature Methods 2025 · Contributing co-author

M. Deistler, K. L. Kadhim, J. Beck, M. Pals, Z. Huang, M. Gloeckler, **J. K. Lappalainen**, C. Schröder, P. Berens, P. J. Gonçalves, J. H. Macke [Paper] [Code]

GPU/TPU-accelerated differentiable biophysical neural simulator in JAX enabling gradient-based optimization of multi-compartment models with hundreds of thousands of parameters.

Graph neural networks recover interpretable circuit models from neural activity — Preprint 2026 · Second author

C. Allier, **J. K. Lappalainen**, V. Kumar, S. Saalfeld [Code] [Project]

Structured GNN framework that jointly forecasts neural dynamics and recovers effective synaptic weights, neuron types, and causal perturbation responses even under severe connectivity noise.

Evaluating Generative Models & Simulation-Based Inference — TMLR 2024 · JOSS 2025 · JMLR sub.

Bischoff et al. (*TMLR* 2024, Paper); Boelts et al. (*sbi reloaded*, *JOSS* 2025, Paper); Deistler et al. (*SBI Practical Guide*, arXiv)

Systematic benchmarks of sample-based statistical distances (MMD, C2ST, Sliced-Wasserstein) and amortized Bayesian inference workflows for scientific simulators.

A theoretical framework to derive simple, firing-rate-dependent mathematical models of synaptic plasticity — Frontiers Comp. Neurosci. 2019 · First author

J. K. Lappalainen, J. Herpich, C. Tetzlaff [Paper] [Code]

RESEARCH & INDUSTRY EXPERIENCE

Shanahan Foundation Postdoctoral Fellow — 01/2026 – present

Allen Institute & University of Washington, Seattle — Independent, mentored by Dr. Forrest Collman & Prof. Adrienne Fairhall

- Developing large-scale ML models on Allen Institute data to uncover patterns in cortical circuits and link their structure to neural computation.
- Investigating with a research assistant how biological structure (cell types, sparse wiring, oscillatory inputs) shapes synaptic plasticity and long-horizon sequence learning.
- Advising robustness work (**NeurIPS 2026 Spotlight**, senior author); PI on NSF ACCESS compute allocation `CIS261112`.

Doctoral Researcher, Machine Learning in Science — 10/2020 – 10/2025

University of Tübingen & Max Planck Institute for Intelligent Systems (Prof. Jakob Macke), with HHMI Janelia (Dr. Srinivas Turaga)

- Created `flyvis` and led the flagship *Nature* (2024) study showing zero-shot neural activity prediction from connectomes via task-driven deep learning.
- Lead scientific contributor to the awarded ERC Starting Grant *DeepCoMechTome* (PI: Prof. Macke); co-authored *Nature Methods* (JAXLEY differentiable simulator), *TMLR* (generative model evaluation), and *JOSS* (`sbi`).
- Provided research guidance to 4 Ph.D. students and 1 postbac on follow-up projects building on the *Nature* work, and co-supervised 8 M.Sc./B.Sc. students and interns throughout Ph.D. (two now Ph.D. students in the lab).

Visiting Researcher 04/2019 – 10/2020
HHMI Janelia Research Campus, Ashburn, VA — Host: Dr. Srinivas C. Turaga

- Developed the initial PyTorch framework for multi-task optimization of connectome-constrained neural networks (M.Sc. thesis, High Distinction).

Machine Learning Intern & Graduate Research Projects 2017 – 2019
Celonis SE (Munich) & Technical University of Munich (Prof. Matthias Nießner, Prof. Laura Leal-Taixé, Prof. Jakob Macke)

- Industry ML internship at Celonis SE; graduate CV/ML projects in U-Net nerve segmentation, multi-agent trajectory GANs, and deep-network representational similarity.

OPEN-SOURCE SOFTWARE & TECHNICAL STACK

- **flyvis** (PyTorch · Creator · 215+ ★) — Deep mechanistic network framework for connectome-constrained neural network training. [Docs]
- **jaxley** (JAX · Contributor · 215+ ★) — GPU/TPU-accelerated differentiable simulator for large-scale biophysically and anatomically detailed neural network training.
- **flyvis-gnn** (PyTorch / GNN · Co-author) — Graph neural networks for recovering interpretable circuit models from neural activity. [Docs]
- **tensordir** (Python · xarray · Creator) — Content-addressed labeled tensor storage for reproducible multi-process HPC/ML pipelines.
- **datamate** (Python · Creator) & **sbi** (PyTorch · Contributor) — Filesystem-as-memory ML experiment management [Docs] and simulation-based Bayesian inference.

Stack & Methods: Python, PyTorch, JAX, xarray, Numba, SQL, Linux / Slurm HPC · Structured Deep Learning, Differentiable Simulation, Graph Neural Networks, Simulation-Based Inference, Mechanistic Interpretability, Adversarial Robustness.

EDUCATION

Dr. rer. nat. (Ph.D.), Machine Learning in Science — *summa cum laude* 2020 – 2026
University of Tübingen & Max Planck Research School for Intelligent Systems · Dissertation DOI · External reporters: Prof. H. Sebastian Seung, Prof. Julijana Gjorgjieva

M.Sc. Neuroengineering — High Distinction 2017 – 2020
Technical University of Munich

B.Sc. Physics — Distinction 2013 – 2017
University of Göttingen

SELECTED HONORS, TALKS & SERVICE

- **Honors & Compute Grants:** Shanahan Foundation Postdoctoral Fellowship (2026); PI, NSF ACCESS Allocation `CIS261112` (*FlyAdVis*, 2026); Aspirational Neuroscience Award (2025); Karl Schlecht Leadership Talent Academy Scholarship (2024).
- **Invited Talks:** Department of Neurobiology, JGU Mainz (2026); Computational Neuroscience Center, UW (2026); Princeton Neuroscience Institute (hosts: M. Murthy & H. S. Seung, 2024); Bernstein Conference Frankfurt (2024); EPFL Gerstner Lab (2024); Champalimaud Research Symposium (2021).
- **Service & Teaching:** Reviewer for NeurIPS 2026 and *PLOS Computational Biology*; Instructor, CAJAL NeuroAI Programme (Lisbon, 2025); Lead Lecturer, Computational Connectomics Seminar (Tübingen); Co-founder, *Healthy Minds* workshop series (Tübingen AI Center).

Updated November 2026