Leo Kozachkov

leokoz8@{gmail.com, brown.edu}

Current Affiliation

Howard E. Zimmerman Asst. Prof. of Engineering and Brain Science Aug 2025 –
School of Engineering
Carney Institute for Brain Science
Brown University, Providence, RI

Education

Doctor of Philosophy Sept 2017 – Nov 2022
Department of Brain and Cognitive Sciences
MIT, Cambridge, MA
Advisors: Earl K. Miller & Jean-Jacques Slotine

Bachelor of Science, Physics Sept 2012 – May 2016
Rutgers University, New Brunswick, NJ
- Minor in Mathematics

Papers

(*co-first author †co-senior author)

Eisen, A. J., Ostrow, M., Chandra, S., **Kozachkov, L.**, Miller, E. K., and Fiete, I. R. "Characterizing control between interacting subsystems with deep Jacobian estimation"
arXiv preprint (2025). [Link]

Keller, R., Tornell, A., Pei, F., Pitkow, X., **Kozachkov, L.**†, and Nayebi, A†. "Autonomous Behavior and Whole-Brain Dynamics Emerge in Embodied Zebrafish Agents with Model-based Intrinsic Motivation"
arXiv preprint (2025). [Link]

Eisen, A*., **Kozachkov, L*.**, Bastos, A., Donoghue, J., Mahnke, M., Brincat, S., Chandra, S., Brown, E., Fiete, I., Miller, E.K "Propofol anesthesia destabilizes neural dynamics across cortex"
Neuron (2024). [Link]

Shoji, L., Suzuki, K., and **Kozachkov, L.**. "Is All Learning (Natural) Gradient Descent?"
arXiv preprint (2024). [Link]

Tauber, J., Brincat, S., Stephen, E., Donoghue, J., **Kozachkov, L.**, Brown, E. and Miller, E.K. "Propofol mediated unconsciousness disrupts progression of sensory signals through the cortical hierarchy"
Journal of Cognitive Neuroscience (2023). [Link]

Ostrow, M., Eisen, A., **Kozachkov, L.**, and Fiete, I. "Beyond Geometry: Comparing the Temporal Structure of Computation in Neural Circuits with Dynamical Similarity Analysis"
Neural Information Processing Systems (2023). [Link]

Kozachkov, L., Kastanenka, K.V., and Krotov, D. "Building Transformers from Neurons and Astrocytes".
Proceedings of the National Academy of Sciences (2023). [Link]

Kozachkov, L., Wensing, P., and Slotine, J.-J. "Generalization as Dynamical Robustness: The Role of Riemannian Contraction in Supervised Learning".
Transactions of Machine Learning Research (2023). [Link]

Kozachkov, L*., Tauber, J*., Brincat, S., Slotine, J.-J., and Miller, E.K. "Robust and Brain-Like Working Memory through Short-Term Synaptic Plasticity".
PLoS Computational Biology (2022). [Link]

Kozachkov, L., Slotine, J.-J. "Matrix Measure Flows: A Novel Approach to Stable Plasticity in Neural Networks".
arXiv preprint (2022). [Link]

Kozachkov, L*., Ennis, M*., and Slotine, J.-J. "RNNs of RNNs: Recursive Construction of Stable Assemblies of Recurrent Neural Networks".
Neural Information Processing Systems (2022). [Link]

Kozachkov, L*., Lundqvist, M*., Slotine, J.-J., and Miller, E.K. "Achieving stable dynamics in neural circuits".
PLoS Computational Biology (2020). [Link]

Kozachkov, L., Michmizos, K. "Sequence learning in Associative Neuronal-Astrocytic Networks".
13th International Conference on Brain Informatics (2020). [Link]

Kozachkov, L., Michmizos, K. "The causal role of astrocytes in slow-wave rhythmogenesis: A computational modelling study".
arXiv preprint (2017). [Link]

Research Experience

Goldstine Postdoctoral Fellow July 2024 – 2025
IBM Research
IBM Thomas J. Watson Research Center
Yorktown Heights, NY

MIT-IBM Watson AI Lab May 2022 – August 2022
IBM Research
MIT-IBM Watson AI Lab Summer Research Intern
Research Advisor: Dmitry Krotov

- Developed a biologically plausible implementation of Transformer models, based on neurons and astrocytes. Provided a mathematical/computational argument that neuron-astrocyte networks in the brain can perform Transformer-like computations.

Miller Lab + Nonlinear Systems Lab Sept 2018 – November 2022
Department of Brain and Cognitive Sciences
Graduate Student
Research Advisor(s): Prof. Earl K. Miller & Jean-Jacques Slotine

- Developed a theoretical framework using tools from control theory to understand the role of dynamic stability in neural computations. Validated theory by comparing directly to neural data taken from frontal lobe of non-human primate performing a working memory task.

Laboratory for Computational Brain April 2016 – August 2017
Department of Computer Science
Research Assistant

Research Advisor: Prof. Konstantinos Michmizos

- Designed simulations to elucidate the role of low-frequency glial calcium waves in modulating large neural populations.
- Developed minimal, neurophysiologically plausible models of glia-neuron and glia-synapse interactions.

Sengupta Lab Sept 2015 – May 2016
Department of Physics and Astronomy
Senior Honors Thesis Student
Thesis Advisor: Prof. Anirvan Sengupta

- Modeled and analyzed the effects of epigenetic chromatin silencing on *Neurospora Crassa* circadian rhythm.

Computational Vision and Psychophysics Lab Sept 2015 – Feb 2016
Department of Psychology, Center for Cognitive Science
Research Assistant
Research Advisor: Prof. Melchi Michel

- Studied the effects of intrinsic position uncertainty on search times in object identification tasks for natural, cluttered images.

Shinbrot Lab Summer 2014
Department of Biomedical Engineering
Research Assistant
Research Advisor: Prof. Troy Shinbrot

- Developed an Ising-like model to simulate spontaneous tribocharging of similar materials. Research was presented at American Physical Society, 2015.

Laboratory of Vision Research Sept 2013 – May 2014
Rutgers Center for Cognitive Science
Aresty Research Assistant
Research Advisor: Prof. Thomas V. Papathomas

- Studied the 3-D perception of faces and scenes. Research presented at the Aresty Undergraduate Research Symposium. Poster.

Academic Service

Reviewer, [Physical Review Letters] (2025), [ICLR] (2025), [TMLR] (2025); Reviewer, [Science Advances] (2024); Reviewer, [TMLR] (2024); Reviewer, [ICLR Main Conference] (2024); Reviewer, [NeurIPS Main Conference] (2024); Reviewer, [CogSci 2024] (2024); Reviewer, [6th Annual Learning for Dynamics & Control Conference (L4DC)] (2024); Reviewer, [Neural Computation] (2024); Reviewer, [NeurIPS Workshop: Associative Memory and Hopfield Networks] (2023); Program Committee Member, [NeurIPS Workshop: Associative Memory and Hopfield Networks] (2023); Reviewer, [COSYNE 24] (2023); Reviewer, [PLOS Computational Biology] (2023); Reviewer, [Mathematical Population Studies] (2023)

Teaching & Mentoring Experience

Mentor May 2022 – Present
Mitchell Ostrow
MIT Graduate Student

Mentor May 2020 – Present
Adam Joseph Eisen
MIT Graduate Student

Mentor May 2020 – Sept 2020

Emily Huang
Undergraduate Summer Researcher

Teaching Assistant Spring 2019, 2020
MIT 9.53
Emergent Computations in Distributed Neural Circuits

Part-Time Lecturer Sept 2015 – Dec 2015
Rutgers Physics 206
General Physics Lab

Talks

September 18 2023: Mathematical Challenges in Neuronal Network Dynamics, ICERM, RI (Lightning Talk)

September 07 2023: SynAGI Group, IBM Research, NY

October 26 2022: NeuroAI Lab, Stanford University, CA

October 20 2022: Francesco Bullo Group, University of Santa Barbara, CA

September 01 2022: Center for Computational Neuroscience, Flatiron Institute, New York

Honors & Awards

NeurIPS Scholar Award 2022

Singleton Fellowship 2021-2022

Best Paper Award, 1st Runner Up, 13th International Conference on Brain Informatics 2020

Paul Robeson Scholar, School of Arts and Sciences 2016

Dean's List 2013 – 2014 – 2015 – 2016

Bronze Medal, University Physics Competition 2014

Research Assistant Award, Aresty Research Center 2013 – 2014
- 29% acceptance rate.

Writers Foundation Award 2012
- For "excellence in creative writing."

Conferences

Kozachkov, L., et al. "RNNs of RNNs" Mathematical Challenges in Neural Network Dynamics Workshop, 2023, ICERM, Providence, RI.

Kozachkov, L., et al. "Robust and Brain-Like Working Memory Through Short-Term Synaptic Plasticity" Gordon Conference on Neurobiology, 2022, ME.

Kozachkov, L., et al. "Dynamic stability underlies cortical computations during working memory" Society for Neuroscience 2021, Chicago, IL.

Eisen, A., **Kozachkov, L.**, et al. "Propofol anesthesia changes dynamic stability in cortex" Society for Neuroscience 2021, Chicago, IL.

Kozachkov, L., Michmizos, K. "Sequence learning in Associative Neuronal-Astrocytic Network" 13th International Conference on Brain Informatics, 2020.

Kozachkov, L., et al. "Achieving and using stability in neural circuits" Society for Neuroscience 2019, Chicago, IL.

Kozachkov, L., et al. "Combination and Stability Properties of Echo-State Networks" Society for Neuroscience 2018, San Diego, CA.

Kozachkov, L., Michmizos, K. "A Biomimetic Neural-Astrocytic Network: Adding a Slow Layer for Fast Information Processing" NICE 2017, Dayton, Ohio.

Shinbrot T, **Kozachkov, L.**, Siu T. "A nonlinear feedback model for granular and surface charging." Applied Physics Society Meeting, 2015, San Antonio, TX.

Technical skills

Languages: Python, MATLAB

Packages: PyTorch, PyTorch Lightning, scikit-learn, NumPy, SciPy, LaTeX

Developer Tools: Git, Windows Subsystem for Linux (WSL)

Mathematics (Selected Topics): Nonlinear Control Theory, Dynamical Systems Theory, Linear Algebra, Calculus, ODEs, PDEs, Mathematical Theory of Statistics & Probability, Statistical Learning Theory

Extra-Curricular Activites

Staff Writer 2013 – 2015
Applied Sentience
Rutgers University

- Published monthly articles on science, philosophy, mathematics, and literature.