

Leo Kozachkov

Pronounced ‘Cause-Itch-Cove’
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CURRENT AFFILIATION *Postdoctoral Associate* Dec 2022 – Present
McGovern Institute for Brain Research
MIT, Cambridge, MA
PI: Guangyu Robert Yang

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 Tauber, J., Brincat, S., Stephen, E., Donoghue, J., **Kozachkov, L.**, Brown, E., 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.**, 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., & Krotov, D. “Building Transformers from Neurons and Astrocytes”.
Proceedings of the National Academy of Sciences (2023). [\[Link\]](#)

Kozachkov, L., Wensing, P., & 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., & 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 (2022). [\[Link\]](#)

Kozachkov, L., Ennis, M., 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., & 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 rhyth-mogenesis: A computational modelling study”.
arXiv (2017). [\[Link\]](#)

RESEARCH EXPERIENCE

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. Pappathomas

- Studied the 3-D perception of faces and scenes. Research presented at the Aresty Undergraduate Research Symposium. [Poster](#).

**ACADEMIC
 SERVICE**

Reviewer 2023
 NeurIPS Workshop
 Associative Memory and Hopfield Networks

Program Committee Member 2023
 NeurIPS Workshop
 Associative Memory and Hopfield Networks

Reviewer 2023
 COSYNE

Reviewer 2023
 PLOS Computational Biology

Reviewer 2023
 Mathematical Population Studies

**TEACHING &
 MENTORING
 EXPERIENCE**

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

Mentor May 2020 – Sept 2020
 Emily Huang
 Undergraduate Summer Researcher

Mentor May 2020 – Present
 Adam Joseph Eisen
 MIT Graduate Student

Mentor May 2022 – Present
 Mitchell Ostrow
 MIT Graduate Student

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, L^AT_EX

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
ACTIVITIES**

Staff Writer

2013 – 2015

Applied Sentience

Rutgers University

- Published monthly [articles](#) on science, philosophy, mathematics, and literature.