# 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, Brain and Cognitive Sciences* — Sept 2017 – Nov 2022
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

**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]

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"
*bioRxiv* (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"
*arXiv* (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 rhythmogenesis: A computational modelling study".
*arXiv* (2017). [Link]

## Invited Talks

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. "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

## Teaching 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

## Research Experience

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

- Developing theoretical framework using tools from control theory to understand the role of dynamic stability in neural computations.
- Helping conduct/analyze electrophysiological experiments with non-human primates to understand the role of stability in cortical computations underlying working memory.

*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.

## Extra-Curricular Activites

*Research Intern* 2022 – 2022
MIT-IBM Watson AI Lab
IBM Research

*Lifeguard* 2012 – 2013 – 2014 – 2015
Candlewood Management Service Inc

*Custodian* Jan 2011 – June 2011
Raritan Valley YMCA East Brunswick, NJ

*Staff Writer* 2013 – 2015
Applied Sentience
Rutgers University

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

*Lifeguard* 2012 – 2013 – 2014 – 2015
Candlewood Management Service Inc

*Custodian* Jan 2011 – June 2011
Raritan Valley YMCA East Brunswick, NJ