Leo Kozachkov

Pronounced 'Cause-Itch-Cove'
leokoz8@{gmail.com, ibm.com}

CURRENT AFFILIATION

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

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)

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]

Kozachkov, L., Slotine, J.-J., and Krotov, D. "Neuron-Astrocyte Associative Memory"
arXiv (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 (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 (2017). [Link]

RESEARCH EXPERIENCE	*MIT-IBM Watson AI Lab*	May 2022 – August 2022

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   2024
NeurIPS Main Conference

Reviewer   2024
CogSci 2024

Reviewer   2024
6th Annual Learning for Dynamics & Control Conference (L4DC)

Reviewer   2024
Neural Computation

Reviewer   2023
NeurIPS Workshop
Associative Memory and Hopfield Networks

Program Commitee Member   2023
NeurIPS Workshop
Associative Memory and Hopfield Networks

Reviewer   2023
COSYNE 24

Reviewer   2023
PLOS Computational Biology

Reviewer   2023
Mathematical Population Studies

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* Applied Sentience Rutgers University	2013 – 2015

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