

Benjamin Kuznets-Speck, Ph.D.

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Work Experience

Postdoctoral Research Fellow — Adilson Motter Group

Center for Network Dynamics, Northwestern University, Dept. of Physics - Evanston, IL
August 2023 to Present

I leverage machine learning on high-throughput next generation sequencing data to predict/classify disease states and infer significant causal genes associated with complex immune diseases. I have developed a machine learning pipeline that learns groups of genes significant to classifying disease states from gene expression data. My pipeline uses a variety of modern machine learning techniques from variational auto-encoders to classify expression profiles and generate new ones with disease features, to deep neural network classifiers to learn networks of disease genes from gene correlations. We are currently preparing this work for publication.

Postdoctoral Researcher — Michael DeWeese Group

University of California, Berkeley, Dept. of Physics - Berkeley, CA
May 2023 to August 2023

Counterdiabatic free energy estimation with optimal control, controlling evolution with neural networks.

Graduate Research Fellow — Carlos Bustamante Lab

Kavli Energy Nano Science Institute, University of California, Berkeley- Berkeley, CA
March 2022 to May 2023

Experimental tests of speed limits on single molecule transitions; experiments, simulations and data analysis pipeline development for single molecule force spectroscopy to study protein folding.

Graduate Research Assistant — David Limmer Group

University of California, Berkeley, Dept. of Chemistry - Berkeley, CA
August 2019 to March 2022

Speed limits on accelerating collective phenomena and the energetic cost to do so; generative design/control of noisy systems with reinforcement learning, model-free transition rate inference.

Research Assistant — Michael Hinczewski Group

Case Western Reserve University, Dept. of Physics - Cleveland, OH
August 2015 to May 2018

Using non-equilibrium statistical mechanics to map trade-offs in speed, cost and information transfer in living cells; steering evolution in clonal populations, stochastic control of biophysical networks.

Education

Ph.D. in Biophysics — University of California, Berkeley. September 2018 to May 2023
Thesis - Mountains and rivers: rare events in noisy systems and the forces that shape them

Batchelor of Science in Math and Physics, summa cum laude, honors, 3.98 GPA
Case Western Reserve University. September 2014 to May 2018

Skills

- Next Generation Sequencing and large scale omics datasets
- Machine Learning for Biology and Physics
- Statistical and Nonequilibrium Physics
- Python, PyTorch, NumPy, Pandas, R
- Statistical Analysis and Inference
- Molecular Biology and Biophysics
- Protein structure and dynamics
- Multi-scale Simulations and Sampling Algorithms
- Optimal control theory

Links

<https://www.benkuznets-speck.com>
<https://www.linkedin.com/in/ben-kuznets-speck-3a0061107>

Awards

Kavli Energy Nano Science Institute Graduate Fellow - March 2022

Hertz Foundation Fellowship Finalist (1 of 40 nationwide) - February 2019

Donald A. Glaser Award: for outstanding Sr. Math and Physics student - May 2018

Barry Goldwater Scholar (national award) - March 2017

Albert A. Michelson Prize: for outstanding Jr. Math and Physics student - May 2017

Publications

A. Zhong*, B. Kuznets-Speck* & M. R. DeWeese, 'Time-Asymmetric Protocol Optimization for Efficient Free Energy Estimation,' arXiv:2304.12287, 2023.

B. Kuznets-Speck & D. T. Limmer, 'Inferring equilibrium transition rates from nonequilibrium protocols,' Biophysical Journal, 2022.

A. Das*, B. Kuznets-Speck* & D. T. Limmer, ‘Direct evaluation of rare events in active matter from variational path sampling, Phys. Rev. Lett., 2022.

E. Ilker et al., ‘Shortcuts in Stochastic Systems and Control of Biophysical Processes,’ Phys. Rev. X, 2022.

B. Kuznets-Speck & D. T. Limmer, ‘Dissipation bounds the amplification of transition rates far from equilibrium’ Proc. Natl. Acad. Sci., 2021.

T. Wang, B. Kuznets-Speck, J. Broderick & M. Hinczewski, ‘The price of a bit: energetic costs and the evolution of cellular signaling,’ biorxiv. 2020. In revision at eLife.

S. Iram et al., ‘Controlling the speed and trajectory of evolution with counterdiabatic driving,’ Nature Physics, 2020.

A.W. Eckford, B. Kuznets-Speck, M. Hinczewski & P.J. Thomas, ‘Thermodynamic properties of molecular communication,’ IEEE, 2018.

Conferences and Public Speaking

American Physical Society Annual Meeting, 2022. — *Shaping rare events away from equilibrium: bounds on transition rate enhancement and a new take on optimal control of reaction rates.*

Berkeley Statistical mechanics meeting, 2022. — *Beyond Bell's law: model free transition rate estimation from nonequilibrium trajectories.*

Compass Physics Lecture, UC Berkeley, Fall 2021. — *Bringing the heat: dissipation bounds transition rates far from equilibrium.*

American Physical Society Annual Meeting, 2021. — *Bringing the heat: dissipation bounds transition rates far from equilibrium.*

Second Workshop On Stochastic-thermodynamics (WOSTII), Santa Fe Institute, 2021. — *Bringing the heat: dissipation bounds transition rates far from equilibrium.*

Berkeley Statistical mechanics meeting, 2020. — *Taking transition state theory for a drive.*

Biophysics graduate group retreat, Berkeley, CA, 2019. — *Taking transition state theory for a drive.*

Biophysical Society Annual Meeting, San Francisco, CA, 2018 — *The price of a bit: energetic costs and the evolution of cellular signaling.*