Benjamin Ruben

Biophysics PhD Student

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Education

Harvard University — *Cambridge, MA*

PhD Biophysics — *September 2020 - Present*

- Advisor: Dr. Cengiz Pehlevan
- Rotation Advisors: Dr. Leonid Mirny, Dr. David Nelson

Rice University — *Houston, TX*

BS Physics; BS Chemical Physics; BA Mathematics — *August 2016 - May 2020*

- *summa cum laude*
- *Phi Beta Kappa*
- Advisor: Dr. Jose Onuchic

Publications

Articles

Benjamin S. Ruben, Cengiz Pehlevan, "Learning Curves for Noisy Heterogeneous Feature-Subsampled Ridge Ensembles," in Advances in Neural Information Processing Systems (NeurIPS), 2023

Benjamin S. Ruben, Vinicius Contessoto , Michele Di Pierro, Ryan Cheng, Jose Onuchic; "Structural Reorganization and Relaxation Dynamics of Axially Stressed Chromosomes," Biophysical Journal, 2023

J. A. Zavatone-Veth, A. Canatar, **Benjamin S. Ruben**, and C. Pehlevan, "Asymptotics of representation learning in finite Bayesian networks," in Advances in Neural Information Processing Systems (NeurIPS), 2021

Awards and Fellowships

2020	**Distinction in Research and Creative Work**, Rice University	
	Wagoner Foreign Study Scholarship (declined), Rice University	*$ 13,970*
	Bonner Book Award*, Rice University Department of Physics and Astronomy	*$ 750*
2019	**Summer Undergraduate Research Fellowship**, Rice University Department of Physics and Astronomy	*$ 5,300*
	Bonner Book Award*, Rice University Department of Physics and Astronomy	*$ 750*
2018	**Best Overall Project**, TREND REU at University of Maryland	
	Best Multimedia Project, TREND REU at University of Maryland	
	Bonner Book Award*, Rice University Department of Physics and Astronomy	*$ 750*
2016-2020	**President's Honor Roll**, Rice University	

***"Given each year to the most outstanding sophomore, junior, senior, and first year graduate students in physics"**, see https://physics.rice.edu/graduate-awards

Research Experience

PhD Thesis Research *Cambridge, MA*

Advisor: Dr. Cengiz Pehlevan *Spring 2021-Present*

- Working in the Phelevan group, my research has focused on understanding the effect of biological constraints on the capacity for neural networks to learn. This includes investigating the role of sparse neural connectivity, heterogeneity between neurons, and the structure of population codes in biological learning.

PhD Rotation *Cambridge, MA*

Advisor: Dr. David Nelson *Fall 2021*

- In a rotation with the Nelson group, I performed lattice-model simulations of cell growth to study the demixing of antagonistic bacterial species in bacterial range expansions.

PhD Rotation *Cambridge, MA*

Advisor: Dr. Cengiz Pehlevan *Summer 2021*

- During a rotation with the Pehlevan Group, I studied representation learning in deep Bayesian neural networks, and derived novel expressions describing representation learning in deep convolutional neural networks. My contribution was added to a manuscript now published in NeurIPS, and I have since joined the Pehlevan Group for my PhD research.

PhD Rotation *Cambridge, MA*

Advisor: Dr. Leonid Mirny *Spring 2021*

- Rotating with the Mirny group, I used molecular dynamics simulations to investigate mechanisms of chromatin compaction in molecular dynamics simulations of active polymers.

Rice University Center for Theoretical Biological Physics *Houston, TX*

Advisor: Dr. Jose Onuchic *2018 - 2020*

- For my undergraduate thesis, I used molecular dynamics simulations to study the mechanical properties of chromosomes. Mitotic chromosomes are remarkably extensible objects, which can be reversibly stretched to many times their native length. This high degree of ”stretchiness” had previously been attributed to the extensibility of chromatin fibers. However, in the decades since this hypothesis, our understanding of chromosome organization has been revolutionized by the advent of Hi-C conformation capture techniques, which measure detailed contact maps of chromosomes’ folded conformations. Recent computational models of chromosome structure have been evaluated through their ability to accurately predict these contact maps. Their mechanical properties, however, remained obscure. In simulations of chromosome stretching, I characterized the mechanical properties of model chromosomes. Using a novel structural analysis, I found that model chromosomes stretch through the opening of large-scale chromosome folding, while small-scale structure is unperturbed. This work resulted in a paper published in the Biophysical Journal.

Training and Research Experience in Nonlinear Dynamics (NSF REU), University of Maryland *College Park, MD*

Advisors: Edward Ott, Tom Antonsen, Michelle Girvan *Summer 2018*

- Natural systems like spin-lattices, cardiac muscle, and neural networks consist of a large a large number of interacting individuals. The Kuramoto model is a simplified representation of such systems, describing a population of globally coupled oscillators. With my project partner, I used nonlinear dynamical systems theory and numerical simulations to study a generalization of the Kuramoto Model to systems of higher-dimensional oscillators (which can be understood as unit vectors on spheres of any dimension). Specifically, my project addressed the question of how agents with a natural tendency to repel each other can be forced to synchronize their motion by coupling to a shared leader. After presenting at the TREND research fair, my project partner and I won awards for ”best overall project” and ”best multimedia project.”
- Multimedia Project: terpconnect.umd.edu/ dsvolpe/TREND/2018/Media/OrtizTavarezandRuben/MPOrtizTavarezandRuben/oscillators.html
- Recorded presentation: https://www.youtube.com/watch?v=4b2v7NOjTEE

National Human Genome Research Institute, National Institutes of Health *Bethesda, MD*

Advisor: Dr. Daniel Kastner *Summers 2015, 2016, 2017*

- Carried out projects investigating the genetics and pathology of autoinflammatory diseases, learning wet-lab techniques such as sanger sequencing, flow cytometry, and western blot.
- Shadowed doctors in the clinic seeing patients with rare or undiagnosed autoinflammatory diseases

Presentations

Contributed Presentations

Benjamin S. Ruben, Vinícius G. Contessoto , Michele Di Pierro, Ryan Cheng, Antonio B. Oliveira Junior, José N. Onuchic. 2023. *Structural Reorganization and Relaxation Dynamics of Axially Stressed Chromosomes*. APS March Meeting.

Posters

Benjamin S. Ruben, Vinícius G. Contessoto , Michele Di Pierro, Ryan Cheng, Antonio B. Oliveira Junior, José N. Onuchic; *Structural Reorganization and Relaxation Dynamics of Axially Stressed Chromosomes*. APS March Meeting, July 29, 2019

Benjamin S. Ruben, Vinícius G. Contessoto , Michele Di Pierro, Ryan Cheng, José N. Onuchic; *Pulling on a Theoretical Model for Chromosome Folding*. ORBItS research fair, July 29, 2019

Benjamin S. Ruben, José M. Ortiz Tavárez, T. M. Antonsen, S. Chandra, M. Girvan, E. Ott; *Herding Cats: Inducing Cooperation of Uncooperative Multi-Dimensional Agents*. TREND research fair, August 10, 2018

Benjamin Ruben, Natalia Sampaio Moura, Oskar Schnappauf, JaeJin Chae, Ivona Aksentijevich, Massimo Gadina, Daniel Kastner; *Quantitative Assessment of Inflammasome Formation: ASC Speck Analysis by Flow Cytometry*. NIH Summer Poster Day, August 10, 2017

Sharon Sun, Sabeer Pourmotabbed, **Benjamin Ruben**, Yuming Zhao, Jesse Liebman; *Music and Geometry*. Rice Geometry Lab poster presentation December 1, 2017.

Benjamin Ruben, Natalie Deuitch, Daniel Kastner, Ivona Aksentijevich; *Search for Cryptic Second CECR1 Mutations in Families with Deficiency of ADA2 (DADA2)*. NIH Summer Poster Day July 29, 2016.

Benjamin Ruben, Kevin Bishop, Monique Stoffels, Daniel Kastner; *Studying Defects in Development in Embryonic Lethal TRNT1 Homozygous Zebrafish by In Situ Hybridization*. NIH Summer Poster Day August 6, 2015.

Teaching Experience

Spring 2024	**Applied Math 50: Introduction to Applied Mathematics**, Teaching Fellow	*Harvard*
Fall 2022	**Applied Math 226: Theory of Neural Computation**, Teaching Fellow	*Harvard*
Spring 2022	**Physics 181: Statistical Physics**, Teaching Fellow	*Harvard*
Fall 2021	**Applied Physics 50A: Physics as a Foundation for Science and Engineering**, Teaching Fellow	*Harvard*

Service & Professional Development

Professional Memberships

Phi Beta Kappa

Service

Fall 2018-Spring 2020	**Academic Fellow in Physics**, Volunteered as a tutor for students in introductory physics classes.	*Rice*
Spring 2018	**Mission: Wolf Service Trip**, one-week trip with with the Rice Wildlife Conservation Corps to volunteer at a wolf sanctuary in Colorado	