

# Nilai M. Sarda

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<b>Research Interests</b>	I am interested in the intersection of computational and statistical methods with problems in high-energy phenomenology and condensed matter physics.	
<b>Education</b>	<b>Massachusetts Institute of Technology</b> , Cambridge, MA, USA <i>Computer Science &amp; Artificial Intelligence Laboratory</i>  M.Eng., Computer Science (expected: May, 2020) <i>Concentration: Machine Learning and Artificial Intelligence</i> Thesis: “On anomaly detection at particle colliders” Advisor: Justin Solomon GPA: 5.0/5.0 B.S., Computer Science (expected: May, 2020) <i>Minors: Physics, Mathematics</i> GPA: 4.9/5.0	
<b>Research Experience</b>	<b>Research Assistant</b> <i>Computer Science and Artificial Intelligence Laboratory, MIT</i> <i>Advisor: Justin Solomon</i>  I am applying techniques for anomaly detection to datasets over point clouds (e.g., di-jet events, stellar velocity distributions, flow cytometry readings). We use the sliced Wasserstein distance to induce a kernel over the space. Part of my work involves understanding and bounding the error induced by low-rank and Nystrom approximations to this kernel, as it is expensive to compute. I am also developing tools to perform robust ecological inference and learning in noisy settings.	<b>Fall 2019 - present</b>
	<b>Undergraduate Researcher</b> <i>Center for Theoretical Physics, MIT</i> <i>Advisor: Jesse Thaler</i>  I am searching for signatures of new physics in simulated LHC data with unsupervised methods. I leverage the factorized structure of hard QCD processes to fit nonparametric mixture models to common observables (e.g., jet mass, n-subjettiness). In addition, I am learning disentangled and separable embeddings of jets with deep learning models that aim to mimic the factorized generative process. This research was presented at the	<b>Fall 2019 - present</b>

ML4Jets conference in January 2020.

**Undergraduate Researcher**

**Fall 2019 - present**

*Kavli Institute for Astrophysics, MIT*

*Advisor: Mark Vogelsberger*

I am modeling the structure and formation of the cosmic web in the Illustris-TNG simulation, and comparing it with observed cosmological data. First, I am statistically comparing the cosmic web from Illustris with that of other simulations. Using structured autoencoders, I will then use the location of galaxy clusters to infer the Sunyaev-Zeldovich spectrum of the interstellar medium, and predict the location of hot gas filaments.

**SuperUROP Scholar**

**Fall 2018 - Spring 2019**

*Computer Science and Artificial Intelligence Laboratory, MIT*

*Advisor: Justin Solomon*

I used the notion of Ricci flow on discrete metric spaces to perform unsupervised graph clustering. Using a definition of discrete Ricci curvature based on optimal transport theory, we demonstrated results competitive with state-of-the-art on a difficult natural language processing problem. This work was awarded a Best Poster prize at the MIT SuperUROP Showcase.

**Undergraduate Researcher**

**Spring 2019**

*Department of Brain and Cognitive Sciences, MIT*

*Advisor: Joshua Tenenbaum*

My goal was to understand human intuition in complex deductive reasoning games. I formulated a particle-filter inspired method to model how humans play the game Avalon, a cooperative-exploitative party game. We implemented the model, then collected human data from two study groups to learn the optimal parametrization to defeat experts.

**Undergraduate Researcher**

**Fall 2017 - Spring 2018**

*Media Lab, MIT*

*Advisor: Joe Jacobsen*

I applied supervised deep learning methods to improve the virtual screening of drug molecules. I created a convolutional neural network to predict binding affinity given crystallographic structure, leveraging the physical characteristics of individual atoms. I also helped write an annealing-based docking algorithm to find optimal receptor-ligand conformations.

**Research Intern**

**Fall 2015 - Spring 2016**

*Department of Chemical Engineering, Georgia Tech*

*Advisor: Rigoberto Hernandez*

I studied computationally the structure and formation of clusters in electrically-charged striped nanoparticles. I wrote C++ codes to optimally distribute charge over the surface of the nanoparticles *in silico* and simulate an equilibration procedure using LAMMPS. I then analyzed the compressibility and stability of the resulting colloid. This work was

awarded an Intel STS Semifinalist prize.

<b>Academic Experience</b>	<b>Instructor/TA</b> <i>6.176, Pokerbots</i> I led the game theory and engine development teams for the Pokerbots class and competition. I was responsible for designing and coding a custom poker variant for which students would develop AI-based bots. I also co-taught lectures and ran bi-weekly office hours.	<b>IAP 2019, 2020</b>
	<b>Grader</b> <i>6.437, Inference and Information</i> I was one of two graders for this graduate-level seminar as a sophomore. I was responsible for grading 60+ problem sets per week.	<b>Spring 2018</b>
<b>Preprints and publications</b>	<b>On anomaly detection at particle accelerators.</b> <i>N. Sarda</i> <i>Thesis submitted in partial fulfillment of requirements for a Master in Engineering from MIT.</i>	
	<b>Stochastic sliced wasserstein kernels.</b> <i>J. Solomon., S. Power, A. Baggag, N. Sarda, Y. Wang</i>	
	<b>Factorized anomaly detection for particle physics.</b> <i>P. Komiske, E. Metodiev, N. Sarda, J. Thaler</i>	
<b>Presentations</b>	<b>Factorized jet learning</b> Presentation at ML4Jets 2020, NYU	<b>January 2020</b>
	<b>Group Anomaly Detection in Flow Cytometry Data</b> Poster at MIT-QCRI Annual Meeting, MIT	<b>October 2019</b>
	<b>Discrete Ricci Flow for Word Sense Induction</b> Poster at SuperUROP Showcase, MIT	<b>May 2019</b>
<b>Honors and Awards</b>	<i>Tau Beta Pi Honor Society</i>	<b>2019</b>
	<i>SuperUROP Top Student Poster Award</i>	<b>2019</b>
	<i>Intel Science Talent Search (Semifinalist)</i>	<b>2016</b>
	<i>International Linguistics Olympiad (2x Bronze Medal, Best Solution)</i>	<b>2013, 2015</b>
	<i>United States Physics Olympiad (Silver Medal)</i>	<b>2015</b>

*United States Chemistry Olympiad (Honorable Mention)* 2015  
*United States Mathematics Olympiad (Honorable Mention)* 2015

**Grants and Scholarships** *SuperUROP Undergraduate Research and Innovation Scholar* 2019  
*Thomas J Watson Scholarship* 2016, 2017, 2018  
*National Merit Semifinalist* 2016  
*National Honor Society* 2016