Dylan Hirsch | Curriculum Vitae

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I am a third-year Ph.D. student in Mechanical and Aerospace Engineering at UC San Diego, working with Dr. Sylvia Herbert and Dr. Boris Krämer. I have independent training in both control theory and computational biology, and I particularly enjoy doing research at their intersection. I currently work on using model reduction and learning techniques to increase the scalability and functionality of Hamilton-Jacobi Safety Analysis, a tool for safe control of nonlinear systems. The methods we are constructing are geared toward leveraging patient-specific pharmacological models for designing drug dosing regimens that balance safety and efficacy in a mathematically optimal fashion. This project fits into my broader research vision of using models, data, and algorithms to lessen the guess-work involved in bioscience and medicine.

Education

University of California, San Diego
Ph.D., Mechanical Engineering *Sep. 2020 - Present*
Research Advisors: Sylvia L. Herbert and Boris M. Krämer
Research Topic: Theoretical and computational methods for safe control and model reduction, with biomedical applications
GPA: 4.0/4.0

Massachusetts Institute of Technology
S.M., Biological Engineering *Sep. 2020 - Aug. 2023*
Resarch Advisor: Domitilla Del Vecchio
Research Topic: Feedback control in biomolecular circuits
Thesis: Mathematical modeling and endogenous ratiometric control of isogenic cell populations engineered with synthetic bistable circuits
Teaching: 20.430 (Fields, Forces, and Flows in Biological Systems, BE/ME/EECS/HST)
GPA: 4.9/5.0

Johns Hopkins University
B.S., Biomedical Engineering *Sep. 2014 - Dec. 2017*
Resarch Advisor: Rachel Karchin
Research Topic: Machine Learning for predicting cancer immunotherapy outcomes
Minor: Computational Biology
GPA: 3.97/4.0

Additional Research Experience

John Tsang Lab
National Institutes of Health *Jul. 2018 - Jun. 2020*
Role: Post-baccalaureate research trainee (full-time)
Project: Multi-omics characterization of monogenic immune patients

Rachel Karchin Lab
Johns Hopkins University *Jan. - Jun. 2018*
Role: Research assistant (full-time)
Project: Investigating anti-PD1 response through TCR sequencing

Christina Leslie Lab
Memorial Sloan Kettering Cancer Center *Jun. - Aug. 2017*
Role: Undergraduate summer research intern
Project: Statistical learning for exploring exhausted T cell transcriptional landscapes

Highlighted Graduate-Level Coursework

Real Analysis
Measure Theory, General Topology, Functional Analysis, Fourier Analysis, Distribution Theory
UCSD MATH 240ABC

Functional Analysis
Topological Vector Spaces, Convexity, Spectral Theory
UCSD MATH 241A

Partial Differential Equations
Representation Formulas, Linear Theory, Nonlinear Theory
UCSD MATH 231ABC

Control Theory
Linear Control, Nonlinear Control, Optimal Control, Model Reduction, Control of Biomolecular Systems
MIT 2.152, 2.18, 6.241; UCSD MAE 274, 281AB, 288A

Quantitative and Computational Biology
Machine Learning, Network Analysis, Biophysics, Modeling & Simulation, Quantitative Neuroscience
JHU CHBE 540.63; MIT 7.81, 20.420, 20.430, 7.81; UCSD BENG 219, 276

Honors and Awards

2025: ARCS Foundation Scholar (∼$10,000 total)
2024: UCSD Interfaces Training Grant Awardee (∼$88,000 total)
2022: Teaching Assistant of the Year, MIT Bioengineering
2020: NSF Graduate Research Fellow (∼$140,000 total)
2018: NIH Post-Baccalaureate Intramural Research Training Award
2018: JHU School of Engineering Richard J. Johns Award
2018: JHU Departmental Honors in Biomedical Engineering
2017: JHU General Honors
2017: NIH Cancer Systems Biology Consortium Summer Program Grantee
2016: Tau Beta Pi National Engineering Honors Society
2014-2017: JHU, Dean's List (all semesters)

Outreach and Volunteering

UCSD RoboGrads: Outreach chair (2024 - present)
MIT BE DEI Working Groups: Graduate student representative (2020 - 2023)
College Bound (Washington D.C.): Student mentor / tutor (2019 - 2020)
Thread Tutoring and Mentoring (Baltimore): Student mentor / tutor (2019 - 2020)
Engineering Design Outreach (Barclay Middle School, Baltimore): Project assistant (2016 - 2018)
JHU Relay for Life: Executive board chair, sponsorship committee chair (2015 – 2017)

Publications

[1] Dylan Hirsch, Jaime Fernández Fisac, and Sylvia Herbert. *Viscosity CBFs: bridging the control barrier function and Hamilton-Jacobi reachability frameworks in safe control theory*. In: *Submitted to the 2026 American Control Conference*.

[2] Azra Begzadic, Nikhil Shinde, Sander Tonkens, Dylan Hirsch, Kaleb Ugalde, Michael Yip, Jorge Cortes, and Sylvia Herbert. *Back to base: towards hands-off learning via safe resets with reach-avoid safety filters*. In: *Proceedings of the 7th Annual Learning for Dynamics & Control Conference*. Vol. 283. PMLR, 2025, pp. 1154–1166.

[3] Dylan Hirsch and Sylvia Herbert. *Approximate Hamilton-Jacobi reachability analysis for a class of two-timescale systems, with application to biological models*. In: *64th IEEE Conference on Decision and Control [Accepted]*. 2025.

[4] Dylan Hirsch and Sylvia Herbert. *Control of subpopulation fractions in a population of bistable cells*. In: *IEEE Control Systems Letters* 9 (2025), pp. 2253–2258.

[5] Dylan Hirsch, William McEneaney, Jaime Fisac, Claire Tomlin, and Sylvia Herbert. *An update to the Level Set Theorems in Hamilton-Jacobi reachability analysis*. In: *Submitted to IEEE Transactions on Automatic Control (as a technical note)* (2025).

[6] William Sharpless*, Dylan Hirsch*, Sander Tonkens, Nikhil Shinde, and Sylvia Herbert. *Dual-objective reinforcement learning with novel Hamilton-Jacobi-Bellman formulations*. In: *arXiv* (2025).

[7] Rachel Sparks*, Nicholas Rachmaninoff*, William W Lau*, Dylan C Hirsch*, Neha Bansal*, Andrew J Martins, Jinguo Chen, Candace C Liu, ..., and John S Tsang. *A unified metric of human immune health*. In: *Nature Medicine* (2024).

[8] Dylan Hirsch, Theodore W Grunberg, and Domitilla Del Vecchio. *Error bound for Hill-function approximations in a class of stochastic transcriptional network models*. In: *Proceedings of the 62nd Conference on Decision and Control (CDC)*. IEEE. 2023.

[9] Dylan Hirsch and Domitilla Del Vecchio. *Differential equation model for the population-Level dynamics of a toggle switch with growth-feedback*. In: *Proceedings of the 61st Conference on Decision and Control (CDC)*. IEEE. 2022.

[10] Xiaoshan M Shao, Rohit Bhattacharya, Justin Huang, I K Ashok Sivakumar, Collin Tokheim, Lily Zheng, Dylan Hirsch, Benjamin Kaminow, ..., and Rachel Karchin. *High-throughput prediction of MHC class I and II neoantigens with MHCnuggets*. In: *Cancer Immunology Research* (2020).

Presentations

Talks

Berkeley Semi-autonomous Seminar: Berkeley, CA; Jan. 2025

"Anomalies in translating games of kind to games of degree in Hamilton-Jacobi Reachability."

UCSD Controls & Pizza Seminar: La Jolla, CA; Jan. 2025

"On the level set theorems of Hamilton-Jacobi Reachability."

IEEE Conference on Decision and Control: Cancún, Mexico; Dec. 2022

"Differential equation model for the population-level dynamics of a toggle switch with growth feedback."

MIT Biological Engineering and Toxicology Seminar: Boston, MA; Dec. 2022

"Controlling subpopulation fractions of bistable biomolecular circuits: theory, design, and simulations."

NIH Immune System Biology Seminar: Bethesda, MD; Oct. 2019

"Delineating immune health and disease: extracting multi-omics parameters to fingerprint monogenic immunological diseases."

Posters

UCSD MAE 60th Anniversary: La Jolla, CA; Apr. 2025

"Advances in Hamilton-Jacobi Reachability for safe autonomy: fundamental theory and biological applications."

CSHL Systems Immunology Conference: Cold Spring Harbor, NY; Mar. 2019

"Fingerprinting the human immune system: multi-disease mapping and dissection."

Cancer Systems Biology Consortium Junior Investigator Meeting: Bethesda, MD; Aug. 2017

"Epigenetic characterization of T cell exhaustion."

Patents

Sterilizable Peritoneal Dialysis Connection Device: PCT / US2019 / 058568