Thomas A. Berrueta

CONTACT   tberrueta@u.northwestern.edu   tberrueta.github.io

EDUCATION

Northwestern University, Evanston, IL   Harvey Mudd College, Claremont, CA
Ph.D. Candidate in Mechanical Engineering   B.S. Engineering, Graduated with Honors

HONORS

- Northwestern University Presidential Fellow (highest honor attainable)   2022-2024
- Microsoft Future Leader in Robotics and AI   2024
- Schmidt Science Fellows Finalist   2023
- Microsoft Ada Lovelace Fellowship Finalist   2019
- Walter P. Murphy Fellowship   2017-2018
- Harvey S. Mudd Merit Scholarship   2013-2017
- Dean's List   2013-2017

RESEARCH

Center for Robotics and Biosystems
- My work explores the role of embodiment in robot learning and control across scales. I combine insights from artificial intelligence, statistical physics, and optimal control in the pursuit of more life-like autonomy by developing methods that exploit the physical intelligence of engineered systems.

PUBLICATIONS

Journal Papers (* indicates equal authorship)
- **T. A. Berrueta**, A. Pinosky, T. D. Murphey, "Maximum diffusion reinforcement learning." *Nature Machine Intelligence*, DOI: 10.1038/s42256-024-00829-3 (2024).
- **T. A. Berrueta**, T. D. Murphey, R. L. Truby, "Materializing autonomy in soft robots across scales." *Advanced Intelligent Systems*, vol. 6, no. 2, 2300111, (2024).
- **T. A. Berrueta***, J. F. Yang*, A. M. Brooks, A. T. Liu, G. Zhang, D. G. Medrano, S. Yang, V. B. Koman, P. Chvykov, M. Z. Miskin, T. D. Murphey, M. S. Strano, "Emergent microrobotic oscillators via asymmetry-induced order." *Nature Communications*, vol. 13, 5734, (2022).
- J. F. Yang, A. T. Liu, **T. A. Berrueta**, G. Zhang, A. M. Brooks, V. B. Koman, S. Yang, X. Gong, T. D. Murphey, M. S. Strano, "Memristor circuits for colloidal robotics: Temporal access to memory, sensing, and actuation." *Advanced Intelligent Systems*, vol. 4, no. 4, 2100205 (2022).
- P. Chvykov, **T. A. Berrueta**, A. Vardhan, W. Savoie, A. Samland, T. D. Murphey, K. Wiesenfeld, D. I. Goldman, J. L. England, "Low rattling: A predictive principle for self-organization in active collectives." *Science*, vol. 371, no. 6524, pp. 90-95 (2021).
- A. Taylor, **T. A. Berrueta**, T. D. Murphey, "Active learning in robotics: A review of control principles." *Mechatronics*, vol. 77, 102576, (2021).
- W. Savoie, **T. A. Berrueta**, Z. Jackson, A. Pervan, R. Warkentin, S. Li, T. D. Murphey, K. Wiesenfeld, D. I. Goldman, "A robot made of robots: Emergent transport and control of a smarticle ensemble." *Science Robotics*, vol. 4, no. 34 (2019).
- **T. A. Berrueta**, A. Pervan, K. Fitzsimons, T. D. Murphey, "Dynamical system segmentation for information measures in motion." *IEEE Robotics and Automation Letters*, 4 (1), 169-176 (2019).

Conference Papers (* indicates equal authorship)
- K. Rudy, **T. A. Berrueta**, T. D. Murphey, "Task-agnostic shared control for safety constrained human-robot systems." *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (In Review).
- **T. A. Berrueta***, A. Q. Nilles*, A. Pervan*, T .D. Murphey, S. M. LaValle, "Information requirements of collision-based micromanipulation." *Proceedings of the Workshop on the Algorithmic Foundations of Robotics (WAFR)* (2020).
- A. Kalinowska, **T. A. Berrueta**, T .D. Murphey, "Data-driven gait segmentation for walking assistance in a lower-limb assistive device." *IEEE International Conference on Robotics and Automation (ICRA)* (2019).

Book Chapters
- **T. A. Berrueta**, I. Abraham, T. D. Murphey, "Experimental applications of the Koopman operator in active learning for control." *The Koopman Operator in Systems and Control*, Springer (2020).

Workshop Papers and Abstracts
- A. Taylor, **T. A. Berrueta**, T. D. Murphey, "Emergent mechanism design via robot swarms." *Robotics: Science and Systems*, (2022).

- **T. A. Berrueta**, J. F. Yang, A. M. Brooks, A. T. Liu, M. S. Strano, T. D. Murphey, "Emergent beating in colloidal matter: Stabilization via symmetry breaking." *Bulletin of the American Physical Society*, (2022).
- A. Taylor, **T. A. Berrueta**, T. D. Murphey, "Optimizing the locomotion of a robotic active matter system of smarticles." *Bulletin of the American Physical Society*, (2021).
- A. Q. Nilles, A. Pervan, **T. A. Berrueta**, T. D. Murphey, "Controlling active Brownian particles with 'active billiard' particles." *Bulletin of the American Physical Society*, (2020).
- **T. A. Berrueta**, A. Pervan, T. D. Murphey, "Towards robust motion planning for synthetic cells in a circulatory system." *Robotics: Science and Systems*, (2019).

INVITED TALKS
- **T. A. Berrueta**, "Towards transparent & reliable embodied reinforcement learning agents." *Microsoft Future Leaders in Robotics and AI Seminar Series*. University of Maryland, April 26th, 2024.
- **T. A. Berrueta**, "Robot thermodynamics: Making complex systems task-capable." *Gordon Research Conference* (GRC): Complex Active and Adaptive Material Systems, Ventura Beach Marriott, February 1st, 2023.
- **T. A. Berrueta**, "Engineering robotic active matter through nonequilibrium self-organization." *Gordon Research Seminar* (GRS): Emergent Phenomena in Active and Living Materials, Ventura Beach Marriott, January 29th, 2023,
- **T. A. Berrueta**, "Imprecision engineering: Lowering cost while increasing capability." *Presidential Fellows Lecture Series*, Northwestern University, October 20th, 2022,
- **T. A. Berrueta**, "Designing for emergence: Making materials 'robotic' with self-organization." *Center for Robotics and Biosystems Seminar Series*, Northwestern University, June 17th, 2022, YouTube Video.
- **T. A. Berrueta**, "Robot thermodynamics: Analysis, control, and design of complex systems." *Allen Discovery Center Invited Seminar*, Department of Biology, Tufts University, April 26th, 2022.
- **T. A. Berrueta**, "Online learning in physical systems." *SIAM Dynamical Systems*, Symposium on Leveraging Machine Learning for Dynamics and Control, May 26th, 2021, YouTube Video.
- **T. A. Berrueta**, "Low rattling: Predicting driven self-organization." *Center for Robotics and Biosystems Seminar Series*, Northwestern University, December 4th, 2020, YouTube Video.

SERVICE

Reviewer
- IEEE Transactions on Robotics (T-RO), IEEE Robotics and Automation Letters (RA-L), IEEE International Conference on Robotics and Automation (ICRA), IEEE International Conference on Intelligent Robots and Systems (IROS), Nature Scientific Reports.

TEACHING

Northwestern University

ME314: Theory of Machines - Dynamics   Teaching Assistant (2019), Grader (2018, 2021)
- Lectured large senior-level course (∼70 students) on rigid body dynamics and Lagrangian mechanics.
- Redesigned class content and homeworks as it pivoted to an online-friendly format.

ME455: Active Learning in Robotics   Guest Lecturer (2022, 2023)
- Invited to give a series of lectures for a graduate-level course on active learning in robotics.
- Lecture topics included deriving the ELBO objective, CVAE architectures, and building real-time closed-loop robot perception pipelines based on CVAEs.

EXPERIENCE

Harvey Mudd College

Kaiam Corporation Capstone   2016-2017
- Designed a MEMS-based laser diode burn-in platform for testing of optical transceivers, which are crucial to data centers worldwide.

Amazon Lab126 Capstone   2016
- Designed a robotic hardware platform for improving the voice-responsiveness of the Amazon Echo.

Northrop Grumman

Control Systems Intern: Survivability Group   2016
- Developed an infrared signature estimator model and worked on algorithms to minimize aircraft IR exposure in real-time.

SpaceX

Vehicle Engineering Intern: Engine Dynamics Group   2014-2015
- Modelled and characterized flight environments experienced by M1D and MVacD rocket engines in order to anticipate design failure modes and ensure mission safety.

LEADERSHIP & OUTREACH	**Northwestern University** • Board member of the Northwestern Mechanical Engineering Graduate Student Society (2017-2019). • Organizer of recruitment activities for incoming mechanical engineering graduate students (2018). • Mentor to 8 Ph.D. and Masters students through the department mentorship program (2017-current). • Volunteer at the Chicago Museum of Science and Industry, teaching members of the public about robots and technology (2017-current).

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- Board member of the Northwestern Mechanical Engineering Graduate Student Society (2017-2019).
- Organizer of recruitment activities for incoming mechanical engineering graduate students (2018).
- Mentor to 8 Ph.D. and Masters students through the department mentorship program (2017-current).
- Volunteer at the Chicago Museum of Science and Industry, teaching members of the public about robots and technology (2017-current).

Harvey Mudd College
- Member of the Harvey Mudd College Entrepreneurial Network (2017).
- Mentor in the Harvey Mudd College mentorship program (2016-2017).

SKILLS

Technical
- Proficient in Python, C++, and MATLAB.
- Expertise in robotics, control theory and dynamical systems, as well as artificial intelligence, information theory, statistical physics, and optimization.

Other
- I am fluent in Spanish and English, and conversational in French.
- I have played jazz guitar/bass since 2008.
- I do music composition and production in my spare time.
- I love to run, and ran competitively in a NCAA college track and field team.

NOTABLE PRESS
- *Northwestern News*, "PhD Student Chosen as a Presenter for the Future Leaders in Robotics and AI Seminar Series", 2024.
- *Northwestern News*, "Chemistry flexes robotic arm without electronics," 2022.
- *MIT News*, "Tiny particles work together to do big things," 2022.
- *Northwestern News*, "Two Graduate Students Receive Presidential Fellowships," 2022.
- *Science Magazine (Podcast)*, "The uncertain future of North America's ash trees, and organizing robot swarms," 2021.
- *Gizmodo*, "Meet the Pint-Sized Robots that Spontaneously Dance," 2020.
- *Popular Mechanics*, "These Robots Literally Just Flap Their Wings. That's It. But the Army Loves Them.," 2019.
- *Scientific American*, "Prehistoric Suckers, Slapping Robots and Three Billion Birds Gone," 2019.
- *Science Magazine (News)*, "Watch a robot made of robots move around," 2019.