

Thomas A. Berrueta

CONTACT	tberrueta@u.northwestern.edu	tberrueta.github.io
EDUCATION	Northwestern University, Evanston, IL Ph.D. Candidate in Mechanical Engineering	Harvey Mudd College, Claremont, CA B.S. Engineering, Graduated with Honors
HONORS	<ul style="list-style-type: none">• Presidential Fellowship Finalist (Northwestern University) 2022• Microsoft Ada Lovelace Fellowship Finalist (top 20 of 600+ applicants) 2019• Walter P. Murphy Fellowship (Northwestern University) 2017-2018• Harvey S. Mudd Merit Scholarship (Harvey Mudd College) 2013-2017• Dean's List (Harvey Mudd College) 2013-2017	
RESEARCH	Center for Robotics and Biosystems <ul style="list-style-type: none">• I study complex physical systems and their emergent capabilities through the lens of robotics. I look to the physics of self-organization for designing control strategies in settings where most methods fail.• I develop algorithms that identify emergent simplicity and discrete structure arising from the interactions of robot swarms, many-body systems, and human-machine systems.• I derive techniques that simultaneously leverage modern machine learning, control theory, statistical physics, and information theory towards making complex systems controllable.	
PUBLICATIONS	<i>Journal Papers</i> (* indicates equal authorship) <ul style="list-style-type: none">• 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." <i>Science</i>, vol. 371, no. 6524, pp. 90-95 (2021).• 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." <i>Advanced Intelligent Systems</i>, 2100205 (2021).• A. Taylor, T. A. Berrueta, T. D. Murphey, "Active learning in robotics: A review of control principles." <i>Mechatronics</i>, 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." <i>Science Robotics</i>, vol. 4, no. 34 (2019).• T. A. Berrueta, A. Pervan, K. Fitzsimons, T. D. Murphey, "Dynamical system segmentation for information measures in motion." <i>IEEE Robotics and Automation Letters</i>, 4 (1), 169-176 (2019). <i>Conference Papers</i> (* indicates equal authorship) <ul style="list-style-type: none">• A. Taylor, T. A. Berrueta, A. Pinosky, T. D. Murphey, "Constrained ergodic specifications for safe exploration." <i>IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)</i>, (Submitted, 2022).• A. Q. Nilles*, A. Pervan*, T. A. Berrueta*, T. D. Murphey, S. M. LaValle, "Information requirements of collision-based micromanipulation." <i>Proceedings of the Workshop on the Algorithmic Foundations of Robotics (WAFR)</i> (2020).• A. Kalinowska, T. A. Berrueta, T. D. Murphey, "Data-driven gait segmentation for walking assistance in a lower-limb assistive device." <i>IEEE International Conference on Robotics and Automation (ICRA)</i> (2019). <i>Book Chapters</i> <ul style="list-style-type: none">• T. A. Berrueta, I. Abraham, T. D. Murphey, "Experimental applications of the Koopman operator in active learning for control." <i>The Koopman Operator in Systems and Control</i>, Springer (2020). <i>Workshop Papers</i> <ul style="list-style-type: none">• 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." <i>Bulletin of the American Physical Society</i>, (2022).• A. Taylor, T. A. Berrueta, T. D. Murphey, "Optimizing the locomotion of a robotic active matter system of smarticles." <i>Bulletin of the American Physical Society</i>, (2021).• A. Q. Nilles, A. Pervan, T. A. Berrueta, T. D. Murphey, "Controlling active Brownian particles with "active billiard" particles." <i>Bulletin of the American Physical Society</i>, (2020).• T. A. Berrueta, A. Pervan, T. D. Murphey, "Towards robust motion planning for synthetic cells in a circulatory system." <i>Workshop on Robust Task and Motion Planning at Robotics: Science and Systems</i>, (2019).	

INVITED TALKS	<ul style="list-style-type: none"> • T. A. Berrueta, “Robot thermodynamics: Analysis, control, and design of complex systems.” <i>Allen Discovery Center Invited Seminar</i>, Department of Biology, Tufts University, April 26th, 2022. • T. A. Berrueta, “Online learning in physical systems.” <i>SIAM Dynamical Systems</i>, Symposium on Leveraging Machine Learning for Dynamics and Control, May 26th, 2021, YouTube Video. • T. A. Berrueta, “Low rattling: Predicting driven self-organization.” <i>Center for Robotics and Biosystems Seminar Series</i>, Northwestern University, Dec. 4th, 2020, YouTube Video.
EXPERIENCE	<p>Northwestern University</p> <p>ME314: Theory of Machines - Dynamics Co-teacher (2019), Grader (2018, 2021)</p> <ul style="list-style-type: none"> • 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. <p>Harvey Mudd College</p> <p>Kaia Corporation Capstone 2016-2017</p> <ul style="list-style-type: none"> • Designed a MEMS-based laser diode burn-in platform for the testing of optical transceivers, which are crucial to data centers world-wide. • Implemented embedded temperature and current controllers for the microscopic laser diodes. <p>Amazon Lab126 Capstone 2016</p> <ul style="list-style-type: none"> • Designed a hardware platform for testing the voice-responsiveness of the Amazon Echo in various experimental conditions capable of autonomous maneuvering and obstacle avoidance in rooms. <p>Northrop Grumman</p> <p>IR and Visual Control Systems Intern: Survivability Group 2016</p> <ul style="list-style-type: none"> • Developed an infra-red (IR) signature estimator model for autonomous aircraft control, and developed algorithms that optimize aircraft trajectories to minimize IR exposure in real-time. <p>SpaceX</p> <p>Vehicle Engineering Intern: Engine Dynamics Group 2014-2015</p> <ul style="list-style-type: none"> • 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	<p>Northwestern University</p> <ul style="list-style-type: none"> • 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). <p>Harvey Mudd College</p> <ul style="list-style-type: none"> • Member of the Harvey Mudd College Entrepreneurial Network (2017). • Mentor in the Harvey Mudd College mentorship program (2016-2017).
SKILLS	<p>Technical</p> <ul style="list-style-type: none"> • Proficient in Python, C++, and MATLAB. • Expertise in control theory and analysis of dynamical systems, as well as machine learning, information theory, statistical physics, and optimization. <p>Other</p> <ul style="list-style-type: none"> • 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 an NCAA college track and field team.

NOTABLE PRESS

- *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).