Thomas A. Berrueta

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EDUCATION

Northwestern University, Evanston, IL
Ph.D. Candidate in Mechanical Engineering

Harvey Mudd College, Claremont, CA
B.S. Engineering, Graduated with Honors

HONORS

- Presidential Fellow (highest honor attainable by NU graduate students) 2022-2024
- Microsoft Ada Lovelace Fellowship Finalist (top 20 of 600+ applicants) 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

- 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

Journal Papers (* indicates equal authorship)

- J. F. Yang*, **T. A. Berrueta***, 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* (In Review, 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).
- 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*, 2100205 (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)

- A. Taylor, **T. A. Berrueta**, A. Pinosky, T. D. Murphey, "Constrained ergodic specifications for safe exploration." *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, (In Review, 2022).
- A. Q. Nilles*, A. Pervan*, **T. A. Berrueta***, 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

- **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." *Workshop on Robust Task and Motion Planning at Robotics: Science and Systems*, (2019).

Invited Talks

- **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, Dec. 4th, 2020, YouTube Video.

Experience

Northwestern University

ME314: Theory of Machines - Dynamics — Co-teacher (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.

Harvey Mudd College

Kaiam Corporation Capstone — 2016-2017

- 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.

Amazon Lab126 Capstone — 2016

- 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.

Northrop Grumman

IR and Visual Control Systems Intern: Survivability Group — 2016

- 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.

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).

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 control theory and analysis of dynamical systems, as well as machine learning, 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 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).