

# 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	<ul style="list-style-type: none"><li>• Northwestern University Presidential Fellow (highest honor attainable) 2022-2024</li><li>• Schmidt Science Fellows Finalist 2023</li><li>• Microsoft Ada Lovelace Fellowship Finalist 2019</li><li>• Walter P. Murphy Fellowship 2017-2018</li><li>• Harvey S. Mudd Merit Scholarship 2013-2017</li><li>• Dean's List 2013-2017</li></ul>	
RESEARCH	<b>Center for Robotics and Biosystems</b> <ul style="list-style-type: none"><li>• I help robots self-organize their own intelligence.</li><li>• From microrobots the size of paramecia to macroscopic locomoting agents, my work takes advantage of statistical physics, emergence, and embodied intelligence to enable robot learning and control across all scales. My work makes engineered systems more life-like by embracing noise and uncertainty.</li></ul>	
PUBLICATIONS	<i>Journal Papers</i> (* indicates equal authorship) <ul style="list-style-type: none"><li>• <b>T. A. Berrueta</b>, A. Pinosky, T. D. Murphey, "Maximum diffusion reinforcement learning." <i>Nature Machine Intelligence</i> (In Review).</li><li>• <b>T. A. Berrueta</b>, T. D. Murphey, R. L. Truby, "Materializing autonomy in soft robots across scales." <i>Advanced Intelligent Systems</i>, 2300111, (2023).</li><li>• J. F. Yang*, <b>T. A. Berrueta</b>*, 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." <i>Nature Communications</i>, vol. 13, 5734, (2022).</li><li>• J. F. Yang, A. T. Liu, <b>T. A. Berrueta</b>, 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>, vol. 4, no. 4, 2100205 (2022).</li><li>• P. Chvykov, <b>T. A. Berrueta</b>, 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).</li><li>• A. Taylor, <b>T. A. Berrueta</b>, T. D. Murphey, "Active learning in robotics: A review of control principles." <i>Mechatronics</i>, vol. 77, 102576, (2021).</li><li>• W. Savoie, <b>T. A. Berrueta</b>, 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).</li><li>• <b>T. A. Berrueta</b>, 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).</li></ul> <i>Conference Papers</i> (* indicates equal authorship) <ul style="list-style-type: none"><li>• A. Q. Nilles*, A. Pervan*, <b>T. A. Berrueta</b>*, 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).</li><li>• A. Kalinowska, <b>T. A. Berrueta</b>, 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).</li></ul> <i>Book Chapters</i> <ul style="list-style-type: none"><li>• <b>T. A. Berrueta</b>, 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).</li></ul> <i>Workshop Papers and Abstracts</i> <ul style="list-style-type: none"><li>• J. F. Yang, <b>T. A. Berrueta</b>, A. M. Brooks, A. T. Liu, G. Zhang, S. Yang, V. B. Koman, T. D. Murphey, M. S. Strano, "Emergent microrobotic oscillators via asymmetry-induced order." <i>AICHe Annual Meeting</i> (2022).</li><li>• A. Taylor, <b>T. A. Berrueta</b>, T. D. Murphey, "Emergent mechanism design via robot swarms." <i>Robotics: Science and Systems</i>, (2022).</li><li>• <b>T. A. Berrueta</b>, 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</i></li></ul>	

*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**, “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

- Kaia 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).

#### 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*, “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.