Anastasia Bizyaeva

Distributed control & AI · Nonlinear dynamics · Multi-agent systems · Collective decision-making · Complex networks

Postdoctoral Fellow · NSF AI Institute in Dynamic Systems, University of Washington · Seattle, WA 98195

anabiz@uw.edu | anastasiabzv.github.io

Education & Research Appointments

University of Washington *Seattle, WA, USA*

Postoctoral fellow, NSF AI Institute for Dynamic Systems *Oct. 2022 — Present*

- Exploring how data-driven methods for learning and forecasting of nonlinear dynamical systems can be leveraged for system identification and control of collective behavior.
- Supervised by Steve Brunton (Mechanical Engineering) and J.Nathan Kutz (Applied Math)

Princeton University *Princeton, NJ, USA*

Doctor of Philosophy in Mechanical and Aerospace Engineering *Sep. 2017 — Sep. 2022*

- Dissertation: *Nonlinear dynamics of multi-agent multi-option belief and opinion formation*
- Developed and analyzed a new mathematical model of social decision-making for multi-agent systems; applied this framework to explore interdisciplinary research questions, e.g. new approaches for decentralized coordination of autonomous teams.
- Advisor: Naomi Ehrich Leonard

University of California, Berkeley *Berkeley, CA, USA*

Bachelor of Arts in Physics, minor in Mechanical Engineering *Sep. 2012 — Dec. 2016*

Awards

2022 **Distinguished Postdoctoral Fellowship**
NSF AI Institute in Dynamic Systems, University of Washington

2022 **Simons Postdoctoral Fellowship (offered, declined)**
NSF-Simons Center, Harvard University

2021 **Princeton School of Engineering and Applied Science Award for Excellence**
Awarded to 15 graduate students who performed at the highest level as scholars and researchers

2019 **Larisse Rosentweig Klein Memorial Prize, Princeton University**
Awarded for outstanding research achievements by the third year of enrollment

2019 **National Science Foundation Graduate Research Fellowship**
Award in mechanical engineering; five-year graduate research fellowship

2019 **Ford Foundation Predoctoral Fellowship Competition Honorable Mention**
Fellowship for scholars who combine academic excellence with strong commitment to diversity

2019 **Student Travel Award, SIAM DS19 Conference**
Society for Industrial and Applied Mathematics, Conference on Applications of Dynamical Systems

2018 **Howard Crathorne Phillips Fellowship in Mechanical Engineering, Princeton University**
Award recognizing a second-year student who demonstrates excellence in coursework and research

2017 **Gordon Y.S. Wu Fellowship in Engineering, Princeton University**
Fellowship awarded to the most outstanding incoming doctoral students in engineering

2017 **Student Service Award, UC Berkeley Physics**
Award recognizing two undergraduate students for their service contributions to the department

Publications

Journal papers

[J5] **A. Bizyaeva**, A. Franci, and N.E. Leonard, "Nonlinear opinion dynamics with tunable sensitivity", *IEEE Transactions on Automatic Control*, 2022, Early Access

[J4] **A. Bizyaeva**, G. Amorim, M. Santos, A. Franci and N. E. Leonard, "Switching transformations for decentralized control of opinion patterns in signed networks: application to dynamic task allocation", *IEEE Control Systems Letters*, June 2022.

[J3] S. Park, **A. Bizyaeva**, M. Kawakatsu, A.Franci, N.E. Leonard, "Tuning cooperative behavior in games with nonlinear opinion dynamics", *IEEE Control Systems Letters*, vol. 6, pp. 2030-2035, December 2021.

[J2] N.E. Leonard, K. Lipsitz, **A. Bizyaeva**, A. Franci, and Y. Lelkes. "The nonlinear feedback dynamics of asymmetric political polarization", *"Proceedings of the National Academy of Sciences"*, vol. 118, no. 50, pp. 1-9, December 2021

[J1] A. Franci, **A. Bizyaeva**, S. Park, and N.E. Leonard. "Analysis and control of agreement and disagreement opinion cascades", *Swarm Intelligence*, vol. 15, pp. 47–82, May 2021

Peer-reviewed conference papers

[C4] **A. Bizyaeva**, T. Sorochkin, A. Franci, N.E. Leonard, "Control of agreement and disagreement cascades with distributed inputs", IEEE Conference on Decision and Control, December 2021.

[C3] **A. Bizyaeva**, A. Matthews, A. Franci, N.E. Leonard, "Patterns of nonlinear opinion formation on networks", American Control Conference, May 2021

[C2] L. Rosendahl, **A. Bizyaeva**, J.D. Cohen, A novel quantum approach to the dynamics of decision making", 42nd Annual Meeting of the Cognitive Science Society, July 2020

[C1] S. Musslick, **A. Bizyaeva**, S. Agaron, N.E. Leonard, and J.D. Cohen. "Stability-flexibility dilemma in cognitive control: a dynamical system perspective", 41nd Annual Meeting of the Cognitive Science Society, July 2019

Peer-reviewed extended conference abstracts

[A1] C. Cathcart, S. Park, **A. Bizyaeva**, N.E.Leonard, "Robot navigation around oncoming movers using bio-inspired opinion dynamics", *International Conference on Intelligent Robots and Systems (IROS), workshop on robotics-inspired biology*, 2020

Under review and in preparation

[1] **A. Bizyaeva**, A. Franci, N.E. Leonard. "Sustained oscillations in multi-topic belief dynamics over signed networks", ***under review.*** **Preprint: [arXiv:2210.00353]**

[2] A. Franci, M. Golubitsky, I. Stewart, **A. Bizyaeva**, and N.E. Leonard, "Decision from indecision in multi-agent multi-option dynamics", ***under review.*** **Preprint: [arXiv:2009.13600]**

[3] A. Franci, **A. Bizyaeva**, N.E. Leonard. "Multiagent opinion dynamics: agreeing, disagreeing, and avoiding indecision". *In prep for Annual Review of Control, Robotics, and Autonomous Systems.*

[4] **A. Bizyaeva**, A. Franci, and N.E. Leonard. "Bifurcations in nonlinear multi-topic value formation networks", *in prep.*

[5] S. Musslick, **A. Bizyaeva**, B. Jongkees, N.E. Leonard, J.D. Cohen. "On the rational boundedness of cognitive control: cognitive stability versus cognitive flexibility", *in prep.*

[6] **A. Bizyaeva**, Y. Zhou, N.E. Leonard, S. Levin. "Network actSIS: active control of epidemic dynamics on networks", *in prep.*

Presentations & Tutorials

2023 **Upcoming invited talk:** "Nonlinear dynamics of collective belief formation"
Invited virtual talk in the research group of Francesco Bullo, Department of Mechanical Engineering, UC Santa Barbara

2023 **Upcoming invited poster:** "Collective belief formation on multiple interdependent options"
"From individual to group decision making: experiments and theory" workshop at the Weizmann Institute of Science, Israel

2023 **Upcoming invited talk:** "Nonlinear dynamics of collective belief formation"
Conference on Dynamical Systems in the Life Sciences

2023 **Upcoming invited minisymposium talk:** "Nonlinear dynamics of collective belief formation"
SIAM Conference on Applications of Dynamical Systems (DS23)

2022 **Invited paper presentation:** "Switching transformations for decentralized control of opinion patterns in signed networks: application to dynamic task allocation"
2022 IEEE Conference on Decision and Control

2022 **Invited tutorial:** "Network dynamic modeling of cognitive control"
3rd Workshop on Mental Effort, Carney Institute for Brain Science, Brown University

2022 **Invited talk:** "Decision-making in multi-agent systems: a tale of symmetries and deadlocks"
Talk in the research group of Lakshminarayanan Mahadevan, Department of Physics, Harvard University

2021 **Invited talk:** "Sensitive transitions in collective behavior: perspectives from neuronal dynamics and bifurcation theory"
Virtual talk in the research group of Iain Couzin, Department of Collective Behaviour, Max Planck Institute of Animal Behaviour

2021 **Invited paper presentation:** "Control of agreement and disagreement cascades with distributed inputs"
2021 IEEE Conference on Decision and Control

2021 **Invited tutorial:** "Network dynamic modeling of cognitive control"
2nd Workshop on Mental Effort (virtual)

2021 **Contributed talk & poster:** "Patterns of nonlinear opinion formation on networks"
2021 American Control Conference

2021 **Invited minisymposium talk:** "Nonlinear dynamics of opinion cascades on networks"
SIAM Conference on Applications of Dynamical Systems

2020 **Contributed poster**: "A general model of opinion dynamics with tunable sensitivity"
UCLA Institute for Pure & Applied Mathematics, Mathematical Challenges and Opportunities for Autonomous Vehicles Program, Workshop IV: Social Dynamics beyond Vehicle Autonomy

2020 **Invited minisymposium talk:** "Nonlinear dynamics of agreement and disagreement decision making"
SIAM Conference on the Life Sciences

2019 **Contributed poster**: "Stability-flexibility dilemma in cognitive control: a dynamical system perspective"
52nd Annual Meeting of the Society for Mathematical Psychology

2019 **Invited minisymposium talk:** "Symmetry and synthesis of agreement and disagreement dynamics"
SIAM Conference on Applications of Dynamical Systems

Research Mentorship

2021 - 2022 Ritika Ramprasad (Princeton ECE '22), senior thesis
Designing and implementing strategies for human-robot interaction using a nonlinear model of opinion dynamics; mentored with María Santos, Naomi Ehrich Leonard, and Jaime Fisac

2021 - 2022 Christine Ohenzuwa (Princeton MAE '23), junior independent work
Spatial decision-making via opinion dynamics; mentored with María Santos and Naomi Ehrich Leonard

2020 - 2021 Timothy Sorochkin (University of Waterloo Physics '22), independent work
Numerical investigations of opinion cascades in networks of agents with dynamic attention; co-author of paper in 2021 IEEE Conference on Decision and Control; mentored with Naomi Ehrich Leonard

2019 - 2020 Ayanna Matthews (Princeton Physics '20), senior thesis
The role of network structure and heterogeneity in nonlinear multi-agent opinion formation; co-author of paper in 2021 American Control Conference; mentored with Naomi Ehrich Leonard

Teaching

Assistant in Instruction — *Princeton University*
Mechanical and Aerospace Engineering — *2019 - 2022*

- F19: MAE501 Mathematical Methods of Engineering Analysis; Instructor: Luc Deike
- S20: MAE434 Modern Control; Instructor: Naomi Ehrich Leonard
- F20: MAE501 Mathematical Methods of Engineering Analysis; Instructor: Luc Deike
- S22: MAE541/APC571 Applied Dynamical Systems; Instructor: Clarence Rowley

Instructor — Princeton Prison Teaching Initiative — *Princeton Prison Teaching Initiative*
Taught math courses accredited by Rariton Valley Community College in the New Jersey state prison system — *2018-2021*

- F18: MATH015 Basic Mathematics (East Jersey State Prison)
- S19: MATH030 Intermediate Algebra (Edna Mahan Correctional Facility for Women)
- F19: MATH020 Basic Algebra (Mountainview Youth Correctional Facility) — **Lead instructor**
- S20: MATH015 Basic Mathematics (Edna Mahan Correctional Facility for Women)
- F21: MATH015 Basic Mathematics (East Jersey State Prison)

Math & Physics Peer Tutor — *UC Berkeley*
Athletic Study Center — *2013-2017*
Held part-time job providing one-on-one and small-group tutoring support in math and physics for student-athletes at UC Berkeley; received weekly training on equitable teaching practices

Undergraduate Instructor — *UC Berkeley*
Women in Tech DeCal (student-run course) — *Fall 2016*
Co-designed course curriculum, led lectures and group activities in student-run course on professional development for women interested in STEM careers in industry and academia

Professional Service

Reviewer

Journals

IEEE Transactions on Automatic Control, IEEE Transactions on Control of Network Systems, IEEE Control Systems Letters, Automatica, SIAM Journal on Applied Dynamical Systems, Proceedings of the National Academy of Sciences of the USA

Conference proceedings

IEEE Conference on Decision and Control, American Control Conference, IEEE International Symposium on Multi-Robot and Multi-Agent Systems

Institutional committee service

Princeton University

Graduate student member of Climate and Inclusion Committee, Department of Mechanical and Aerospace Engineering (2019-2021); Princeton School of Engineering and Applied Science Diversity and Inclusion Advisory Committee Member (2021-2022)

UC Berkeley

Physics department: undergraduate member of Reading Room Planning Committee (2014-2015); undergraduate member of Major Course Committee, Service Course Committee, and Physics Chair Advisory Committee Against Sexual Harassment (2015-2016)

2023 **Organizing committee member**
Upcoming workshop on "Convergence with Control: Bridging the Arts, Ecology, Neuroscience, and Engineering" at Princeton University

2023 **Co-organizer of invited session**
Upcoming minisymposium on "Collective decisions and entropy in data-driven optimization landscapes" at SIAM Conference on Optimization

2021 **Co-organizer of invited session**
Invited session on "Dynamics of social networks" at IEEE Conference on Decision and Control

2021 **Co-organizer of invited session**
Minisymposium on "Collective behaviour in biological and biologically inspired systems" at SIAM Conference on Applications of Dynamical Systems

2015 **Organizing committee member**
Zone 18 Meeting for the Society of Physics Students at UC Berkeley — Annual regional conference for physics undergraduates across California, Nevada, and Hawaii

Selected Leadership, Professional Development & Outreach

2023 **"Network Dynamics and Control" Focus Period Participant, Linköping, Sweden**
I am one of 20 early-career researchers selected for an invited 3-week residency at Linköping University followed by a 3-day workshop with leading senior scholars, with the goal of stimulating interdisciplinary interaction between scientists working on network dynamics and control from different perspectives

2021 **NextProf Nexus Workshop Participant, Ann Arbor, Michigan**
Three-day workshop that prepares selected participants for a faculty position in engineering academia

2019 **Future Digileaders Workshop Participant, Stockholm, Sweden**
Three day event for selected early career female researchers interested in the broad area of digitalization technology

2018 - 2021 **Officer, Princeton Graduate Society of Women Engineers**
Organized various social and professional development events for women engineers at Princeton

2019 **Near-peer mentor, Princeton Biophysics REU**
Mentored a community college student who was participating in a summer research program in the Biophysics department at Princeton

2019 **Panelist - Pathways to Graduate School, Princeton School of Engineering and Applied Science**
Served on a panel about demystifying graduate school admissions at an event for high-achieving, rising college seniors majoring in STEM disciplines with strong potential to contribute to the diversity and excellence of our academic community

2018,2019 **Volunteer - Princeton MAE Harlem Prep Elementary School visit**
Led control engineering demos at an annual Princeton visit for elementary school children from Harlem

2018 **Volunteer - Princeton Center for Complex Materials Frankenstein Day**
Science experiments with elementary school-aged children

2015 - 2017 **Student Program Coordinator, Cal NERDS (New Experience for Research and Diversity in Sciences)**
Held part-time job helping organize programs for a center at UC Berkeley that provides mentorship, funding, and professional development oppportunities for high achieving STEM undergraduates and graduate students from diverse backgrounds

2013 - 2016 **Officer, UC Berkeley Society of Physics Students**
Served as Activities Officer, Vice President, and President of the physics student club at UC Berkeley