Nathan Lawrence

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Education

- 2023 Ph.D. in Mathematics, The University of British Columbia
 Thesis: Deep reinforcement learning agents for industrial control system design
 Advisors: Philip Loewen, Bhushan Gopaluni
- 2018 M.S. in Mathematics, Portland State University
- 2016 **B.A. in Mathematics**, Portland State University Honors College summa cum laude

Employment

2024- **Postdoctoral Scholar**, *Chemical & Biomolecular Engineering*, UC Berkeley present

2023-2024 Postdoctoral Research Fellow, Mathematics, UBC

Publications

Click title for arXiv preprint.

[Google Scholar]

Preprints

- 2 MPCritic: A Plug-and-Play MPC Architecture for Reinforcement Learning Nathan P. Lawrence, Thomas Banker, and Ali Mesbah Preprint (under review) 2025
- A View on Learning Robust Goal-Conditioned Value Functions: Interplay between RL and MPC
 Nathan P. Lawrence, Philip D. Loewen, Michael G. Forbes, R. Bhushan Gopaluni, and Ali Mesbah Preprint (under review) 2025

Journal Articles

6 Machine learning for industrial sensing and control: A survey and practical perspective

Nathan Lawrence, Seshu Kumar Damarla, Jong Woo Kim, Aditya Tulsyan, Faraz Amjad, Kai Wang, Benoit Chachuat, Jong Min Lee, Biao Huang, and Bhushan Gopaluni

Control Engineering Practice 2024

5 Stabilizing reinforcement learning control: A modular framework for optimizing over all stable behavior

Nathan Lawrence, Philip Loewen, Shuyuan Wang, Michael Forbes, and Bhushan Gopaluni

Automatica 2024

- 4 Automated deep reinforcement learning for real-time scheduling strategy of multi-energy system integrated with post-carbon and direct-air carbon captured system Tobi Michael Alabi, **Nathan Lawrence**, Lin Lu, Zaiyue Yang, and Bhushan Gopaluni
 - Applied Energy 2023
- 3 Meta-reinforcement learning for the tuning of PI controllers: An offline approach Daniel McClement, **Nathan Lawrence**, Johan Backström, Philip Loewen, Michael Forbes, and Bhushan Gopaluni Journal of Process Control 2022
- 2 Deep reinforcement learning with shallow controllers: An experimental application to PID tuning
 Nathan Lawrence, Michael Forbes, Philip Loewen, Daniel McClement, Johan Backström, and Bhushan Gopaluni
 Control Engineering Practice 2022
- 1 Toward self-driving processes: A deep reinforcement learning approach to control Steven Spielberg, Aditya Tulsyan, **Nathan Lawrence**, Philip Loewen, and Bhushan Gopaluni AIChE Journal 2019

Conference Proceedings

- Local-Global Learning of Interpretable Control Policies: The Interface between MPC and Reinforcement Learning Thomas Banker, Nathan P. Lawrence, and Ali Mesbah American Control Conference 2025
- 10 Deep Hankel matrices with random elements Nathan Lawrence, Philip Loewen, Shuyuan Wang, Michael Forbes, and Bhushan Gopaluni Learning for Dynamics & Control Conference 2024
- 9 Guiding Reinforcement Learning with Incomplete System Dynamics Shuyuan Wang, Jingliang Duan, Nathan P Lawrence, Philip D Loewen, Michael G Forbes, R Bhushan Gopaluni, and Lixian Zhang IROS 2024
- 8 A modular framework for stabilizing deep reinforcement learning control **Nathan Lawrence**, Philip Loewen, Shuyuan Wang, Michael Forbes, and Bhushan Gopaluni IFAC World Congress 2023
- 7 Reinforcement learning with partial parametric model knowledge Shuyuan Wang, Philip Loewen, **Nathan Lawrence**, Michael Forbes, and Bhushan Gopaluni IFAC World Congress 2023
- Meta-reinforcement learning for adaptive control of second order systems
 Daniel McClement, Nathan Lawrence, Michael Forbes, Philip Loewen,
 Johan Backström, and Bhushan Gopaluni
 IEEE International Symposium on Advanced Control of Industrial Processes 2022

- 5 A meta-reinforcement learning approach to process control
 Daniel McClement, Nathan Lawrence, Philip Loewen, Michael Forbes,
 Johan Backström, and Bhushan Gopaluni
 IFAC Symposium on Advanced Control of Chemical Processes 2021 (Keynote)
- 4 Almost surely stable deep dynamics **Nathan Lawrence**, Philip Loewen, Michael Forbes, Johan Backström, and Bhushan Gopaluni NeurIPS 2020 (Spotlight)
- 3 Optimal PID and antiwindup control design as a reinforcement learning problem **Nathan Lawrence**, Gregory Stewart, Philip Loewen, Michael Forbes, Johan Backström, and Bhushan Gopaluni IFAC World Congress 2020
- 2 Modern machine learning tools for monitoring and control of industrial processes: A survey Bhushan Gopaluni, Aditya Tulsyan, Benoit Chachuat, Biao Huang, Jong Min Lee, Faraz Amjad, Seshu Kumar Damarla, Jong Woo Kim, and Nathan Lawrence IFAC World Congress 2020
- Reinforcement learning based design of linear fixed structure controllers
 Nathan Lawrence, Gregory Stewart, Philip Loewen, Michael Forbes, Johan Backström, and Bhushan Gopaluni
 IFAC World Congress 2020

Patents

- 3 Application of simple random search approach for reinforcement learning to controller tuning parameters
 Nathan Lawrence, Philip Loewen, Bhushan Gopaluni, and Gregory Stewart US Patent 11,307,562 2022
- Method and system for directly tuning PID parameters using a simplified actorcritic approach to reinforcement learning
 Nathan Lawrence, Philip Loewen, Bhushan Gopaluni, and Gregory Stewart US Patent 11,500,337 2022
- Process controller with meta-reinforcement learning Daniel McClement, Nathan Lawrence, Philip Loewen, Bhushan Gopaluni, Michael Forbes, and Johan Backström US Patent App. 17/653,175 2022

Theses

- 2 Deep reinforcement learning agents for industrial control system design Nathan Lawrence
 The University of British Columbia 2023
- Convex and nonconvex optimization techniques for the constrained Fermat-Torricelli problem
 Nathan Lawrence
 Portland State University 2016

Honors & Awards

2022 Graduate Research Award – Applied mathematics Doctoral; UBC mathematics departmental award

2022 FIPSE Graduate Student Participation Award 1 of 5 graduate students invited to attend Future Innovations in Process Systems Engineering in Crete, Greece

- 2020–2023 Alexander Graham Bell Canada Graduate Scholarship Doctoral; National scholarship awarded by NSERC; Ranked 5th of 107 in Mathematical Sciences [Interview]
- 2020–2023 Four Year Doctoral Fellowship Doctoral; UBC scholarship
 - 2017 F.S. Cater Prize Master's; Departmental scholarship at PSU

Talks

Invited

- 2024 "A reinforcement learning perspective on industrial model predictive control" Upper Bound, Edmonton
- 2023 "Deep reinforcement learning agents for industrial control" Math department colloquium, UBC
- 2021 "How to make a professional website" Workshop fascilitator, Institute of Applied Mathematics, UBC

Organizer

- 2025 "Learning Interpretable Control Policies: Unifying Reinforcement Learning, Differentiable Programming and Bayesian Optimization" Tutorial session, ACC, Denver, CO (forthcoming)
- 2022 "Making reinforcement learning a practical technology for industrial control" Workshop organizer, AdCONIP, Vancouver, BC

Conference

- 2025 "Local-global interface of reinforcement learning and model predictive control" NorCal Control Workshop, UC Davis
- 2024 "Stability-by-design for industrial reinforcement learning" TrustML Workshop, UBC
- 2023 "A modular framework for stabilizing deep reinforcement learning control" SIAM PNW biennial meeting, Western Washington University, Bellingham, WA
- 2023 "A modular framework for stabilizing deep reinforcement learning control" IFAC World Congress, Yokohama, Japan
- 2022 "Reinforcement learning for maintenance-free control" Canadian Society for Chemical Engineering annual event, Vancouver, BC
- 2022 "Deep reinforcement learning for real-world control" Institute of Applied Mathematics retreat, UBC
- 2022 "Reinforcement learning for maintenance-free control" Systems and Control Webinar (remote)
- 2020 "Almost surely stable deep dynamics" NeurIPS Spotlight, Vancouver, BC (remote)
- 2020 "Reinforcement learning based PID tuning" BC Universities Systems and Control Meeting, University of Victoria (remote)

- 2020 "Reinforcement learning based design of linear fixed-structure controllers" IFAC World Congress, Berlin, Germany (remote)
- 2020 "Optimal PID and antiwindup control design as a reinforcement learning problem" IFAC World Congress, Berlin, Germany (remote)

Teaching

Instructor of Record

Intermediate algebra	Winter 2018
Introductory College Mathemat-	Fall 2016, Winter 2017
ics II	
Calculus II	Summer 2017, Spring 2018
Calculus III	Spring 2017, Fall 2017

Mentor

UBC:

Daniel McClement	M.Sc.	2020-2022
Kenechukwu Ene	B.Sc.	2022
Leo Wei, James Penfold, Aniket	B.Sc.	2020
Chakraborty, Farbod Chamanian		

Related Experience

- 2018-2019 Teaching Assistant, Department of Mathematics, UBC
- $2018\mathchar`-2019$ Mathematics tutor, The Math Learning Centre, UBC
- 2014-2016 Mathematics tutor, The Learning Center, PSU

Research Experience

- 2018-2023 **Graduate Research Assistant**, UBC, with Philip Loewen, Bhushan Gopaluni Deep reinforcement learning, industrial process control R&D with Honeywell Process Solutions
 - 2018 **Research Assistant**, PSU, with Gerardo Lafferriere Urban traffic simulation, networked control systems
- 2017-2018 **Research Assistant**, PSU, with Dacian Daescu Low-dimensional characterization of human faces from gappy data
- 2015-2016 **Research Assistant**, PSU, with Mau Nam Nguyen Convex analysis and optimization

Professional Activities

Reviewing: Automatica, Computers & Chemical Engineering, Scientific Reports, Control Engineering Practice, IEEE, IFAC

Member: Society for Industrial and Applied Mathematics (SIAM)

- 2020-2021 Organizer: DAIS research lab
- 2017-2018 Vice-president: SIAM, PSU Chapter

Skills

Programming: Python, Julia

Frameworks: PyTorch, TensorFlow, Stable-Baselines3, Spinning Up, Pandas, SciPy, Flux.jl, ReinforcementLearning.jl

Tools: Matlab, git, LaTex

References

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Philip Loewen	L
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Bhushan Gopaluni	L —
	⊠ bhushan.gopaluni@ubc.ca
Michael Forbes	L
	⊠Michael.Forbes@Honeywell.com