

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

- July 2023 **Postdoctoral Research Fellow**, *Department of Mathematics, UBC*

Publications

(Refereed articles and conference proceedings.)

[[Google Scholar](#)]

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

- 9 Deep Hankel matrices with random elements
Nathan Lawrence, Philip Loewen, Shuyuan Wang, Michael Forbes, and Bhushan Gopaluni
Learning for Dynamics & Control Conference (to appear) 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
- 6 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
- 1 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

Under Review or In-Progress

- 2 Reinforcing actions with half of the dynamics
Shuyuan Wang, Jingliang Duan, **Nathan Lawrence**, Philip Loewen,
Michael Forbes, Bhushan Gopaluni, and Lixian Zhang
submitted to IROS 2024
- 1 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

Patents

- 2 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
- 1 Method and system for directly tuning PID parameters using a simplified actor-critic approach to reinforcement learning
Nathan Lawrence, Philip Loewen, Bhushan Gopaluni, and Gregory Stewart
US Patent 11,500,337 2022

Theses

- 2 Deep reinforcement learning agents for industrial control system design
Nathan Lawrence
The University of British Columbia 2023
- 1 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
- 2018 **Eugene Enneking Doctoral Fellowship**
Declined; PSU
- 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

- 2022 “Making reinforcement learning a practical technology for industrial control”
Workshop organizer, AdCONIP, Vancouver, BC

Conference

- 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 Mathematics	Fall 2016, Winter 2017
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 Chakraborty, Farbod Chamanian	B.Sc. 2020

Related Experience

- 2018-2019 Teaching Assistant, Department of Mathematics, UBC
- 2018-2019 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, NumPy, Flux.jl, ReinforcementLearning.jl

Tools: Matlab, git, LaTeX

References

Philip Loewen	☎ +1 (604) 679-5969 ✉ loew@math.ubc.ca
Bhushan Gopaluni	☎ +1 (604) 314-6085 ✉ bhushan.gopaluni@ubc.ca
Michael Forbes	☎ +1 (778) 387-4090 ✉ Michael.Forbes@Honeywell.com