

# 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

- 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

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## 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

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## Talks

### Invited

- 2024 “Predictive control from the perspective of reinforcement learning”  
Upper Bound, Edmonton (forthcoming)
- 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)

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## 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 B.Sc. 2020  
Chakraborty, Farbod Chamanian

## 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  —  
 loew@math.ubc.ca  
Bhushan Gopaluni  —  
 bhushan.gopaluni@ubc.ca  
Michael Forbes  —  
 Michael.Forbes@Honeywell.com