Faraz Khoshbakhtian

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About Me

- Leveraging a unique blend of philosophical background, machine learning expertise, operations research, and full-stack development to solve complex real-world challenges
- Expert in representation learning, reinforcement learning, operations research, and agentic AI systems with track record at Amazon, Mastercard, and RBC
- Leading innovative projects in pandemic modeling, transportation optimization, and strategic network analysis

Education

Ph.D., Industrial engineering, University of Toronto (CGPA:4.00)   Expected 2025
- Thesis: Learning to detect critical nodes in large networks with applications to strategic vaccination
- Supervisor: Dionne M. Aleman, Ph.D.

H.B.Sc., Philosophy, Computer Science, and Statistics, University of Toronto (CGPA:3.7)   2020

Professional Experience

Applied science intern, Amazon   Summer 2024
- Developed a novel self-supervised learning platform for evaluating and optimizing Amazon Air's transportation networks.

Applied science intern, Mastercard   2023-2024
- Developed novel multi-task, multi-encoder self-supervised algorithms for generalized learning on graphs. Proposed models significantly improved performance for a variety of downstream learning tasks.

Data scientist and software developer, Ctrl Designer   2017-2019
- Applied machine learning techniques to optimize and automate industrial processes and developed full-stack web-applications for delivering tools to customers.

Data scientist, RBC   Summer 2021
- Designed, implemented, and validated climate analytics tools using interpretable machine learning and statistics. Extensively used Hadoop and Spark to handle big data, train models, and interpret them.

Developer and curriculum writer, Code at the Edge   2018-2019
- Developed educational tools and comprehensive curriculum for teaching computer science fundamentals to high school students in remote Himalayan villages.

Department assistant, Department of Philosophy, University of Toronto   Summer 2018

Research assistant, Scholars in Residence, University of Toronto   Summer 2017

Areas of Expertise and Technical Skills

ML science: graph neural networks, representation learning, reinforcement learning, self-supervised learning, deep neural networks, transformer architecture, training dynamics, interpretability

LLM engineering: agentic systems, RAGs, GraphRAGs, AgentOps, Bedrock, LangChain, LangGraph, CrewAI, Pydantic, PydanticAI, MCP

Software engineering: Python, C++, Java, Mojo, MLflow, Weights & Biases, Django, FastAPI, PyTorch, PyG, DGL, Gurobi

Cloud & infrastructure: AWS, CI/CD, SageMaker, Hadoop, Spark, Distributed Computing, Database Management Systems, KumoAI

Domain expertise: machine learning theory, data engineering, operations research, combinatorial optimization, computer science theory, pandemic modelling, large-scale agent-based simulation, recommendation systems, data analytics

Notable Projects

Q-learning CNDP (In progress)

- Deep reinforcement learning suite for critical node detection in large networks, featuring diverse training strategies, model architectures, and interpretability tools. Flexible design to support other combinatorial optimization problems.
- Built with Cython, Pydantic, PyTorch, and PyG.

MEGA (github.com/faraz2023/MEGA)

- Novel self-supervised, multi-encoder, and multi-task graph learning architecture for automated representation learning and feature engineering on relational data. Streamlines and significantly improves downstream learning projects.
- Developed in collaboration with Mastercard AI Garage; Built with PyTorch and DGL.

TuneCabinet (tunecabinet.farazkhoshbakhtian.ca)

- Novel agentic AI system for generating expressive musical composition (MIDI format) using off the shelf LLMs (e.g., Sonnet) and with natural language. Can be used to generate short musical ideas and full pieces.
- MIDI output format allows for complete control over the creative process for the artist.
- Built with CrewAI, LangGraph, and monitored with AgentStack; open sourced and freely available for use.

PanSim (pansim-demo.vercel.app)

- Led full-stack development of a pandemic simulation platform capable of modeling infectious disease spread across millions of agents.
- Built with Django, React, and AWS for an accessible, high-performance research tool

DailyZaphyr (github.com/faraz2023/daily_zephyr)

- Agentic AI system for automatic daily newspaper generation, focusing on geopolitical and market trends.
- Built with PerplexityAI, Tavily, and LangGraph; open sourced and freely available for use.

COVIDomaly (github.com/faraz2023/COVIDomaly)

- Developed a Convolutional Variational Autoencoder for anomaly detection of COVID-19 cases from chest X-ray images
- Built with PyTorch, TensorFlow, and OpenCV.

Publications

Published

1. Khoshbakhtian, F., Validi, H., Ventresca, M., Aleman, D. M. Distance-based critical node detection for effective vaccine policies. *Operations Research Letters.* 2024.

2. Khoshbakhtian, F., Gaurav, O., Aleman, A., and Asthana, S. MEGA: Multi-Encoder GNN Architecture for stronger task collaboration and generalization. *Lecture Notes in Computer Science Series (LNCS)*. 2024.

3. Khan, S. S., Khoshbakhtian, F., and Ashraf, A. B. Anomaly detection approach to identify early cases in a pandemic using chest X-rays. *Proceedings of the Canadian Conference on Artificial Intelligence*. 2021. doi: 10.21428/594757db.fab70f8a

Submitted

4. Khoshbakhtian, F., Ventresca, M., and Aleman, D. "MUSE-CN: MUlti-encoder Self-supervised Expert for learning to identify Critical Nodes in large graphs". submitted for publication in *KDD 2025* proceedings.

In-progress

5. Khoshbakhtian, F., Ventresca, M., Aleman, D. M. Q-learning for critical node detection: a comprehensive and modular learning suite for generalized CNDP. *targeted for INFORMS Journal on Computing.*

6. Khoshbakhtian, F., Ahamd, A., Cohen, A., and Aleman, D. M. Sequential critical node detection with beam search: a heuristic-agnostic approach. *targeted for INFORMS Journal on Computing.*

Pre-prints

7. Khoshbakhtian, F., Lagman, A., Aleman, D. M., Giffen, R., and Rahman, P. (2021). Prediction of severe COVID-19 infection at the time of testing: A machine learning approach. medRxiv. doi: 10.1101/2021.10.15.21264970v1

Teaching Experience

Head teaching assistant, University of Toronto   2018-2024

- Courses: Big Data Science (MIE1628); Data Modelling (MIE253); Fundamentals of Object-Oriented Programming (MIE250); Fundamentals of Computer Programming (APS106); Introduction to Philosophy (PHL101)

Leadership and Service

Co-Founder, Executive Member, University of Toronto Students for a Free Iran   2022-2024

Co-Director, Marketing Team, ILead:Grad, University of Toronto Faculty of Applied Science & Engineering   2020-2021

Co-Lead, Design Team, Cyrus International Film Festival of Toronto   2016-2018

Conference and Workshop Presentations

(***bold** for presenter)

1. **Khoshbakhtian, F.**, Ahamd, A., Cohen, A., and Aleman, D. M. Enhancing critical node detection with beam search: a heuristic-agnostic approach. INFORMS Annual Meeting. Seattle, US. October 2024.

2. **Khoshbakhtian, F.**, Gaurav, O., Aleman, A., and Asthana, S. MEGA: Multi-Encoder GNN Architecture for stronger task collaboration and generalization. ECML PKDD. Vilnius Lithuania, September 2024.

3. **Khoshbakhtian, F.**, Ahamd, A., Cohen, A., and Aleman, D. M. Enhancing critical node detection with beam search: a heuristic-agnostic approach. CORS Annual Meeting. London, Canada. June 2024.

4. **Khoshbakhtian, F.**, Validi, H., Ventresca, M., Aleman, D. M. Distance-based critical node detection for effective vaccine policies. INFORMS Annual Meeting. Phoenix, US. October 2023.

5. **Khoshbakhtian, F.**, Validi, H., Ventresca, M., Aleman, D. M. Distance-based critical node detection for effective vaccine policies. INFORMS Healthcare. Toronto, Canada. July 2023.

6. **Khoshbakhtian, F.**, Validi, H., Ventresca, M., Aleman, D. M. Distance-based critical node detection for effective vaccine policies. CORS / Optimization Days. Montreal, Canada. May 2023.

7. Khoshbakhtian, F., Validi, H., Ventresca, M., **Aleman, D. M.** Distance-based critical node detection for effective vaccine policies. Panoptic: view on global optimization. Florida, US. March 2023.

8. **Khoshbakhtian, F.**, Lagman, A., Aleman, D. M., Giffen, R., and Rahman, P. Prediction of severe COVID-19 infection at the time of testing: A machine learning approach. *CORS/INFORMS International Conference*. Vancouver, Canada. June 2022.

9. **Pirmorad, E.**, Khoshbakhtian, F., Mansouri, F., and Farahmand, A. M. Deep reinforcement learning for online control of stochastic partial differential equations. Spotlight presentation at *The Symbiosis of Deep Learning and Differential Equations*. virtual. Dec 2021.

10. **Khoshbaktian, F.** Machine learning for early detection of severe COVID infection. *University of Toronto Engineering Research Conference (UTERC)*. virtual, Canada. July 2021.

11. **Navabzadeh, F.**, Khoshbakhtian, F., Aleman, D. M., Giffen, R., and Rahman, P. Machine learning to predict clinical outcomes of psoriasis patients (*invited presentation*). INFORMS Healthcare Conference. virtual, Canada. July 2021

Awards

- MITACS Accelerate award (toward applied science internship at Mastercard) ($17,500) (2024)
- Ontario graduate scholarship (OGS) ($15,000) (2023-2024)
- MITACS Accelerate award (toward applied science internship at Mastercard) ($15,000) (2023)
- Emerging and Pandemic Infections Consortium (EPIC) doctoral award ($10,000) (2023)
- 6T6 Industrial Engineering 50th Anniversary Award in Healthcare Engineering ($3,000) (2022)
- Faculty of Applied Science & Engineering Graduate Student Endowment Award ($3,000) (2020)
- Woodsworth College Brookfield's Leadership Scholarship ($6,000) (2018)
- Jackman Humanities Scholars in Residence Scholarship ($1,500) (2017)
- Sam & Mary Restivo Family Admission Scholarship ($1,200) (2015)

Mentorship

Name	Timeline	Current Position	Project Description
Ali Ahmad	2023-2025	Student at UofT	Beam search strategies for enhancing critical node detection in large graphs
Issa Al Rawwash	2024	Student at UofT	Full-stack application development for pandemic modelling and mitigation
Yousef Al Rawwash	2023	Machine learning engineer at AMD	Large scale pandemic simulation modelling on distributed systems
Solar Rezaei	Summer 2022	Engineering career center peer coach at UofT	Large scale pandemic simulation modelling on distributed systems
Ardian Lagman	2021-2022	Data scientist at Swiss Re	Prediction of severe COVID-19 infection at the time of testing
Fereshteh Navabzadeh	Summer 2020	Senior SDE at theScore	Machine learning to predict clinical outcomes of psoriasis patients