Muhammad Sulaiman

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About me

I am a fifth-year CS Ph.D. student at the University of Waterloo. I am passionate about using artificial intelligence for autonomous management and orchestration of mobile networks.

Education

- **University of Waterloo** — Waterloo, ON
  Ph.D. *in Computer Science; Area of research: Mobile network management,* — *Jan. 2022 – Present*
  CGPA: 96.7/100, Supervisor: Prof. Raouf Boutaba
  Expected Graduation: Sept. 2026

- **University of Waterloo** — Waterloo, ON
  MMATH. *in Computer Science; Area of research: Mobile network management,* — *Sept. 2020 – Jan. 2022*
  Fast-tracked to Ph.D, Supervisor: Prof. Raouf Boutaba

- **National University of Sciences and Technology (NUST)** — Islamabad, PK
  Bachelor of Engineering. *in Electrical Eng* — *Sept. 2015 – Jul. 2019*
  CGPA: 3.89/4, Project advisor: Prof. Seyd Ali Hassan

Publications

- **M. Sulaiman**, B. Sun, M. A. Salahuddin, R. Boutaba, and A. Saleh, "Data-driven Online Slice Admission Control and Resource Allocation for 5G and Beyond Networks," *arXiv (Under Review)*, 2025. [PDF].
- **M. Sulaiman**, B. Sun, M. A. Salahuddin, R. Boutaba, and A. Saleh, "vNetRunner: Per-VNF Slice Modeling for 5G and Beyond Networks," in Proceedings of IEEE/IFIP Network Operations and Management Symposium (NOMS), 2025. [PDF].
- **M. Sulaiman**, M. Ahmadi, B. Sun, N. Saha, M. A. Salahuddin, R. Boutaba, and A. Saleh, "MicroOpt: Model-driven Slice Resource Optimization in 5G and Beyond Networks," *arXiv (Under Review)*, 2024. [PDF].
- N. Saha, N. Shahriar, **M. Sulaiman**, N. Limam, R. Boutaba, and A. Saleh, "Monarch: Monitoring Architecture for 5G and Beyond Network Slices," *IEEE Transactions on Network and Service Management (TNSM)*, 2024. [PDF].
- M. Ahmadi, A. Moayyedi, **M. Sulaiman**, M. A. Salahuddin, R. Boutaba, and A. Saleh, "Generalizable 5G RAN/MEC Slicing and Admission Control for Reliable Network Operation," IEEE Transactions on Network and Service Management (TNSM), 2024. [PDF].
- **M. Sulaiman**, M. Ahmadi, M. A. Salahuddin, R. Boutaba, and A. Saleh, "Generalizable Resource Scaling of 5G Slices using Constrained Reinforcement Learning," in Proceedings of IEEE/IFIP Network Operations and Management Symposium (NOMS), 2023. [PDF].
- **M. Sulaiman**, A. Moayyedi, M. Ahmadi, M. A. Salahuddin, R. Boutaba, and A. Saleh, "Coordinated Slicing and Admission Control Using Multi-Agent Deep Reinforcement Learning," IEEE Transactions on Network and Service Management (TNSM), 2022. [PDF].
- **M. Sulaiman**, A. Moayyedi, M. A. Salahuddin, R. Boutaba, and A. Saleh, "Multi-Agent Deep Reinforcement Learning for Slicing and Admission Control in 5G C-RAN," in Proceedings of IEEE/IFIP Network Operations and Management Symposium (NOMS), 2022. [PDF].
- **M. Sulaiman**, S. A. Hassan, H. Jung, "True Detect: Deep Learning-based Device-Free Activity Recognition using WiFi," in Proceedings of the IEEE Wireless Communications and Networking Conference Workshops (WCNCW), 2020. [PDF].

Research and Technical Experience

- **University of Waterloo**
  PhD Research Assistant *Sept. 2020 - Present*
  - **5G Testbed Deployment**: Deployed end-to-end (E2E) in-lab 5G testbeds, including simulated and real UEs, RAN, transport, and core network components. Containerized and deployed several open-source network function implementations (srsRAN, OAI, Free5GC, Open5GS, OvS, P4) using Kubernetes. Developed and integrated scalable low-level network monitoring framework with the testbed. Published containers, deployment instructions, and datasets on GitHub to support reproducibility and collaboration.
  - **Autonomous 5G Network Slicing**: Addressed the gaps in SOTA literature on 5G slice modeling, 5G slice admission control (SAC), and resource allocation. Developed a novel slice modeling approach, and proposed an online SAC framework with a theoretical performance guarantee for practical applicability. Proposed an RL-based framework for dynamic resource scaling of 5G slices. Validated the different solutions on an in-lab 5G testbed.
  - **Workshops and Use-Case Deployment**: Showcased network slicing, scalable monitoring, and resource scaling algorithms by conducting workshops, and demo'ing use-cases at multiple Rogers' annual showcases. Demonstrated applications included cloud gaming (Moonlight, Sunshine) and VR gaming (Virtual Desktop, Meta Quest Link).
- **Information Processing and Transmission Lab, NUST**
  Ungraduate Research Assistant *Jun. 2018 - Aug. 2018*
  - **Activity recognition using Channel State Information**: Developed expertise in Universal Software Radio Peripherals (USPRs) using GNU Radio. Researched Channel State Information (CSI) obtained through laptop NIC for activity recognition. Developed a ML-based Live Activity Recognition Framework using MATLAB.

Teaching Experience

- **Teaching Assistant**
  - **CS115 Introduction to Computer Science** *Course homepage*
  - **CS136 Elementary Algorithm Design and Data Abstraction** *Course homepage*
  - **CS456 Computer Networks** *Instr: Prof.Mohammad Ali Salahuddin*
  - **CS485: Foundations of Machine Learning** *Instr: Prof. Shai Ben David*

Honors and Awards

- Won the conference best paper award at the Network Operations and Management Symposium, 2023.
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- Awarded the travel grant for Network Operations and Management Symposium, held in Budapest, Hungary.
- Received Cheriton Scholarship for Winter 2023. Awarded to top 5 students based on scholastic excellence.
- Received the Entrance Award of David Cheriton School of Computer Science, University of Waterloo.
- Received principal's appreciation certificate for excellent academic performance, twice, during undergrad.

Relevant Courses

Introduction to Machine Learning	*97/100*	Software Eng.for Big Data & AI	*96/100*
Advanced Network Architectures	*95/100*	Neural Networks	*100/100*
Network Softwarization	*99/100*	Programmable Networks	*98/100*
Reinforcement Learning	*99/100*	Robust Machine Learning	*97/100*
Robustness of Machine Learning	*97/100*	Human-Computer Interaction	*89/100*

Certifications

- **Machine Learning (2018)**: Issued by Stanford University.
- **Convolutional Neural Networks (2019)**: Issued by DeepLearning.AI.
- **Structuring Machine Learning Projects (2019)**: Issued by DeepLearning.AI.
- **Improving Deep Neural Networks: Hyperparameter Tuning, Regularization, and Optimization (2019)**: Issued by DeepLearning.AI.
- **Neural Networks and Deep Learning (2019)**: Issued by DeepLearning.AI.

Technical Strength

Programming	C/C++, Python, Bash, Git, MATLAB/R
Networking	Linux networking, Open vSwitch, ONOS, P4
Data	Spark, Hadoop, Elasticsearch, Pytorch, Tensorflow, Pandas
Cloud	OpenStack, Kubernetes, Docker