

# Muhammad Sulaiman

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## ABOUT ME

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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

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- **University of Waterloo** Waterloo, ON  
*Ph.D. in Computer Science; Area of research: Mobile network management,*  
*CGPA: 96.7/100, Supervisor: Prof. Raouf Boutaba* *Jan. 2022 – Present*  
*Expected Graduation: Sept. 2026*
- **University of Waterloo** Waterloo, ON  
*MMATH. in Computer Science; Area of research: Mobile network management,*  
*Fast-tracked to Ph.D, Supervisor: Prof. Raouf Boutaba* *Sept. 2020 – Jan. 2022*
- **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

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- **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.
- **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 at TNSM)*, 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

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### • 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

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### • Teaching Assistant

- **CS115 Introduction to Computer Science**
- **CS136 Elementary Algorithm Design and Data Abstraction**
- **CS456 Computer Networks**
- **CS485: Foundations of Machine Learning**

*Course homepage*

*Course homepage*

*Instr: Prof. Mohammad Ali Salahuddin*

*Instr: Prof. Shai Ben David*

## HONORS AND AWARDS

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- Won the conference best paper award at the Network Operations and Management Symposium, 2023.
- Won the conference best paper award at Network Operations and Management Symposium, 2022.
- 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

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|                                  |        |                                |         |
|----------------------------------|--------|--------------------------------|---------|
| 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

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- **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

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