

Muhammad Sulaiman

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ABOUT ME

Final-year Ph.D. candidate at the University of Waterloo, specializing in AI-native 5G network management and orchestration. My research applies machine learning and optimization to slice orchestration, dynamic resource allocation, network digital twins, and intelligent RAN control at PHY/MAC layers. I have extensive experience deploying 5G testbeds with open-source O-RAN implementations (OAI, srsRAN, UERANSIM, Open5GS), validating novel theoretical algorithms on practical systems, with several publications in top IEEE venues.

EDUCATION

- **Ph.D. in Computer Science | University of Waterloo**

Waterloo, Canada

Area of research: AI-native network operation and management

CGPA: 96.7/100, Supervisor: Prof. Raouf Boutaba

Expected Graduation: Sept. 2026

Jan. 2022 – Present

- **Master's of Mathematics in Computer Science | University of Waterloo**

Waterloo, Canada

Area of research: AI-native network operation and management

Fast-tracked to Ph.D (degree not conferred), Supervisor: Prof. Raouf Boutaba

Sept. 2020 – Jan. 2022

- **Bachelor of Eng. in Electrical Eng. | NUST**

Islamabad, Pakistan

Area of research: WiFi Channel State Information for Activity Recognition

CGPA: 3.89/4, Project advisor: Prof. Seyd Ali Hassan

Sept. 2015 – Jul. 2019

EXPERIENCE

- **Ericsson, Ottawa**

AI/ML Software Development Intern

May 2025 - Dec 2025

Projects: [AI-native Link Adaptation](#)

- **Rogers Communications / MITACS, Waterloo**

MITACS Research Intern

May 2021 - Dec 2024

Project: [5G-ELITE – AI-driven 5G Network Slice Operations & Management](#)

- **Hardware Lab, University of Waterloo**

PhD Research Assistant

Sept. 2020 - May 2025

Projects: [5G Testbed and Use-case Deployment](#), [Network Digital Twins](#),

[Adaptive Network Monitoring](#), [5G Service Orchestration](#), [Dynamic Resource Management](#)

- **Information Processing and Transmission Lab, NUST**

Undergraduate Research Assistant

Jun. 2018 - Aug. 2018

Projects: [CSI-based Activity Recognition](#)

PROJECTS

- **5G Testbed and Use-case Deployment | Docker, Kubernetes, srsRAN, OAI, Free5GC, Open5GS, UERANSIM, USRP SDRs, OvS, ONOS, P4, Moonrise/Sunshine, SteamVR/MetaQuest**

◦ Containerized and automated the deployment of fully functional 5G testbeds.

◦ Enabled experimentation and validation of intelligent algorithms.

◦ Deployed Cloud-gaming and VR use-cases over the 5G testbed.

◦ [\[Github Repo\]](#), [\[VR Gaming Demo\]](#)

- **Network Digital Twins | Bayesian Neural Networks, Transformers, Recurrent Neural Networks**

- Built AI-based digital twins of the 5G RAN, transport, and core networks for accurate network modeling.
- Proposed a novel flow-level chain-of-VNFs model for scalable, and generalizable slice modeling.
- [\[Dataset-1\]](#), [\[Dataset-2\]](#), [\[Workshop\]](#), Publications: [\[MicroOpt\]](#), [vNetRunner](#), [vChainNet](#)
- **Dynamic Resource Management** | Deep Reinforcement Learning, Primal-dual Optimization
 - Built AI-native approaches for end-to-end dynamic resource allocation in 5G networks.
 - Proposed constrained reinforcement learning and primal-dual based optimization algorithms for fast resource optimization while ensuring QoS constraints.
 - [\[Workshop\]](#), Publications: [\[MicroOpt\]](#), [GRS](#)
- **AI Native Link Adaptation** | Deep Learning, Reinforcement Learning
 - Designed and validated AI algorithms for dynamic link adaptation in 5G RAN.
 - Leveraged advanced AI algorithms to enable real-time modulation and coding scheme (MCS) selection to maximize throughput.
 - [\[Press release\]](#)
- **Adaptive Network Monitoring** | Kubernetes, Grafana, Prometheus, Spark, Logstash, Kafka, Hadoop
 - Designed and deployed a big-data processing store and process large scale network data. Optimized for query speed and long-term data storage.
 - Engineered an adaptive cloud-native monitoring framework for slice-level KPI monitoring with capability to dynamically adjust data collection granularity and reduce monitoring overhead.
 - Publications: [\[Data Processing Pipeline\]](#), [MonArch](#)
- **5G Service Orchestration** | Multi-agent DRL, Graph Neural Networks (GNNs), Ray RLlib, Stable Baselines
 - Developed intelligent orchestration algorithms for slice admission control and VNF placement in 5G.
 - Proposed multi-agent DRL for joint slicing and admission control, and Graph Attention Nets for generalizable VNF embedding.
 - Publications: [\[DSAC\]](#), [MADRL](#), [CSAC](#), [G-SAC](#)
- **CSI-based Activity Recognition** | WiFi CSI, GNU Radio, Convolutional neural nets (CNNs), MATLAB
 - Designed an activity recognition framework leveraging WiFi Channel State Information (CSI).
 - Used CNNs for classification, and MATLAB for real-time signal processing and inference.
 - [\[GitHub Repo\]](#), Publications: [\[TrueDetect\]](#)

PUBLICATIONS

JOURNAL ARTICLES

- **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,” *IEEE Transactions on Network and Service Management (TNSM)*, 2025. [\[PDF\]](#) [\[MicroOpt\]](#)
- 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. [\[PDF\]](#) [\[Monarch\]](#)
- 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. [\[PDF\]](#) [\[G-SAC\]](#)

- **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. [\[PDF\]](#) [CSAC]

CONFERENCE PROCEEDINGS

- **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*, 2025 (Under review at INFOCOM '26). [\[PDF\]](#) [DSAC]
- H. Ahmed, S. Mostafa, **M. Sulaiman**, R. Boutaba, and M. Youssef, “vChainNet: Accurate and Scalable End-to-End Slice Modeling for 5G and Beyond Networks,” *To appear in: International Conference on Wireless Networks and Mobile Communications (WINCOM)*, 2026. [vChainNet]
- **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. [\[PDF\]](#) [vNetRunner]
- **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. [\[PDF\]](#) [GRS]
- **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. [\[PDF\]](#) [MADRL]
- **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. [\[PDF\]](#) [TrueDetect]

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.
- Won the conference **best paper award** at Network Operations and Management Symposium, 2022.
- Awarded **travel grant** for Network Operations and Management Symposium, held in Budapest, Hungary.
- Received **Cheriton Scholarship**. 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, NUST, Pakistan.

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

AI	Torch, Tensorflow, Stable Baselines, RLlib, CNNs, Transformers, GNNs, Attention Nets.
Programming	C/C++, Python, Bash, Git, MATLAB/R
Networking	Linux networking, Open vSwitch, ONOS, P4
Open RAN	OpenAirInterface, srsRAN, UERANSIM, Free5GC, Open5GS, USRP SDRs, GNU Radio
Data	Spark, Hadoop, Elasticsearch, Pandas
Cloud	OpenStack, Kubernetes, Docker