Muhammad Sulaiman

Personal Website
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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

Experience

- **Ericsson, Ottawa**
  AI/ML Software Development Intern — *May 2025 - Dec 2025*
  Projects: AI-native Link Adaptation

- **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

- **Rogers Communications / MITACS, Waterloo**
  MITACS Research Intern — *May 2021 - Dec 2024*
  Project: 5G-ELITE – AI-driven 5G Network Slice Operations & 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**
  Containerized and automated the deployment of a fully functional 5G testbed integrating srsRAN and Open5GS, enabling experimentation and validation of intelligent algorithms. Also deployed Cloud-gaming and VR use-cases over the 5G testbed. Relvant tools: Kubernetes, srsRAN, OAI, Free5GC, Open5GS, OvS, ONOS, P4, Moonrise/Sunshine, SteamVR/MetaQuest [Testbed Repo], [VR Gaming Demo]

- **Network Digital Twins**
  Built AI-based digital twins of the 5G network for accurate, scalable and generalizable network modeling. Relevant tools: Bayesian Neural Networks, Transformers, Recurrent Neural Networks. [Dataset-1], [Dataset-2] [Workshop], Publications: [vChainNet, vNetRunner, MicroOpt]

- **Dynamic Resource Management**
  Implemented reinforcement learning and traditional optimization based algorithms for end-to-end dynamic resource allocation in 5G network, ensuring efficient resource utilization while meeting Quality of Service (QoS) constraints. Relevant tools: Constrained Deep Reinforcement Learning, Primal-dual Optimization [Workshop], Publications: [MicroOpt, GRS]

- **AI Native Link Adaptation**
  Designed and validated several AI-algorithms for dynamic link adaptation in 5G networks, enabling real-time modulation and coding scheme (MCS) selection under dynamic wireless conditions. Leveraged advanced deep learning algorithms to outperform current approachs for enhanced spectral efficiency. [Press release]

- **Adaptive Network Monitoring**
  Deployed a big-data processing pipeline and Engineered an adaptive cloud-native monitoring framework for slice-level KPI monitoring that dynamically adjusts data collection granularity to reduce monitoring overhead. Tools used: Kubernetes, Graphana, Prometheus, Spark, Logstash, Kafka, Hadoop. [Data Processing Pipeline] Publication: [MonArch]

- **5G Service Orchestration**
  Developed intelligent orchestration mechanisms for automating service provisioning addressing problems of Slice Admission Control, and VNF embedding in 5G networks. Relevant tools: Multi-agent DRL, Graph Neural Networks, Ray RLlib. Publications: [DSAC, MADRL, CSAC, G-SAC]

- **CSI-based Activity Recognition**
  Designed a CSI-based activity recognition system leveraging wireless signal patterns to classify human activities, enhancing applications in security, healthcare, and smart environments. [GitHub] Publications: [TrueDetect]

Publications

- 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, "Data-driven Online Slice Admission Control and Resource Allocation for 5G and Beyond Networks," *arXiv*, 2025 (Under review at INFOCOM '26). [PDF]. [**DSAC**]

- **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, 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**, 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. 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**]
- **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 the 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
Programming	C/C++, Python, Bash, Git, MATLAB/R
Networking	Linux networking, Open vSwitch, ONOS, P4
Open RAN	OpenAirInterface, srsRAN, UERANSIM, Free5GC, Open5GS
Data	Spark, Hadoop, Elasticsearch, Pandas
Cloud	OpenStack, Kubernetes, Docker