ANNUS ZULFIQAR

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EDUCATION

University of Michigan   Ann Arbor, MI
Ph.D. in Computer Science Engineering   Jan 2025 - Present
Area: *Programmable Networks, Domain-Specific Architectures*
Advisor: Muhammad Shahbaz

Purdue University   West Lafayette, IN
Ph.D. in Computer Science   Sep 2021 - Dec 2024
Area: *Programmable Networks, Domain-Specific Architectures*
Advisor: Muhammad Shahbaz

National University of Sciences and Technology (NUST)   Islamabad, PK
Bachelor of Electrical Engineering (GPA: 3.96/4.00)   Sep 2015 - May 2019
Thesis: *End-to-End Forest Cover Detection and Change Estimation*
Advisors: Muhammad Shahzad, Faisal Shafait

ACADEMIC RESEARCH

Next-Generation Architectures Lab, University of Michigan   Ann Arbor, MI
Graduate Student Research Assistant   Jan 2025 - Present
Advisor: Muhammad Shahbaz

- Building advanced caching mechanisms for modern SmartNICs
  Collaborators: Ben Pfaff (Feldera/VMware) and team
- Built an architecture search framework for scalable decision trees in the data plane
  Collaborators: Walter Willinger and team

Next-Generation Architectures Lab, Purdue University   West Lafayette, IN
Research Assistant   Aug 2021 - Dec 2024
Advisor: Muhammad Shahbaz

- Explored architectures for the *slow-path* at the control-plane/data-plane interface in SDN
  Collaborators: Ben Pfaff (Feldera/VMware) and team
- Built a Neural Architecture Search framework (Homunculus) for emerging ML-capable data planes
  Collaborators: Kunle Olukotun (Stanford) and team

Pervasive Parallelism Laboratory, Stanford University   Stanford, CA
Remote Researcher   Sep 2020 - Jan 2021
Mentor: Muhammad Shahbaz

- Designed discrete-event network simulations for data center load balancing algorithms

Technical University of Kaiserslautern (TUK)   Kaiserslautern, DE
Research Intern   Jun - Sep 2018
Funded by DAAD

- Worked on multi-temporal forest cover change detection to analyze the largest
  afforestation drive in Pakistan using remote sensing imagery and deep learning

TUKL Lab, NUST   Jun 2017 - May 2019
Research Intern   Islamabad, PK
Advisors: Faisal Shafait, Muhammad Shahzad

- Worked on document processing and land cover classification problems using
  object detection and sequence learning techniques from deep learning

INDUSTRY EXPERIENCE

VMware Research Group (VRG) May - Aug 2022
Research Intern Palo Alto, CA
Mentor: Ben Pfaff
- Characterized the Open vSwitch *slow path* performance bottlenecks and proposed to build an accelerator for the *slow path*

Center for Advanced Research in Engineering (CARE) Jun 2019 - Jul 2021
Design Engineer Islamabad, PK
- Designed Ethernet/Wi-Fi/LTE-capable PoE-enabled IoT Sensor Networks for industrial machine sensing and telemetry

PUBLICATIONS ($* \rightarrow$ Equal contribution)

1. NetSparse: Hardware Acceleration for Distributed Sparse Kernels
   Gerasimos Gerogiannis, Charles Block, <u>Annus Zulfiqar</u>, Muhammad Shahbaz, Josep Torrellas
   In submission (ISCA 2025)

2. Gigaflow: Pipeline-Aware Sub-Traversal Caching for Modern SmartNICs
   <u>Annus Zulfiqar</u>, Ali Imran, Venkat Kunaparaju, Gianni Antichi, Ben Pfaff, Muhammad Shahbaz
   In submission (ASPLOS 2025)

3. Collect-And-Predict: A Recursive Abstraction for Scalable In-Network Model Inference
   Murayyiam Parvez∗, <u>Annus Zulfiqar</u>∗, Muhammad Shahbaz
   In preparation (SIGCOMM 2025)

4. A Smart Cache for a SmartNIC! – Scaling End-host Networking to 400Gbps & Beyond
   <u>Annus Zulfiqar</u>, Ali Imran, Venkat Kunaparaju, Gianni Antichi, Ben Pfaff, Muhammad Shahbaz
   HotChips 2024
   <u>Poster</u>

5. The Slow-Path Needs an Accelerator Too!
   <u>Annus Zulfiqar</u>, Gianni Antichi, Ben Pfaff, William Tu, Muhammad Shahbaz
   ACM SIGCOMM CCR 2023
   <u>Paper</u>

6. Homunculus: Auto-Generating Efficient Data-Plane ML Pipelines for Datacenter Networks
   Tushar Swamy, <u>Annus Zulfiqar</u>, Muhammad Shahbaz, Luigi Nardi, Kunle Olukotun
   ACM ASPLOS 2023
   Distinguished Artifact Award
   <u>Paper</u>, <u>Artifact</u>

7. AI-ForestWatch: Semantic Segmentation Based End-to-End Framework for Forest Estimation and Change Detection using Multi-Spectral Remote Sensing Imagery
   <u>Annus Zulfiqar</u>, Muhammad M. Ghaffar, Muhammad Shahzad, Christian Weis, Muhammad I. Malik, Faisal Shafait, Norbert Wehn
   SPIE Journal of Applied Remote Sensing 2021
   <u>Paper</u>

TUTORIALS

- Tutorial: In-Network Machine Learning using Taurus
  Tushar Swamy, <u>Annus Zulfiqar</u>, Alex Rucker, Muhammad Shahbaz, Kunle Olukotun
  ACM SIGCOMM 2022
  <u>Webpage</u>, <u>Artifact</u>

TALKS AND DEMOS

- Gigaflow: Pipeline-Aware Sub-Traversal Caching for Modern SmartNICs (with Demo) Oct 2024
  SRC JUMP 2.0 – Annual Review Meeting

- Gigaflow: Line-Rate, Pipeline-Aware Caching for Modern SmartNICs (with Demo) May 2024
  SRC JUMP 2.0 – Spring Meeting

- Homunculus: Auto-Generating Efficient Data-Plane ML Pipelines for Datacenter Networks Jul 2023
  SRC JUMP 2.0

- The Slow Path Needs an Accelerator Too! Aug 2022
  VMware Research Group

TEACHING

- CS 38100 – Introduction to the Analysis of Algorithms (Graduate TA) Fall 2023

CERTIFICATIONS

- Tofino Native Architecture (TNA) & P4 February 2022
  Intel Connectivity Academy – Level 1A/B

HONORS AND AWARDS

- Distinguished Artifact Award for Homunculus (ASPLOS 2023)
- Ross Fellowship recipient at Purdue University
- Travel award for ASPLOS (2022), and SIGCOMM (2022)
- National (Pakistan) P@SHA ICT Awards Winner (with *WiserMachines*, IoT spin-off of CARE)
- Travel award for EECamp at KAIST, South Korea
- Funded internship offer for one year at DFKI, Kaiserslautern, Germany (passed)
- DAAD-funded internship at Technical University of Kaiserslautern (TUK), Germany
- NUST merit scholarship recipient from 2015 - 2019

REFERENCES

1. Muhammad Shahbaz (mshahbaz@purdue.edu)
   Purdue University

2. Gianni Antichi (gianni.antichi@polimi.it)
   Politecnico di Milano

3. Ben Pfaff (blp@cs.stanford.edu)
   Feldera