Annus Zulfiqar

Graduate Student and Research Assistant,
Computer Science and Engineering (CSE),
University of Michigan, Ann Arbor, MI

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EDUCATION

University of Michigan — Ann Arbor, MI
Ph.D. in Computer Science & Engineering — Sep 2021 - Present
Research: Programmable Networks, Domain-Specific Architectures
Advisor: Muhammad Shahbaz

National University of Sciences and Technology (NUST) — Islamabad, PK
Bachelor of Electrical Engineering — Sep 2015 - May 2019
Thesis: Forest Cover Detection and Change Estimation using Deep Learning
Advisors: Muhammad Shahzad, Faisal Shafait

HONORS AND AWARDS

- Selected as mentor for Google Summer of Code (GSoC) for P4 Language Consortium 2025
- Distinguished Artifact Award for Homunculus, ASPLOS 2023 2023
- Received conference travel grants: ASPLOS 2022, SIGCOMM 2022, NSDI 2025, SIGCOMM 2025 2022-25
- Ross Fellowship recipient at Purdue University 2021
- National P@SHA ICT Awards Winner with WiserMachines, IoT spin-off of CARE 2021
- MS EE/ECE acceptances: Stanford, UMichigan, UCLA, Columbia, Duke, NYU, KAIST (passed) 2020
- Travel award for graduate EEcamp at KAIST, South Korea 2018
- Funded internship offer for one year at DFKI, Kaiserslautern, Germany (passed) 2018
- DAAD-funded internship at Technical University of Kaiserslautern (TUK), Germany 2018
- NUST scholarship for top academic performance (4.00/4.00 GPA) 2015-19

PUBLICATIONS (*Equal Contribution)

Conference Papers

[Micro 2025] NetSparse: Hardware Acceleration for Distributed Sparse Kernels.
Gerasimos Gerogiannis, Charles Block, Dimitrios Merkouriadis, *Annus Zulfiqar*, Muhammad Shahbaz, and Josep Torrellas.

[ASPLOS 2025] Gigaflow: Pipeline-Aware Sub-Traversal Caching for Modern SmartNICs.
Annus Zulfiqar, Ali Imran, Venkat Kunaparaju, Gianni Antichi, Ben Pfaff, and Muhammad Shahbaz. (Paper, Code)

[ASPLOS 2023] Homunculus: Auto-Generating Efficient Data-Plane ML Pipelines for Datacenter Networks.
Tushar Swamy, *Annus Zulfiqar*, Muhammad Shahbaz, Luigi Nardi, and Kunle Olukotun. (Paper, Code)
Distinguished Artifact Award

Journal Articles

[SIGCOMM CCR 2023] The Slow-Path Needs an Accelerator Too!
Annus Zulfiqar, Gianni Antichi, Ben Pfaff, William Tu, and Muhammad Shahbaz. (Paper)

[Journal of Applied Remote Sensing (JARS) 2021] AI-ForestWatch: Semantic Segmentation Based End-to-End Framework for Forest Estimation and Change Detection using Multi-Spectral Remote Sensing Imagery.
Annus Zulfiqar, Muhammad M. Ghaffar, Muhammad Shahzad, Christian Weis, Muhammad I. Malik, Faisal Shafait, and Norbert Wehn. (Paper)

Conference & Workshop Extended Abstracts

[SIGCOMM 2025] KAIRO: Incremental View Maintenance for Scalable Virtual Switch Caching.
Annus Zulfiqar, Ben Pfaff, Gianni Antichi, Arpit Gupta, and Muhammad Shahbaz. (Poster)

[NSDI 2025] BRANCHPIPE: Scalable Decision Trees for Stateful Processing at Line Rate.
*Annus Zulfiqar**, Murayyiam Parvez*, Sylee Beltiukov, Shir Landau-Feibish, Arpit Gupta, Walter Willinger, and Muhammad Shahbaz. (Poster)

[NSDI 2025] A Smart Cache for a SmartNIC! Rethinking Caching, Locality, & Revalidation for Modern Virtual Switches. *Annus Zulfiqar*, Ali Imran, Venkat Kunaparaju, Gianni Antichi, Ben Pfaff, and Muhammad Shahbaz. (Poster)

[SRC TECHCON 2025] SPLIDT: Partitioned Decision Trees for Scalable Stateful ML Inference at Line Rate.
Marilyn Rego, Murayyiam Parvez, *Annus Zulfiqar*, Sylee Beltiukov, Shir Landau-Feibish, Arpit Gupta, Walter Willinger, and Muhammad Shahbaz.

[Hot Chips 2024] A Smart Cache for a SmartNIC! – Scaling End-host Networking to 400Gbps & Beyond.
Annus Zulfiqar, Ali Imran, Venkat Kunaparaju, Gianni Antichi, Ben Pfaff, and Muhammad Shahbaz. (Poster)

[SRC TECHCON 2024] GigaFlow: A Scalable and Efficient Hardware Fast-Path for Open vSwitch.
Venkat Kunaparaju, *Annus Zulfiqar*, Ali Imran, Gianni Antichi, Ben Pfaff, and Muhammad Shahbaz.

TUTORIALS

[SIGCOMM 2022] Tutorial: In-Network Machine Learning using Taurus.
Tushar Swamy, *Annus Zulfiqar*, Alex Rucker, Muhammad Shahbaz, Kunle Olukotun. (Link, Code)

INVITED TALKS AND DEMOS

Gigaflow: Pipeline-Aware Sub-Traversal Caching for Modern SmartNICs

- P4 Developer Days Event (Link) — Jun 2025
- NetΣyn Lab, Princeton University — Apr 2025
- IBM Thomas J. Watson Research Center — Apr 2025
- Networked Systems Group (NSG), ETH Zurich — Apr 2025
- ACM ASPLOS Conference — Apr 2025
- Network Operations and Internet Security Lab, University of Chicago — Mar 2025
- Systems Seminar, University of Michigan — Mar 2025
- Politecnico di Milano — Mar 2025
- ACE Center for Evolvable Computing (Link), Annual Meeting (with demo) — Oct 2024
- ACE Center for Evolvable Computing (Link), Spring Meeting (with demo) — Mar 2024

Homunculus: Auto-Generating Efficient Data-Plane ML Pipelines for Datacenter Networks

- ACE Center for Evolvable Computing (Link) — Jul 2023

The Slow Path Needs an Accelerator Too!

- VMware Research Group (VRG) — Aug 2022

EXPERIENCE

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 and training framework for scalable decision trees in the data plane
  Collaborators: Walter Willinger and team

VMware Research Group Palo Alto, CA
Research Intern May - Aug 2022
Mentor: Ben Pfaff

- Characterized the Open vSwitch slow path performance bottlenecks and proposed to build an accelerator for the slow path

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 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

Center for Advanced Research in Engineering Islamabad, PK
Design Engineer Jun 2019 - Jul 2021
Manager: Dr. Shoab Khan

- Designed Ethernet/Wi-Fi/LTE-capable PoE-enabled IoT Sensor Networks for industrial machine sensing and telemetry

Technical University of Kaiserslautern Kaiserslautern, DE
Research Intern Jun - Sep 2018
Advisors: Norbert Wehn, Christian Weis

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

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

PROFESSIONAL SERVICE

- Program Committee (PC) Member – NSDI 2026 Artifact Evaluation
- Mentor – P4 Language Consortium, Google Summer of Code (GSoC) Jan 2025
- Volunteer Reviewer – Ph.D. Admissions Committee, University of Michigan Jan 2025

MENTORING EXPERIENCE

- Advay Singh, undergrad at University of Michigan – Cloud Infrastructure 2025 - Present
- Murayyiam Parvez, Ph.D. student at Purdue University – ML for Systems 2024 - Present
- Ali Imran, Ph.D. student at University of Michigan – SmartNICs, ML Systems 2024 - Present
- Venkat Kunaparaju, undergrad at Purdue University – Cloud Infrastructure 2023 - Present

TEACHING EXPERIENCE

- CS 38100 – Introduction to the Analysis of Algorithms Fall 2023

CERTIFICATIONS

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

REFERENCES

1. **Muhammad Shahbaz**
   Assistant Professor of Computer Science and Engineering (CSE) msbaz@umich.edu
   University of Michigan
2. **Gianni Antichi**
   Associate Professor of Computer Science gianni.antichi@polimi.it
   Politecnico di Milano
3. **Ben Pfaff**
   Chief Engineer/Co-Founder blp@cs.stanford.edu
   Feldera