# ANNUS ZULFIQAR

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## EDUCATION

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

**Purdue University** — West Lafayette, IN
Ph.D. in Computer Science (*Transferred to the University of Michigan*) — Sep 2021 - Dec 2024
Research: 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

## HONORS AND AWARDS

- Selected as mentor for Google Summer of Code (GSoC) for P4 Language Consortium — 2025
- Distinguished Artifact Award for Homunculus, ASPLOS'23 — 2023
- Student travel grants: ASPLOS 2022, SIGCOMM 2022, NSDI 2025 — 2022-25
- Ross Fellow 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 merit scholarship recipient — 2015-19

## PUBLICATIONS ($*$ → Equal Contribution)

### Conference Papers

[S&P Oakland 2026] SpliDT: Partitioned Decision Trees for Scalable Stateful Inference at Line Rate.
Murayyiam Parvez*, *Annus Zulfiqar**, Sylee Beltiukov, Shir Landau Feibish, Arpit Gupta, Walter Willinger, Muhammad Shahbaz. (In Submission)

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

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

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

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

**Workshop Papers**

[Hot Interconnects 2025] Reimagining RDMA Through the Lens of ML.
Ertza Warraich, Ali Imran, *Annus Zulfiqar*, Shay Vargaftik, Sonia Fahmy and Muhammad Shahbaz.
(In Submission)

**Conference & Workshop Extended Abstracts**

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

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

[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, Muhammad Shahbaz. (Poster)

**Journal Articles**

[**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, Norbert Wehn. (Paper)

## TUTORIALS

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

## TALKS AND DEMOS

- Gigaflow: Pipeline-Aware Sub-Traversal Caching for Modern SmartNICs — Mar - Jun 2025
  **Politecnico di Milano, University of Chicago, ETH Zurich, IBM Research**, **Princeton University, P4 Developer Days**
- 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**

## 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** 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*

**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** 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

**Technical University of Kaiserslautern** Kaiserslautern, DE
Research Intern Jun - Sep 2018

- 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

## PROFESSIONAL SERVICE

- Mentor — Google Summer of Code (GSoC), P4 Language Consortium Jan 2025
- Volunteer Reviewer — PhD Admissions Committee, University of Michigan Jan 2025

## MENTORING EXPERIENCE

- Advay Singh, undergrad at University of Michigan — Cloud Infrastructure 2025 - Present
- Murayyiam Parvez, PhD student at Purdue University — ML for Systems 2024 - Present
- Ali Imran, PhD 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 (Teaching Assistant) Fall 2023

## CERTIFICATIONS

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

## REFERENCES

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