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 (*Transferred to the University of Michigan*) — 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

HONORS AND AWARDS

- Distinguished Artifact Award for Homunculus (ASPLOS'23) — 2023
- Student travel grants: ASPLOS'22, SIGCOMM'22, NSDI'25 — 2022 - 2024
- 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 - 2019

PUBLICATIONS ($* \rightarrow$ Equal Contribution)

Conference Papers

1. 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
   SIGCOMM 2025 (In Preparation)

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

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

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

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

Journal Articles

1. 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
   SPIE Journal of Applied Remote Sensing 2021 [**Paper**]

Conference & Workshop Extended Abstracts

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

2. 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
   NSDI 2025 [Poster]

3. 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
   NSDI 2025 [**Poster**]

4. 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
   HotChips 2024 [**Poster**]

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 - Apr 2025
  Politecnico di Milano, University of Chicago, ETH Zurich, IBM Research, Princeton University
- 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

- 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