

# Annus Zulfiqar

Graduate Student and Research Assistant,  
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## EDUCATION

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### University of Michigan

Ph.D. in Computer Science & Engineering  
Research: Programmable Networks, Domain-Specific Architectures  
Advisor: Muhammad Shahbaz

Ann Arbor, MI  
Sep 2021 - Present

### National University of Sciences and Technology (NUST)

Bachelor of Electrical Engineering  
Thesis: Forest Cover Detection and Change Estimation using Deep Learning  
Advisors: Muhammad Shahzad, Faisal Shafait

Islamabad, PK  
Sep 2015 - May 2019

## HONORS AND AWARDS

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- 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)

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### 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](#))

## Preprints

[Arxiv 2025] SPLIDT: Partitioned Decision Trees for Scalable Stateful Inference at Line Rate. Murayyiam Parvez\*, *Annus Zulfiqar*\*, Sylee Beltiukov, Shir Landau-Feibish, Arpit Gupta, Walter Willinger, and Muhammad Shahbaz. ([Poster](#))

## 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. Murayyiam Parvez\*, *Annus Zulfiqar*\*, 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

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[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

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

- P4 Developer Days Event ([Link](#)) Jun 2025
- NetSvn 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

## OPEN SOURCE PROJECTS AND CONTRIBUTIONS

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- **aisuite** [★ 12.3K, 🍴 1.2K] <https://github.com/andrewyng/aisuite>
- **AI-ForestWatch** [★ 30, 🍴 8] <https://github.com/annusgit/ForestCoverChange>
- **Taurus In-Network ML** [★ 4, 🍴 1] <https://gitlab.com/dataplane-ai/tutorials/sigcomm22>
- **Gigaflow vSwitch** [★ 2, 🍴 4] <https://github.com/gigaflow-vswitch>
- **Homunculus Framework** <https://gitlab.com/dataplane-ai/homunculus/artifact-asplos23>

## EXPERIENCE

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### Next-Generation Architectures Lab, University of Michigan

Graduate Student Research Assistant

Advisor: Muhammad Shahbaz

Ann Arbor, MI

Jan 2025 - Present

- 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

Research Intern

Mentor: Ben Pfaff

Palo Alto, CA

May - Aug 2022

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

### Next-Generation Architectures Lab, Purdue University

Research Assistant

Advisor: Muhammad Shahbaz

West Lafayette, IN

Aug 2021 - Dec 2024

- 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

Remote Researcher

Mentor: Muhammad Shahbaz

Stanford, CA

Sep 2020 - Jan 2021

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

### Center for Advanced Research in Engineering

Design Engineer

Manager: Dr. Shoab Khan

Islamabad, PK

Jun 2019 - Jul 2021

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

### Technical University of Kaiserslautern

Research Intern

Advisors: Norbert Wehn, Christian Weis

Kaiserslautern, DE

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

Research Intern

Advisors: Faisal Shafait, Muhammad Shahzad

Islamabad, PK

Jun 2017 - May 2019

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

## PROFESSIONAL SERVICE

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

## MENTORING EXPERIENCE

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- 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

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

## CERTIFICATIONS

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

## REFERENCES

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