

# OSAMA YOUSUF

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## Education

### The George Washington University

Jan. 2021 – Present

*Doctor of Philosophy in Computer Engineering*

*Washington, DC*

- Advisor: Gina C. Adam, Funding: National Institute of Standards and Technology, University Fellowships.
- Dissertation: *Memristive Deep Learning Accelerators: Prototyping, Modeling, and Co-Designing Hardware-Software Algorithms*.
- GPA: 4.0.

### Habib University

Aug. 2016 – July 2020

*Bachelor of Science in Computer Science with a Minor in Mathematics*

*Karachi, Pakistan*

- Funding: Full-ride TOPS (Talent Outreach, Promotion & Support) Scholarship, Study Abroad Scholarship 2018, Research Abroad Scholarship 2019.
- Final Year Project: *Personal Outfit Recommendation System*, Advisor: Shahid Hussain.
- GPA: 3.92, awarded the Dean's Medal in Computer Science (Summa Cum Laude), consistently appeared on the Dean's and President's Lists for high academic achievement.

### Stanford University

Jun. 2018 – Aug. 2018

*International Honors Program*

*Stanford, CA*

- Funding: Study Abroad Scholarship from Habib University.
- Completed rigorous coursework in *Technology & Entrepreneurship* and *Web Development Technologies* that enhanced my expertise in building software as a service (SaaS).
- Participated in numerous networking events in the Bay Area and gained invaluable insights into the startup ecosystem of Silicon Valley.

## Relevant Coursework

- |                               |                                     |                                   |
|-------------------------------|-------------------------------------|-----------------------------------|
| • Deep Learning with Python   | • Design of VLSI circuits           | • Operating Systems               |
| • Reinforcement Learning      | • Parallel Computer Architecture    | • Database Systems                |
| • Artificial Intelligence     | • Nanoelectronics                   | • Geometrical Modeling & Analysis |
| • Natural Language Processing | • Design and Analysis of Algorithms | • Computer Graphics               |

## Work Experience

### National Institute of Standards and Technology

Jan. 2022 – Present

*Research Associate in the Alternative Computing Group*

*Gaithersburg, MD*

*A Resistive Neural Network Benchmarking Platform | Python, C, Verilog, Vivado, Uboot*

[3, 10]

- Leading the FPGA bring-up and application-level development of *Daffodil*, which is a novel prototyping platform for benchmarking resistive memory-based crossbar neural networks. It consists of a custom PCB housing an array of up to 20k emerging memory devices and connects to a Zynq-based FPGA host.
- Responsibilities include developing the FPGA design, custom RTL modules, a Linux Kernel based on Xilinx's PYNQ framework for the host FPGA, writing C drivers for SPI devices for Kernel and Programmable Logic (PL) interfacing, and developing device characterization and neural network benchmarking code in Python.
- Leading a study demonstrating parallel hardware inference with a multi-layer perceptron network trained to classify on the Wine Dataset.

*A Streaming Hardware Architecture for Training Neuromorphic Arrays | Python, PyTorch, C++, pyBind11*

[8, 11]

- Assisting in the design, characterization, and testing of a hardware-aware streaming singular value decomposition (SVD) algorithm for supervised and unsupervised learning over matrix manifolds.
- Responsibilities include developing a deep learning framework based on PyTorch that integrates network operations with C++ modules using pyBind11. The framework supports training multi-layer perceptron and transformer architectures, as well as automated hyperparameter optimization based on Bayesian techniques.

### The George Washington University

Jan 2021 – Present

*Graduate Research Assistant at the Department of Electrical and Computer Engineering*

*Washington, DC*

*Memristive Device & Neural Network Modeling | Python, PyTorch, R, Mathematica*

[1, 4, 9]

- Investigated a statistical modeling approach known as jump table modeling. Utilized synthetic and experimental models for efficiently simulating characteristics of a population of emerging memory devices (RRAM, FeFETs) such as conductance vs. applied voltage pulse.
- Developed a framework for training deep networks where layer weights are modeled by a pair of device jump tables, in turn simulating the training of a crossbar of emerging memory devices.
- Proposed novel metrics such as modeling bias, switching sign discrepancy, and prediction sign error for quantifying the goodness of a memristive device model. In addition, proposed a novel jump table model creation algorithm based on Bayesian hyperparameter optimization. Led a study investigating these concepts by training a multi-layer perceptron network on MNIST for image classification.

*Algorithms for Gradient Decomposition Methods | Python, C++, Mathematica*

[2, 5, 6, 7]

- Explored various low-rank, streaming matrix decomposition methods and investigated their applicability in efficiently training crossbar-based hardware neural networks.
- Led a project on identifying desired properties, features, and optimizations for a hardware-aware decomposition algorithm.

## **Stellic Inc.**

**Jul. 2020 – Jan. 2021**

*Frontend Engineer | JavaScript, AngularJS, Python, Django*

*Karachi, Pakistan*

- Worked for the experience engineering team for a startup based in the United States. The product was a modern degree auditing platform focused towards improving student graduation & retention rates.
- Responsibilities included adding new and modifying existing features to and from the codebase, logging changes, meeting bi-yearly development goals, coordinating with other development teams, and introducing continuous integration principles to the development workflow.
- Led quick delivery of several robust features to the product amidst the pandemic, most notably support for time zones, leading to positive feedback from students and advisors and eventually the adoption of Stellic by at least 6 new colleges within the United States.

## **Afiniti**

**Feb. 2020 – Jul. 2020**

*Production Analyst | Python, Bash, SQL, JIRA*

*Karachi, Pakistan*

- Worked for Afiniti's Global Production Support (GPS) team to ensure production operations run smoothly for clients globally. The product was an AI-based pairing algorithm for contact center agents and callers for businesses of all kinds.
- Responsibilities included providing operations support, post-deployment support to clients and internal teams, researching, documenting, and reporting all related incidents, as well as maintaining the health of system databases for clients.
- Utilized Python and Bash scripting to automate several manual workflows within the ticket creation and product monitoring process, improving the average time to identify real-time problems in deployments from several minutes down to a few seconds.

## **Texas A&M University**

**May 2019 – Aug. 2019**

*Research Intern at the Department of Computer Science and Engineering | Python, Gym, CARLA*

*College Station, TX*

- Served as a research scholar at the Pi Star AI and Optimization Lab, conducting collaborative research on a fully functioning code-base that enables an autonomous vehicle (AWS DeepRacer) to detect and follow race tracks through reinforcement learning and artificial intelligence.
- Led the development of a reinforcement learning framework for the CARLA simulator compatible with OpenAI's Gym library. This framework was later utilized by students within the lab for the validation of novel reinforcement algorithms for autonomous vehicles.

## **Habib University**

**Aug. 2017 – Jun. 2020**

*IT Manager, Teaching Assistant, Peer Tutor*

*Karachi, Pakistan*

- Worked at the department of Integrated Sciences & Mathematics at Habib University as the IT Manager at the student-run radio channel "Runway Radio". Responsible for developing a website for live broadcasting and day-to-day maintenance operations.
- Assisted the Dean of the Computer Science Program at Habib University with core design and individual recitation sessions for the course "Discrete Mathematics". Also served as a peer tutor at the Educational Help, Services and Academic Support (EHSAS) Center at Habib University.

## Research Work

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### Publications

1. **Yousuf, O.**, Hossen, I., Daniels, M. W., Lueker-Boden, M., Dienstfrey, A., Adam, G.C. (2023). Device Modeling Bias in ReRAM-based Neural Network Simulations. In *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, January 2023, doi: [10.1109/JETCAS.2023.3238295](https://doi.org/10.1109/JETCAS.2023.3238295).
2. Zhao, J., Huang, S., **Yousuf, O.**, Gao, Y., Hoskins, B. D., Adam, G.C. (2021). Gradient Decomposition Methods for Training Neural Networks with Non-Ideal Synaptic Devices. In *Frontiers in Neuroscience: Neuromorphic Computing 2021*, doi: [10.3389/fnins.2021.749811](https://doi.org/10.3389/fnins.2021.749811).
3. Hoskins, B. D., Ma, W., Fream, M., **Yousuf, O.**, Daniels, M. W., Goodwill, J., Madhavan, A., Tung, H., Branstad, M., Liu, M., Madsen, R., McClelland, J., Adam, G.C., Lueker-Boden, M. (2021). A System for Validating Resistive Neural Network Prototypes. In *International Conference on Neuromorphic Systems (ICONS)*, July 2021, doi: [10.1145/3477145.3477260](https://doi.org/10.1145/3477145.3477260).

### Posters & Presentations

4. **Yousuf, O.**, Hossen, I., Daniels, M. W., Lueker-Boden, M., Dienstfrey, A., Adam, G.C. (2022). Investigating Bias in the Modeling of ReRAM Devices. Poster Presentation at *International Conference on Memristive Materials, Devices & Systems (MEMRISYS)*, November-December 2022.
5. **Yousuf, O.**, Daniels, M. W., Dienstfrey, A., Adam, G.C. (2022). Towards a Hardware-Aware Decomposition Method for ReRAM Neural Network Training. Oral Presentation at *International Conference on Neuromorphic Systems (ICONS)*, July 2022.
6. **Yousuf, O.**, Daniels, M. W., Dienstfrey, A., Adam, G.C. (2022). Streaming Gradient Tracking using Non-negative Matrix Factorization. Poster Presentation at *GW Research Showcase, George Washington University*, April 2022.
7. **Yousuf, O.**, Zhao, J., Daniels, M. W., Hoskins, B. D., Ma, W., Maden, R., Lueker-Boden, M., Adam, G. C. (2021). Algorithmic improvements and optimizations for training memristor-based neural networks. Poster Presentation at *Innovation Bazaar by Western Digital: University Track, Neuromorphic Computing*, October 2021.
8. Daniels, M. W., Hoskins, B. D., Madhavan, A., **Yousuf, O.**, Adam, G. C., Branstad, M., Tung, H., Madsen, R., Lueker-Boden, M., McClelland, J., Stiles, M. D. Quasisystolic Arrays for Pipelined and Resource-Efficient Neural Network Training. Best Poster at *Sigma Xi NIST: AI, Machine Learning, Engineering, Nanotechnology, and Math*, March 2021.

### Ongoing Research

9. **Yousuf, O.**, Hossen, I., Glasmann, A.L., Najmaei, S., Adam, G.C. (2023). Neural Network Modeling Bias for Hafnia-based FeFETs. Submitted to *International Symposium on Nanoscale Architectures (NANOARCH) 2023*.
10. **Yousuf, O.**, Borders, W.A., Hoskins, B.D., Madhavan, A., Ramu, K., Adam, G.C. (2023). Experimental Demonstration of Inference with ReRAM devices using Daffodil: A Mixed-Signal Prototyping Platform. In plan for *Nature Communications: Neuromorphic Hardware and Computing 2023*.
11. Daniels, M. W., Hoskins, B. D., Madhavan, A., **Yousuf, O.**, Adam, G. C., Lueker-Boden, M., McClelland, J., Stiles, M. D. A Quasisystolic ASIC for Pipelined and Resource-Efficient Neural Network Training with Dense Neuromorphic Arrays. In plan for *Physical Review Applied*, 2024.

### Technical Skills

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**Languages:** Python, C, C++, C#, Verilog, HTML/CSS, R, JavaScript, SQL, Bash

**Visualization Tools:** Matplotlib, Mathematica

**Technologies/Frameworks:** PyTorch, NumPy, SciPy, Pandas, Tensorflow, AngularJS, Django, Linux, GitHub, pyBind11, Vivado, Uboot, hls4ml