Abdulrahman Mahmoud

Curriculum Vitae - December 2023

Contact Information

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Research Interests

My research interests are at the intersection of computer architecture, software system design, and machine learning, with the goal of co-designing future ML systems for high performance, scalable reliability, and intelligent resource allocation.

Keywords: Systems for ML; ML for Systems; Reliability and Robustness

Current Employment

Feb '21 – Present | **Harvard University**
Postdoctoral Research Fellow, School of Engineering and Applied Science (SEAS)
Advisors: David Brooks and Gu Yeon-Wei

Jun '23 – Present | **ControlRooms.ai**
Consultant, ML Methodologies for Anamoly Detection

Education

Aug '13 – Dec '20 | **University of Illinois at Urbana-Champaign (UIUC)**
PhD in Computer Science
Advisor: Sarita Adve
Recipient of the **Mavis Future Faculty Fellowship**
Thesis Title: *Towards Scalable and Specialized Application Error Analysis*

Sep '09 – May '13 | **Princeton University**
BSE in Electrical Engineering
Certificate (minor): Applications of Computing
Advisors: David Wentzlaff and Sharad Malik
Recipient of the **John Ogden Bigelow Jr. Prize** in Electrical Engineering
Thesis Title: *Parallel Architecture Optimization for Threaded Applications*

Research and Work Experiences

Dec '20 – June '21 | **Splice Machine**
Systems Engineer and Consultant, ML and Cloud Team
Supervisor: Ben Epstein

May '18 – Sept '18 | **Nvidia Corporation**
Graduate Research Intern, Computer Architecture Research Group
Supervisor: Steve Keckler; Mentor: Siva Hari

May '17 – Aug '17 | **Nvidia Corporation**
Graduate Research Intern, Computer Architecture Research Group
Supervisor: Steve Keckler; Mentor: Siva Hari

June '13 – Aug '13 | **ST Engineering iDirect**
Software Design Architect Intern, Embedded Devices Team
Supervisor: Assem Salama

June '11 – Sept '11 | **Mid-InfraRed Technologies for Health and Environment (MIRTHE)**
Research Experience for Undergraduates (REU), Princeton University
Advisor: Paul Prucnal

Awards and Distinctions

2022 Meta Silent Data Corruptions at Scale RfP Grant - Finalist
2021 Cultural Competence in Computing (3C) Fellow, Duke
2020 NextProf Nexus Future Faculty (1 of 59 invitations, USA), hosted by Berkeley, GTech, UMich
2019 Lynn Conway Research Award for Best Technical Demonstration at ADA, a JUMP center
2019 Mavis Future Faculty Fellowship for promising students pursuing academic careers, UIUC
2019 Heidelberg Laureate Forum Young Researcher (1 of 200 invitations worldwide)
2015 List of Teachers Ranked as Excellent by their Students (Campus Award), UIUC
2013 John Ogden Bigelow Jr. Prize in Electrical Engineering, Princeton
2013 Friedland Senior Thesis Fund for Senior Thesis Research, Princeton
2012 SEAS McCracken Senior Thesis Fund for Senior Thesis Research, Princeton
2012 Friedland Independent Work Fund for Junior Undergrad Research, Princeton
2011 Accenture SEAS Senior Thesis Fund for Junior Undergrad Research, Princeton

Publications

13 top-tier conference/journal papers, 8 workshop papers, 5 open-sourced research tools, 3 invited industry papers, and 1 awarded patent. Undergraduate^U and graduate^G students mentored by me labeled accordingly.

Peer-reviewed Conference Papers

c11. **[NeurIPS 2023] Hardware Resilience Properties of Text-Guided Image Classifiers**
Syed Talal Wasim^U, Kabila Haile Soboka^U, **Abdulrahman Mahmoud**, Salman Khan, David Brooks, Gu-Yeon Wei
In *Conference on Neural Information Processing Systems (NeurIPS), 2023*
Acceptance rate: 26%
* Novel training routine using GPT3 and CLIP to improve DNN accuracy and hardware reliability via textual-visual signaling.

c10. **[MLSys 2023] ApproxCaliper: A Programmable Framework for Application-aware Neural Network Optimization**
Yifan Zhao, Hashim Sharif, Peter Pao-Huang, Vatsin Shah, Arun Narenthiran Sivakumar, Mateus Valverde Gasparino, **Abdulrahman Mahmoud**, Nathan Zhao, Sarita Adve, Girish Chowdhary, Sasa Misailovic, Vikram Adve
In *Sixth Conference on Machine Learning and Systems (MLSys), 2023*
Acceptance rate: 22%
* Enabling cost-effective devices to meet essential ML System performance, prompting EarthSense, a top agri-robotics developer, to explore budget-friendly computing options.

c9. **[DATE 2023] MAVFI: An End-to-End Fault Analysis Framework with Anomaly Detection and Recovery for Micro Aerial Vehicles**
Yu-Shun Hsiao^G, Zishen Wan^G, Tianyu Jia, Radhika Gosal, **Abdulrahman Mahmoud**, Arijit Raychowdhury, David Brooks, Gu-Yeon Wei, and Vijay Janapa Reddi
In *Design Automation and Test in Europe Conference (DATE), 2023*
Acceptance rate: 25.0%
Open-source tool: https://github.com/harvard-edge/MAVBench/tree/mavfi
* First resiliency- and safety-oriented framework for micro-aerial vehicles operating on Robot Operating System (ROS)-based applications.

c8. **[DSN 2022] GoldenEye: A Platform for Evaluating Emerging Numerical Data Formats in DNN Accelerators**
Abdulrahman Mahmoud, Thierry Tambe^G, Tarek Aloui^U, David Brooks, and Gu-Yeon Wei
In *The International Conference on Dependable Systems and Networks (DSN), 2022*
Acceptance rate: 18.7%
Open-source tool: https://vlsiarch.eecs.harvard.edu/software/goldeneye
Featured in the 2022 ICCAD CADathlon as the System Design & Analysis challenge problem!
* An efficient, software-directed, DSE platform which navigates numerical precision, hardware performance, area, and DNN accuracy for accelerator design.

c7. **[DATE 2022] FRL-FI: Transient Fault Analysis for Federated Reinforcement Learning-Based Navigation Systems**
Zishen Wan^G, Aqeel Anwar, **Abdulrahman Mahmoud**, Tianyu Jia, Yu-Shun Hsiao, Vijay Janapa Reddi, and Arijit Raychowdhury
In *Design Automation and Test in Europe Conference (DATE), 2022*
Acceptance rate: 24.0%

* Enables ultra-low cost, system-level detection and recovery mechanisms for swarm-based federated learning environments.

c6. **[ISSRE 2021] Optimizing Selective Protection for CNN Resilience**
Abdulrahman Mahmoud, Siva Kumar Sastri Hari, Christopher W. Fletcher, Sarita V. Adve, Charbel Sakr, Naresh Shanbhag, Pavlo Molchanov, Michael B. Sullivan, Timothy Tsai, and Stephen W. Keckler
In *The International Symposium on Software Reliability Engineering (ISSRE), 2021*
Acceptance rate: 27.5%
* Presents a novel domain-specific metric for quickly and accurately measuring DNN vulnerability to hardware errors.

c5. **[DSN 2019] gem5-Approxilyzer: an Open Source Tool for Application-Level Soft Error Analysis**
Radha Venkatagiri, Khalique Ahmed[G], **Abdulrahman Mahmoud**, Sasa Misailovic, Darko Marinov, Christopher W. Fletcher, and Sarita V. Adve
In *The International Conference on Dependable Systems and Networks (DSN), 2019*
Acceptance rate: 21.4%
Open-source tool: https://github.com/rsimgroup/gem5-approxilyzer
* An automated, comprehensive, and ISA-centric framework for software-directed reliability and approximations.

c4. **[ASPLOS 2019] Minotaur: Adapting Software Testing Techniques for Hardware Errors**
Abdulrahman Mahmoud, Radha Venkatagiri, Khalique Ahmed[G], Sasa Misailovic, Darko Marinov, Christopher W. Fletcher, and Sarita V. Adve
In *The International Conference on Architecture Support for Programming Languages and Operating Systems (ASPLOS), 2019*
Acceptance rate: 21.1%
Featured in UMichigan EECS481: Software Engineering reading list, Winter 2020!
* Lays the foundation for a software engineering discipline for hardware errors, leading to principled and scalable software resiliency anaylses and hardening for hardware errors.

c3. **[SC 2018] Optimizing Software-Directed Instruction Replication for GPU Error Detection**
Abdulrahman Mahmoud, Siva Kumar Sastry Hari, Michael B. Sullivan, Timothy Tsai, and Stephen W. Keckler
In *The International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), 2018*
Acceptance rate: 19.1%
* The first GPU-specific hardware-software co-designed reliability techniques, and a granted patent for its discovery.

c2. **[MICRO 2016] Approxilyzer: Towards a Systematic Framework for Instruction-Level Approximate Computing and its Application to Hardware Resiliency**
Radha Venkatagiri, **Abdulrahman Mahmoud**, Siva Kumar Sastry Hari, and Sarita V. Adve
In *The 49th Annual IEEE/ACM International Symposium on Microarchitecture (MICRO), 2016*
Acceptance rate: 21.6%
Open-source tool: https://ma3mool.github.io/Approxilyzer/
* Novel approximate computing framework which navigates the space between hardware reliability overhead and end-to-end application quality.

c1. **[ICNP 2012] Verification and Synthesis of Firewalls Using SAT and QBF**
Shuyuan Zhang, **Abdulrahman Mahmoud**, Sharad Malik, and Sanjai Narain
In *The 20th IEEE International Conference on Network Protocols (ICNP), 2012*
Acceptance rate: 22.9%
* A SAT-based technique for equivalence and inclusion checking in network firewalls.

Peer-reviewed Journal Papers

j2. **[TCAD 2023] Silent Data Corruption in Robot Operating System: A Case for End-to-End System-Level Fault Analysis Using Autonomous UAVs**
Yu-Shun Hsiao[G], Zishen Wan[G], Tianyu Jia, Radhika Gosal, **Abdulrahman Mahmoud**, Arijit Raychowdhury, David Brooks, Gu-Yeon Wei, and Vijay Janapa Reddi
In *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), 2023*

j1. **[TACO 2020] Inter-Kernel Reuse-Aware Thread Block Scheduling**
Muhammad Huzaifa, Johnathan Alsop, **Abdulrahman Mahmoud**, Giordano Salvador, Matthew D. Sinclair, and Sarita V. Adve
In *ACM Transactions on Architecture and Code Optimization (TACO), 2020*

Peer-reviewed Workshop Papers

w8. **[YARCH 2022] A Dataflow-Aware Fault Resilience Analysis Framework for Deep Neural Network Accelerators**
Jaylen Wang[U], **Abdulrahman Mahmoud**, David Brooks, and Gu-Yeon Wei
In *The Fourth Young Architect Workshop (YArch)*, co-located with ASPLOS, 2022

w7. **[WCAE 2021] Mentoring Opportunities in Computer Architecture: Analyzing the Past to Develop the Future**
Elba Garza, Gururaj Saileshwar, Udit Gupta, Tianyi Liu, **Abdulrahman Mahmoud**, Saugata Ghose, and Joel Emer
In *Workshop on Computer Architecture Education (WCAE)*, co-located with ISCA, 2021

w6. **[DSN-DSML 2020] PyTorchFI: A Runtime Perturbation Tool for DNNs**
Abdulrahman Mahmoud, Neeraj Aggarwal[U], Alex Nobbe[U], Jose Rodrigo Sanchez Vicarte, Sarita V. Adve, Christopher W. Fletcher, Iuri Frosio, and Siva Kumar Sastry Hari
In *Dependable and Secure Machine Learning (DSML)*, co-located with DSN, 2020
Open-source tool: https://github.com/pytorchfi
Downloaded more than 47,000×!
Accepted into the PyTorch EcoSystem!
Adopted by Intel Labs!
Received Lynn Conway Award for Best Technical Demo at the ADA Research Center!

w5. **[SARA 2020] Feature Map Vulnerability Evaluation in CNNs**
Abdulrahman Mahmoud, Siva Kumar Sastry Hari, Christopher W. Fletcher, Sarita V. Adve, Charbel Sakr, Naresh Shanbhag, Pavlo Molchanov, Michael B. Sullivan, Timothy Tsai, and Stephen W. Keckler
In *Workshop on Secure and Resilient Autonomy (SARA)*, co-located with MLSys, 2020
Extended version on arXiv: https://arxiv.org/abs/2002.09786

w4. **[WAX 2019] Approximate Checkers**
Abdulrahman Mahmoud, Paul Reckamp[U], Panqiu Tang[U], Christopher W. Fletcher, and Sarita V. Adve In *Workshop on Approximate Computing Across the Stack (WAX)*, co-located with PLDI, 2019

w3. **[WACI 2019] VR Swarms: Enabling Shared Virtual Experiences**
Muhammad Huzaifa and **Abdulrahman Mahmoud**
In *Workshop on Wild and Crazy Ideas (WACI)*, co-located with ASPLOS, 2019

w2. **[WAX 2017] Leveraging Software Testing to Explore Input Dependence for Approximate Computing**
Abdulrahman Mahmoud, Radha Venkatagiri, Khalique Ahmed[G], Sarita V. Adve, Darko Marinov, and Sasa Misailovic
In *Workshop on Approximate Computing Across the Stack (WAX)*, co-located with ASPLOS, 2017

w1. **[WAX 2016] Towards More Precision in Approximate Computing**
Radha Venkatagiri, **Abdulrahman Mahmoud**, and Sarita V. Adve
In *Workshop on Approximate Computing Across the Stack (WAX)*, co-located with ASPLOS, 2016

Invited Industry Papers

i3. **[TECHCON 2020] HarDNN: Fine-Grained Vulnerability Evaluation and Protection for CNNs**
Abdulrahman Mahmoud, Siva Kumar Sastry Hari, Christopher W. Fletcher, Sarita V. Adve, Charbel Sakr, Naresh Shanbhag, Pavlo Molchanov, Michael B. Sullivan, Timothy Tsai, and Stephen W. Keckler
In *Semiconductor Research Corporation Workshop (SRC TECHCON), 2020*

i2. **[TECHCON 2019] Towards General-Purpose, Comprehensive, and Automated Soft Error Analysis**
Radha Venkatagiri, Khalique Ahmed[G], **Abdulrahman Mahmoud**, Sasa Misailovic, Darko Marinov, Christopher W. Fletcher, and Sarita V. Adve
In *Semiconductor Research Corporation Workshop (SRC TECHCON), 2019*

i1. **[TECHCON 2018] Harnessing Software Testing Techniques for Hardware Resiliency Analysis**
Abdulrahman Mahmoud, Radha Venkatagiri, Khalique Ahmed[G], Sasa Misailovic, Darko Marinov, Christopher W. Fletcher, and Sarita V. Adve
In *Semiconductor Research Corporation Workshop (SRC TECHCON), 2018*

Patents

p1. **Optimizing Software-Directed Instruction Replication for GPU Error Detection**
Siva Kumar Sastry Hari, Michael B. Sullivan, Timothy Tsai, Stephen W. Keckler, and **Abdulrahman Mahmoud**
US2019/0102180A1. Filed Oct. 3, 2018. Granted Oct. 27, 2020.

Grants and Gifts

- **[Salata Institute Seed Grant – Harvard University]** Carbon Facts: Counting and Reporting Carbon for Computers and Electronics. 2023.
  PIs: Gu-Yeon Wei (Primary), David Brooks, and Abdulrahman Mahmoud
  Funded amount: $30,000.
  Wrote major sections of grant proposal.
- **[Meta Research]** An Automated Framework for Principled, Selective Reliability on Underutilized Hardware. 2022.
  PIs: David Brooks (Primary), Gu-Yeon Wei, and Abdulrahman Mahmoud
  Selected as a finalist from 65 proposals.
  Wrote full grant proposal with feedback from advisors, building upon [c3, c6, w6] as prior work.
- **[NSF Medium]** Software Engineering for Hardware Errors. 2020.
  PIs: Sarita Adve (Primary), Darko Marinov, Sasa Misailovic, and Christopher Fletcher
  Funded amount: $1,200,000.
  Assisted in writing portions of the grant, building upon [c5, c4, c2] as prior work.
- **[Nvidia Research]** 2× Titan Xp GPU gift. 2018.

Non-Refereed Tech Articles

I have published 7 feature articles on TechSpot.com, a tech enthusiast website. These articles discuss technical topics for a general audience. My articles have garnered over 126k views and 1.7k shares on social media platforms.

ts7. **Explainer: Number Representations in Computer Hardware**
https://www.techspot.com/article/2630-number-representation-in-hardware/
March 6, 2023

ts6. **What is Sustainable Computing? A shift in how we develop the hardware of the future**
https://www.techspot.com/article/2474-sustainable-computing/
Sep 6, 2022

ts5. **Dual Booting: Windows and Ubuntu**
https://www.techspot.com/article/2422-dual-boot-windows-ubuntu/
Mar 14, 2022

ts4. **Explainer: What is a File System?**
https://www.techspot.com/article/2377-file-system-explainer/
Dec 6, 2021

ts3. **The State of Quantum Computing Systems: Current Designs and Future Challenges**
https://www.techspot.com/article/2361-state-of-quantum-computing-systems/
Nov 15, 2021

ts2. **What is Crypto Mining?**
https://www.techspot.com/article/2246-what-is-cryptomining/
Aug 18, 2021

ts1. **What is Quantum Computing?**
https://www.techspot.com/article/2280-what-is-quantum-computing/
Jun 28, 2021

Mentoring and Teaching Certification

2022 FAS Undergraduate Science Mentoring Certificate, Harvard
2020 CITL Certificate in Foundations of Teaching, UIUC
2019 URAP Mentoring Certificate for Undergraduate Student Research Mentorship, UIUC

Teaching Experience

Sept '23 – Dec '23 | **CS247r: Advanced Topics in Computer Architecture, Harvard University**
Co-Instructor, co-taught with David Brooks
ISCA-50 Anthology Seminar: Co-led seminar series to discuss the ISCA@50 25-Year Retrospective: 1996-2020 (https://sites.coecis.cornell.edu/isca50retrospective/papers/).

Jan '23 – May '23 | **CS246: Advanced Computer Architecture, Harvard University**

Teaching assistant; Instructor: David Brooks

Assisted students choose and pursue a course project on computer architecture. Led a weekly "Fireside Chat" series with industry folks working in computer architecture.

SEPT '22 – DEC '22 | **CS247r: Advanced Topics in Computer Architecture, Harvard University**
Co-Instructor, co-taught with David Brooks

Designed a new programming assignment based off of [c2]. Taught lecture on "Reliability + Architecture". Syllabus design, weekly office hours, and maintain course website.

SEPT '19 – DEC '19 | **CS433: Computer System Organization, UIUC**
Teaching Assistant; Instructor: Sarita Adve

Held weekly office hours, prepared HWs and Exams, updated course website, and answered student questions on Piazza. Taught one lecture on memory consistency and coherence.

JAN '19 – MAY '19 | **KGSP: Introduction to Computer Science, UIUC**
Co-Instructor, co-taught with Maxim Belkin
https://kgsp.kaust.edu.sa/

Updated course syllabus and material, taught 50% of lectures, and administered assignments and exams.

JAN '18 – MAY '18 | **KGSP: Introduction to Computer Science, UIUC**
Co-Instructor, co-taught with Nahil Sobh
https://kgsp.kaust.edu.sa/

Designed course from scratch, taught 90% of lectures, and administered assignments and exams.

SEPT '15 – DEC '15 | **CS233: Computer Architecture, UIUC**
Teaching Assistant; Instructors: Sarita Adve and Craig Zilles

Taught discussion sessions, helped write and administer quizzes and exams. Taught a few lectures with a class size of 200+ students.

JAN '13 – MAY '13 | **ELE302: System Design and Analysis, Princeton University**
Lab Teaching Assistant; Instructors: Andrew Houck and Antoine Kahn

Assist upperclassmen in ELE core lab: designing an automated car with speed control and lane-maintaining algorithms. Help in electronic circuitry, algorithmic design, and sensor-μcontroller interface.

SEPT '12 – DEC '12 | **ELE206: Introduction to Logic Design, Princeton University**
Lab Teaching Assistant; Instructor: Sharad Malik

Assist underclassmen in digital logic design, specifically Verilog programming and learning design concepts.

SEPT '11 – MAY '13 | **General Undergraduate CS Lab TA, Princeton University**
Lab Teaching Assistant

Assist students and help debug their programs in intro computer science courses, including Intro to CS, Algorithms and Data Structures, and Intro to Programming Systems. Languages include Java and C.

GRADUATE AND UNDERGRADUATE RESEARCH MENTORING

Mentored and co-advised **19** *students, including* **two senior undergraduate theses** *at Harvard University.*

19. Celine Lee (Graduate student, Cornell Tech)
18. Amrit Baveja (BS '26, Stanford)
17. Ali Khan (BS '26, Harvard)
16. Syed Talal Wasim (Fatima Fellowship mentee, '22 cohort)
    Co-authored [c11].
15. Kabila Haile Soboka (Fatima Fellowship mentee, '22 cohort)
    Co-authored [c11].
14. Sneha Khandelwal (Fatima Fellowship mentee, '22 cohort) ⇒ Data Scientist at Genpact
13. Muhammad Sajid Ahmed (Fatima Fellowship mentee, '22 cohort) ⇒ ML Engineer at AlterSense
12. Hasnain Naeem (Fatima Fellowship mentee, '22 cohort) ⇒ Software Engineer at Motive
11. Joshua Park (BS '25, Harvard)
    Selected for Harvard SPUDS 2023 program (https://datascience.harvard.edu/programs/spuds/).

10. Tarek Aloui (BS '24, Harvard)
    Selected as a Harvard PRISE Fellow 2022 (https://uraf.harvard.edu/uraf-opportunities/prise).
    Co-authored [c8].
9. William Meng (BS '22, Harvard) ⇒ UPenn Graduate School
    Senior Thesis Advisor.
8. Jaylen Wang (BS '22, Harvard) ⇒ CMU Graduate School
    Senior Thesis Advisor.
    2022 Dean's Award for Outstanding Senior Thesis (awarded to 4 Harvard undergrads per year).
    2023 NSF Graduate Research Fellowship Program (GRFP) Award Winner.
    Co-authored [w8].
7. Rahul Singh (Graduate Student, UIUC)
6. Alex Nobbe (BS '22, UIUC) ⇒ Boeing
    Co-authored [w6].
5. Neeraj Aggarwal (BS '21, UIUC) ⇒ CMU Graduate School
    Co-authored [w6].
4. Paul Reckamp (BS '20, UIUC) ⇒ UIUC Graduate School
    Co-authored [w4].
3. Panqui (Phoebe) Tang (BS '20, UIUC) ⇒ UCLA Graduate School
    Co-authored [w4].
2. Aditi Ghosalkar (BS '21, UIUC)
1. Khalique Ahmed (MS '18, UIUC) ⇒ AMD Research
    Co-authored [c4, c5, w2].

Professional Services and Activities

Reviewing:	
2024	YArch Program Committee (PC)
2024	ISQED Program Committee (PC)
2023	MICRO SRC Program Committee (PC)
2023	ML and Systems Rising Stars (PC Co-Chair)
2023	ICCD Program Committee (PC)
2023	MICRO Program Committee (PC)
2023	YArch Program Committee (PC)
2022	ASPLOS Extended Review Committee (ERC)
2022	YArch Program Committee (PC)
2022	Transactions of Computing Reviewer
2021	MICRO Artifact Evaluator (AE)
Leadership and Service:	
2023-Present	Organizing Committee for Fatima Fellowship
2022-Present	Co-chair of Computer Architecture Long-term Mentoring (CALM)
2020-Present	Founding Member of Computer Architecture Student Association (CASA)
2021, 2022	Steering Committee for CALM
2021, 2022	Social Co-Chair at ASPLOS 2021 and ASPLOS 2022
2013-2022	Princeton Alumni Schools Committee (ASC) - Interviewer
2013-2020	UIUC Graduate Student Ambassador for recruiting
Workshop Organization:	
2023-Present	ML and Systems Rising Stars, in collaboration with ML Commons
2021, 2022, 2023, 2024	Undergrad Architecture Mentoring Workshop (uArch), co-located with ISCA
2022	JOBS Workshop, co-located with MICRO
2022	Mental Health Workshop for CASA, in collaboration with Rice University
2021	Mental Health Workshop for CASA, in collaboration with PhD Balance
Student Mentoring Activities:	
May 2020	Judge for UIUC Undergraduate Research Symposium
February 2020	HackIllinois Mentor. Theme: Open-Source Contribution
Fall 2018 - Spring 2019	URAP Mentor: Undergraduate Research Apprenticeship Program
Fall 2018 - Spring 2019	PURE Mentor: Promoting Undergraduate Research in Engineering
Spring 2019	MUSE Mentor: Mentoring Undergraduates in Science and Engineering