

Deeksha Dangwal

✉ deeksha@cs.ucsb.edu • 🌐 deekshadangwal.com

Research Summary

I am a computer architect and I am interested in the design of private computing systems and applications. My interdisciplinary research spans computer systems, computer vision, machine learning, and privacy.

In my PhD, I have explored the privacy of program traces where the intent is to minimize information leakage to ensure safer sharing of program behavior for co-optimization. The key trade-off is balancing information leakage while maintaining utility of the privatized traces. [Trace wringing](#) was published in ASPLOS 2019 and recognized in [IEEE Micro's Top Picks](#) for 2020. Previously, I have worked on [PyRTL](#), a Python-based RTL specification language, and built the [OpenTPU](#) and cryptographic cores on it. I have also worked on [Charm](#), a high-level architecture modeling language.

During my internship at [Facebook Reality Labs Research](#), I worked on building privacy into AR/VR pipelines. With a novel reverse engineering attack, I demonstrated that feature descriptors, previously considered safe to share, can be used to reconstruct raw user images. I present mitigations that trade off privacy (quality of reconstruction) and utility (in terms of localization accuracy). At [Microsoft Research](#), I developed an automated framework for resource- and architecture-aware graph partitioning and fine tuning quantized neural network layers on the Brainwave NPU.

Education

University of California, Santa Barbara **2016-Present**

Doctor of Philosophy, Department of Computer Science

Advised by [Dr. Timothy Sherwood](#); member of the [ArchLab](#)

University of California, Santa Barbara **2014-2016**

Master of Science, Department of Electrical and Computer Engineering

M. S. Ramaiah Institute of Technology **2010-2014**

Bachelor of Engineering, Department of Instrumentation and Electronics

Experience

Graduate Student Researcher, ArchLab, UC Santa Barbara **Sept. 2015-Present**

Advised by [Dr. Timothy Sherwood](#)

- Safer program behavior sharing with Trace Wringing
- Examining and Quantifying Crosstalk Leakage in USB Protocols
- High-level architecture modeling with Charm
- Evaluating architectures for cryptographic algorithms
- Pythonic RTL design with PyRTL

Part-Time Student Researcher, Facebook Reality Labs Research, Redmond, WA **Sept. 2020-Present**

Research Intern, Facebook Reality Labs Research, Redmond, WA **June-Sept. 2020**

Advised by [Dr. Vincent T. Lee](#), Surreal FLASH team

Additionally mentored by Dr. Armin Alaghi, Dr. Vasileios Balntas, Dr. Eddy Ilg, Dr. Hyo Jin Kim, Dr. Brandon Reagen, Dr. Tianwei Shen, Dr. Caroline Trippel

- Implemented a novel reverse engineering attack on local feature descriptors to reconstruct raw user images with accuracy that surpassed the state-of-the-art.
- Established, for the first time, a privacy threat model for such a computer vision task.
- Developed privacy-preserving mitigation techniques and studied the effect of privatized feature descriptors on the performance of the vision system.

Research Intern, Microsoft Research, Redmond, WA **June-Sept. 2018**

Advised by [Dr. Eric Chung](#) and [Dr. Jeremy Fowers](#), Silicon Systems Futures, Brainwave Team

- Implemented parameterizable architecture-aware machine learning graph primitives for custom hardware instructions
- Wrote tools to automatically convert hardware instructions to high-level graph primitives for machine learning models that remain true-to-hardware
- Designed computational experiments to compare and verify accuracy of neural network models

Research Assistant, Oracle Labs, Austin, TX

June-Sept. 2016

- o Setup testing environment for measuring throughput of network of RAPID Data Processing Unit (DPU), a bandwidth-optimized architecture for big data computation.
- o The DPU provides acceleration for core-core communication via a unique hardware RPC mechanism. I implemented network congestion tests for best and worst case traffic conditions.

Awards

Rising Stars in EECS

Invited to attend Rising Stars in EECS, UC Berkeley

November 2020

IEEE Micro Top Pick: Trace Wrangling for Program Trace Privacy

D. Dangwal, W. Cui, J. McMahan, T. Sherwood

IEEE Micro's Top Picks from Computer Architecture Conferences, May-June 2020

Fiona and Michael Goodchild Graduate Mentoring Award

Awarded by the Graduate Division, UC Santa Barbara

June 2020

Outstanding Graduate Student Award

Awarded by the Department of Computer Science, UC Santa Barbara

June 2020

NXP Embedded Design Challenge

Second Place Winner

August 2015

Conference Publications

Safer Program Behavior Sharing through Trace Wrangling

D. Dangwal, W. Cui, J. McMahan, T. Sherwood

Proceedings of the 24th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), April 2019, Providence, RI

Charm: A Language for Closed-form High-level Architecture Modeling

W. Cui, Y. Ding, D. Dangwal, A. Holmes, J. McMahan, A. JavadiAbhari, G. Tzimpragos, F. Chong, T. Sherwood

Proceedings of the 45th International Symposium on Computer Architecture (ISCA), June 2018, Los Angeles, CA

A Pythonic Approach for Rapid Hardware Prototyping and Instrumentation

J. Clow, G. Tzimpragos, D. Dangwal, S. Guo, J. McMahan, and T. Sherwood

Proceedings of the International Conference on Field-Programmable Logic and Applications (FPL), September 2017, Ghent, Belgium.

Preprints and In Submission

(In Submission) Context-aware Privacy-optimizing Address Trace Scrubbing

D. Dangwal, Z. Zhang, J. Crandall, and T. Sherwood

(In Submission) Analysis and Mitigations of Reverse Engineering Attacks on Local Feature Descriptors

D. Dangwal, T. Sherwood, and Anonymous Authors

Porcupine: A Synthesizing Compiler for Vectorized Homomorphic Encryption

M. Cowan, D. Dangwal, A. Alaghi, C. Trippel, V. T. Lee, and B. Reagen, arXiv, January 2021

Journal and Magazine Publications

Agile Hardware Development and Instrumentation with PyRTL

D. Dangwal, G. Tzimpragos, and T. Sherwood

IEEE Micro Special Topics on Agile & Open Source Hardware, June 2020

Trace Wrangling for Program Trace Privacy

D. Dangwal, W. Cui, J. McMahan, T. Sherwood

IEEE Micro's Top Picks from Computer Architecture Conferences, May-June 2020

Language Support for Navigating Architecture Design in Closed Form

W. Cui, G. Tzimpragos, Y. Tao, J. McMahan, **D. Dangwal**, N. Tsiskaridze, G. Michelogiannakis, D. Vasudevan, and T. Sherwood

ACM Journal on Emerging Technologies in Computing Systems (JETC), October 2019

Workshops, Posters, and Presentations

SoK: Opportunities for Software-Hardware-Security Codesign for Next Generation Secure Computing

D. Dangwal, M. Cowan, A. Alaghi, V. Lee, B. Reagen and C. Trippel

Hardware and Architectural Support for Security and Privacy (HASP) held in conjunction with 53rd International Symposium on Microarchitecture (MICRO), October 2020. **(Paper and Presentation)**

Privacy of Program Traces

D. Dangwal

“Graduate Student Research Talks”, CS Summit, March 2020, UC Santa Barbara, CA. **(Presentation)**

Prototyping ML Accelerators with PyRTL

D. Dangwal

Agile-RTL Workshop, September 2019, UC Santa Barbara, CA. **(Invited Talk)**

Prototyping ML Accelerators with PyRTL

D. Dangwal

Neural Inspired Computing - Systems & Applications track, IEEE Space Computing Conference (SCC), July 2019, Caltech, Pasadena, CA. **(Invited Talk)**

PyRTLMatrix: an Object-Oriented Hardware Design Pattern for Prototyping ML Accelerators

D. Aboye, **D. Kupsh**, M. Lim, J. Mai, **D. Dangwal**, **D. Mirza** and T. Sherwood

The 4th Workshop on Energy Efficient Machine Learning and Cognitive Computing for Embedded Applications (EMC2) held in conjunction with 46th International Symposium on Computer Architecture (ISCA), June 2019, Phoenix, AZ. **(Paper and Presentation)**

PyRTL in Early Undergraduate Research

D. Mirza, **D. Dangwal**, T. Sherwood

Workshop on Computer Architecture Education (WCAE) held in conjunction with 46th International Symposium on Computer Architecture (ISCA), June 2019, Phoenix, AZ. **(Paper and Presentation)**

PyRTL: Hardware design for the masses

D. Dangwal, J. Clow, G. Tzimpragos, J. McMahan, S. Guo, and T. Sherwood

Career Workshop for Women and Minorities in Computer Architecture (CWWMCA) held in conjunction with International Symposium on Microarchitecture (MICRO), November 2017. Cambridge, MA. **(Poster and Presentation)**

Novel Neural Computing Architectures

D. Dangwal, A. Rajagopal, and T. Sherwood

CRA-W Grad Cohort Poster Session, Washington, D.C., April 2017. **(Poster)**

Cultivating Students' Interest in STEM

D. Dangwal and C. Endacott

Tech Savvy Conference, UC Santa Barbara, May 2017 and May 2018. **(Presentation)**

Patents

Deriving a concordant software neural network layer from a quantized firmware neural network layer

J. Fowers, D. Lo, **D. Dangwal**

Microsoft Technology Licensing LLC, US20200279153A1, September 2020.

Mentorship and Teaching

NSF ERSP Mentor, Department of Computer Science, UCSB

Oct. 2018-June 2019

The Early Research Scholars Program (ERSP) is an academic-year, team-based research apprenticeship program that places special emphasis on mentoring women and underrepresented groups in the second year of their studies.

- o Mentored and hosted a team of four UCSB Computer Science sophomores at the ArchLab
- o The students submitted and presented “PyRTLMatrix: an Object-Oriented Hardware Design Pattern for Prototyping ML Accelerators” in Workshop on Energy Efficient Machine Learning and Cognitive Computing for Embedded Applications (EMC2) held in conjunction with International Symposium on Computer Architecture (ISCA), June 2019, Phoenix, AZ

Women in STEM Mentorship Program, UCSB

Oct. 2016-March 2018

Mentored undergraduate women in the Computer Science program. Mentorship included monthly meetings and weekly email discussions about various issues, both technical and non-technical.

Teaching Assistant, Research Mentorship Program (RMP), UCSB

June-Aug. 2019

Teaching assistant for Research Methods in STEM for RMP summer program that engages high-achieving high school students in hands-on, university-level research.

EUREKA Mentorship Program, California NanoSystems Institute (CNSI), UCSB

June-Aug. 2015

o Designed summer research project in hardware security: hardware implementation of AES-128 in PyRTL and mentored a UCSB ECE sophomore student

Teaching Assistant, Department of Physics, UCSB

Jan.-June 2015

PHYS 6AL, PHYS 6BL (Experimental Physics)

Grader, Department of Physics, UCSB

Sept.-Dec. 2014

PHYS 132, Stellar structures and evolution

Service and Activities

Graduate Representative for Faculty Recruitment, Department of Computer Science, UCSB 2019-2020

Co-President, Women in Computer Science (WiCS), Department of Computer Science, UCSB 2018-2020

WiCS is a student-run group open to students, staff, and alumni in the Computer Science department at UCSB. It organizes social, mentoring and outreach events to connect with women in technology in and around the Santa Barbara area.

Graduate Representative for Diversity, Department of Computer Science, UCSB 2018-2019

The Diversity Committee is responsible for coordinating outreach and diversity efforts in the department. As the graduate student representative, I was the interface between the committee and diversity-promoting groups within the department, such as Women in Computer Science (WiCS).

Grace Hopper Celebration of Women

October 2017, 2018, 2019

Awarded department scholarship to attend Grace Hopper Celebration of women.

CRA-W Grad Cohort

April 2017, 2018

Awarded travel scholarship to attend the workshop.

Cultivating Students' Interest in STEM, Tech Savvy Conference, UCSB

May 2017, April 2018

Tech Savvy is an annual conference at UC Santa Barbara for young women in grades 6-9 (and their parents) to explore STEM related careers. Tech Savvy brings them together with female role models who are succeeding in these educational and professional fields. I designed modules for and conducted a workshop for the parents of young women. The focus was on methods young women could use to overcome biases in STEM fields.

I HEART STEM Conference, UCSB

November 2016

I HEART STEM is an annual conference that promotes STEM-literacy for young women (and female-identified students) in grades 9-12. Hands-on workshops and mentorship opportunities are facilitated by STEM-graduate students, faculty, and advanced undergraduates at UCSB. I conducted the "I HEART CODE" workshop which introduced the young women in to coding in Python.

Make a Difference Fellowship, Bangalore, India

December 2012-April 2014

Make A Difference is an Indian non-profit organization, working to ensure better outcomes for children in orphanages and shelters. As a fellow, I supervised operations as Center Head at the St. Patrick's Boys' Home, made key organizational decisions, and led 250 volunteers across Bangalore. I also volunteered as an English teacher.

Professional Service

ASPLOS'20 Artifact Evaluation Committee

Students Mentored

Saurabh Gupta (Summer 2015), Angela Yung (2016-2017), Dawit Aboye (2018-2019), Dylan Kupsh (2018-2019), Maggi Lim (2018-2019), Jacqueline Mai (2018-2019), Junayed Naushad (Summer, Fall 2019), Manu Kondapaneni (Winter 2020)