

# Lillian C. Pentecost

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**Assistant Professor of Computer Science**, Amherst College

July 2022 - Present

## EDUCATION

**Harvard University** Cambridge, MA  
Ph.D. in Computer Science May 2022  
*“Enabling Emerging, Heterogeneous Memory Systems”*, [View Online](#)  
Advisors: David Brooks and Gu-Yeon Wei

**Harvard University** Cambridge, MA  
S.M. (masters in passing) in Computer Science May 2019  
Coursework includes: Advanced Machine Learning, Advanced Computer Architecture, Advanced Topics in Data Visualization, Seminar in Teaching the History of Science and Technology, Algorithms at the End of the Wire, Critical Pedagogy Seminar

**Colgate University** Hamilton, NY  
Bachelor of Arts May 2016  
Double Major: Computer Science and Physics with High Honors  
GPAs: Cumulative: 3.95/4.00, Physics: 4.03/4.00, Computer Science: 4.05/4.00

## RESEARCH EXPERIENCE

**Harvard University** Cambridge, MA  
Ph.D. Candidate August 2016 - May 2022  
Investigating and enabling the design and optimization of memory systems, including integration of emerging and embedded non-volatile memory technologies and specialized hardware for machine learning applications, with an emphasis on understanding resilience and evaluating system and application-level implications of technology design choices.

**NVIDIA Research** Westford, MA  
Ph.D. Research Intern Summer 2020  
Conducted design space exploration of memory architecture and floorplanning choices with intensive analysis of efficient workload mappings for highly-distributed on-chip memory by building upon existing, open-source evaluation frameworks. (Virtual internship conducted from Boston, MA, collaborating with NVIDIA Architecture Research Group.)

**Microsoft Research** Redmond, WA  
Ph.D. Research Intern Summer 2018  
Profiled and analyzed deep neural network performance on a variety of hardware platforms with an emphasis on transformer-based models for translation, in addition to surveying and evaluating the state of available profiling tools across several popular ML frameworks, as part of a collaborative project between Microsoft Research and the Silicon, AI, and Performance group under Azure.

**IBM T.J. Watson Research Center** Yorktown Heights, NY  
Memory Systems Research Intern Summer 2016  
Performed workload characterization and developed simulation tools to determine viability of academic benchmark suites for industrial machine learning research applications.

**Colgate University** Physics & Astronomy Department Hamilton, NY  
Research Assistant August 2015 - May 2016  
Led independent experiments in superconducting electronics and analyzed data related to the

detection of Macroscopic Quantum Tunneling in parallel arrays of Josephson Junctions.

**Colgate University** Computer Science Department  
Research Assistant

Hamilton, NY  
Summer 2015

Designed, implemented, and tested innovative hardware support to improve performance of dynamically-typed programming languages by modifying the Sniper Multi-Core Simulator.

**Cornell University** Laboratory for Accelerator-Based Sciences & Education  
Research Experience for Undergraduates (REU) Participant

Ithaca, NY  
Summer 2014

Developed simulation and data analysis tools to study effects of localized concentrations of electrons in particle accelerators to improve beam quality and performance. Compared simulated data to experimental results from the Cornell Electron Storage Ring Test Accelerator.

## TEACHING EXPERIENCE

**Harvard University** Bok Center for Teaching and Learning  
Pedagogy Fellowship

Cambridge, MA  
Fall 2020 - Spring 2021

Selected as the Pedagogy Fellow for the School of Engineering & Applied Sciences (SEAS); Led teaching workshops and organized pedagogical resources for all graduate student teaching fellows (TFs) across the engineering and computer science departments, in addition to facilitating TF training, consulting and observing TFs, leading an inclusive STEM pedagogy reading group, and growing as a teacher through programs and pedagogical studies with the education center.

**Harvard University** SEAS Teaching Practicum  
Course Co-Lead & Teaching Fellow

Cambridge, MA  
Spring 2021

Teach graduate students across engineering and applied science departments about pedagogical concepts, inclusive teaching strategies, specific techniques for lesson-planning and working with other teachers, and more. An emphasis is placed on meeting students where they are in terms of previous teaching experience and career goals, and we split course meeting time between reflective discussion and students practicing their teaching and communication skills.

**Harvard University** Computer Science Department  
Teaching Fellow

Cambridge, MA  
Fall 2019, Spring 2020

Led in-class paper discussions, designed and tested assignments, hosted office hours for student questions, graded students' problem sets, and occasionally led lectures and planned lessons for graduate-level computer architecture courses enrolling both undergraduate and graduate students (CS246, CS247). Both courses were project-based; I helped individuals and small groups develop independent research projects, guiding students from ideas to experiments to final reports and presentations, with several projects resulting in follow-on work, publication, or further collaboration.

**Harvard University** Computer Science Department  
Teaching Fellow

Cambridge, MA  
Fall 2017, Spring 2019

Hosted office hours for student questions, graded students' problem sets, and led biweekly lectures with supplemental material for an undergraduate computer hardware course (CS141). Contributed to the design of homework and exam questions and collaborated with course staff to prepare and test hands-on lab assignments and projects with FPGAs.

**Colgate University** Physics & Astronomy Department  
Teaching Assistant / Tutor

Hamilton, NY  
August 2013 - May 2016

Led weekly tutoring sessions to answer students' homework questions, assisted with exam prep, graded students' weekly problem sets, and met regularly with faculty to review student progress for an introductory modern physics course each fall and introductory mechanics each spring.

## PUBLICATIONS (or see [Google Scholar](#))

- NVMEplorer: A Framework for Cross-Stack Comparisons of Embedded NVMs* February 2022  
**L. Pentecost\***, A. Hankin\*, M. Donato, M. Hempstead, G. Wei, D. Brooks. \*Authors contributed equally The 28th IEEE International Symposium on High-Performance Computer Architecture (HPCA-28). [View Online](#)
- EdgeBERT: Sentence-Level Energy Optimizations for Latency-Aware Multi-Task Natural Language Processing Inference* October 2021  
T. Tambe, C. Hooper, **L. Pentecost**, T. Jia, E. Yang, M. Donato, V. Sanh, P. Whatmough, A. Rush, D. Brooks, G. Wei. 54th IEEE/ACM International Symposium on Microarchitecture (MICRO-54). [View Online](#)
- Application-Driven Design Exploration for Dense Ferroelectric Embedded Non-Volatile Memories (Fe-FET eNVMs)* July 2021  
**L. Pentecost\***, M. Sharif\*, R. Rajaei, A. Kazemi, Q. Lou, G. Wei, D. Brooks, K. Ni, X. Hu, M. Niemier, M. Donato. ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED 2021). \*Authors contributed equally. [View Online](#).
- Logic Compatible High-Performance Ferroelectric Transistor Memory* Submitted; May 2021  
S. Dutta, H. Ye, A. Khanna, Y. Luo, **L. Pentecost**, A. Khandker, W. Chakraborty, G. Wei, D. Brooks, M. Niemier, X. Hu, S. Yu, K. Ni, S. Datta. [Work Under Review] [View Online](#)
- Introducing Programming Concepts via a Social History of Computing* March 2021  
**L. Pentecost**. Poster at SIGCSE '21: Proceedings of the 52nd ACM Technical Symposium on Computer Science Education. [View Online](#)
- Quantifying the impact of data encoding on DNN fault tolerance* August 2020  
E. Pyne\*, **L. Pentecost**, U. Gupta, G. Wei, D. Brooks. Workshop on Performance Analysis of Machine Learning Systems (FastPath at ISPASS). \*Undergraduate Mentee. [View Online](#)
- Analytically Modeling NVM Design Trade-Offs* March 2020  
**L. Pentecost**, M. Donato, A. Sriraman, G. Wei, D. Brooks. Non-Volatile Memory Workshop (NVMW) 2020. [View Online](#)
- MLPerf Training Benchmark* March 2020  
P. Mattson, C. Cheng, G. Diamos, C. Coleman, P. Micikevicius, D. Patterson, H. Tang, G. Wei, P. Bailis, V. Bittorf, D. Brooks, D. Chen, D. Dutta, U. Gupta, K. Hazelwood, A. Hock, X. Huang, D. Kang, D. Kanter, N. Kumar, J. Liao, D. Narayanan, T. Oguntebi, G. Pekhimenko, **L. Pentecost**, V. Reddi, T. Robie, T. St John, C. Wu, L. Xu, C. Young, M. Zaharia. Proceedings of Machine Learning and Systems (MLSys) 2020. [View Online](#)
- CHAMPVis: Comparative Hierarchical Analysis of Microarchitectural Performance Visualization* November 2019  
**L. Pentecost\***, U. Gupta\*, E. Ngan\*, G. Wei, D. Brooks, J. Beyer, M. Behrisch. Workshop on Programming and Performance Visualization Tools at Supercomputing 2019 (ProTools at SC19). \*Authors contributed equally. [View Online](#)
- MEMTI: Optimizing On-Chip Nonvolatile Storage (embedded NVM) for Visual Multi-task Inference at the Edge* November 2019  
M. Donato, **L. Pentecost**, D. Brooks, G. Wei. IEEE Micro, Vol. 39, Issue 6. [View Online](#)
- MaxNVM: Maximizing DNN Storage Density and Inference Efficiency with Sparse Encoding and Error Mitigation* October 2019  
**L. Pentecost**, M. Donato, B. Reagen, U. Gupta, S. Ma, G. Wei, D. Brooks. 52nd IEEE/ACM International Symposium on Microarchitecture (MICRO-52). [View Online](#)

- MASR: A Modular Accelerator for Sparse RNNs* September 2019  
 U. Gupta, B. Reagen, **L. Pentecost**, M. Donato, T. Tambe, A. Rush, G. Wei, D. Brooks. 28th International Conference on Parallel Architectures and Compilation Techniques (PACT 2019). **Best Paper Nominee** [View Online](#)
- Application of Approx. Matrix Multiplication to NNs and Distributed SLAM* September 2019  
 B. Plancher\*, C. Brumar\*, I. Brumar\*, **L. Pentecost\***, S. Rama\*, D. Brooks. 2019 IEEE High Performance Extreme Computing Conference (HPEC 2019). \*Authors contributed equally. [View Online](#)
- A 16nm 25mm<sup>2</sup> SoC with a 54.5x Flexibility-Efficiency Range from Dual-Core Arm Cortex-A53, to eFPGA, and Cache-Coherent Accelerators* June 2019  
 P. Whatmough, S. Lee, M. Donato, H. Hsueh, S. Xi, U. Gupta, **L. Pentecost**, G. Ko, D. Brooks, G. Wei. 2019 Symposium on VLSI Circuits. [View Online](#)
- A 16nm SoC with Efficient and Flexible DNN Acceleration for Intelligent IoT* August 2018  
 P. Whatmough, S. Lee, S. Xi, U. Gupta, **L. Pentecost**, M. Donato, H. Hsueh, D. Brooks and G. Wei, Hot Chips: A Symposium on High Performance Chips 2018. [View Online](#)
- Ares: A Framework for Quantifying the Resilience of Deep Neural Networks* June 2018  
 B. Reagen, U. Gupta, **L. Pentecost**, G. Wei, and D. Brooks. **nominated for Best Paper** at Design Automation Conference (DAC) 2018. [View Online](#)
- On-Chip Deep Neural Network Storage with Multi-Level eNVM* June 2018  
 M. Donato, B. Reagen, **L. Pentecost**, U. Gupta, D. Brooks, G. Wei. Design Automation Conference (DAC) 2018. [View Online](#)
- A Creative First Assignment in the Modern Graphics Pipeline* April 2018  
 E. Fourquet and **L. Pentecost**. Eurographics (EG) 2018 Education Papers. [View Online](#)
- Human Activity Recognition Using Wearables and a Low-power DNN Accelerator* Summer 2017  
 S. Kodali\*, U. Gupta, **L. Pentecost**, D. Brooks, G. Wei. \*Undergraduate mentee. Semiconductor Research Corporation (SRC) student research workshop at TECHCON 2017.
- Accelerating Dynamically Typed Languages with a Virtual Function Cache* November 2015  
**L. Pentecost** and J. Stratton. Second International Workshop on Hardware-Software Co-Design for High Performance Computing at Supercomputing 2015 (SC15). [View Online](#)
- Measurement and Simulation of Electron Cloud Induced Emittance Growth* May 2015  
**L. Pentecost**, K. G. Sonnad, J. Flanagan, K. Ohmi, L. Bartnik, M. Billing, M. Forster, G. Dugan, R. Holtzapple, K. McArdle, M. Miller, S. Tucker, M.T.F. Pivi. International Particle Accelerator Conference 2015 (IPAC15) Proceedings, [View Online](#)

## SERVICE & LEADERSHIP

- Science in the News (SITN) Public Lecture Series** Cambridge, MA  
 Lecture Series Director Spring 2019 - Summer 2021  
 Organize and facilitate a free, public series of lectures by current Harvard and MIT graduate students on research topics, targeted towards engaging with the general public and improving scientific literacy. This lecture series also specializes in working with graduate students to develop their public speaking and the ability to present their work for a general audience, and attendees tend to include school-age children and retirees.
- Negative Outcomes, Post-Mortems, and Experiences (NOPE)** ASPLOS  
 Workshop Organizer & Moderator Spring 2019; Spring 2021; Spring 2022  
 Organized speakers, facilitated, and moderated half-day NOPE workshop hosted at ASPLOS 2019, 2021, and 2022. The spirit of NOPE is to shed light and spark discussions on research concepts or

previous projects which had missteps, found counterintuitive results, or can otherwise be categorized as a “good failure”. We believe the community as a whole can learn a tremendous amount by examining the ways in which a research project can go awry and by discussing the fundamental limitations or technology trends behind unexpected or uninspiring results.

**Journal of Opportunities, Unexpected limitations, Retrospectives, Negative results, and Experiences (JOURNE)** MLSys 2021

Workshop Co-Founder, Organizer & Moderator Spring 2021

Organized speakers, facilitated, and moderated full-day workshop hosted at MLSys 2021. The goal of this event is to share the evolution of research ideas through specific examples of negative results, retrospectives, and project post-mortems. To this end, we established a workshop venue centered on reflective and in-depth conversations on the meandering path towards research publications, the path that science is inherently all about: iterating over failures to arrive at a more robust understanding of the world. This is a collaboration inspired by the spirit of NOPE from the Systems/Architecture community and ML-RSA from the ML community.

## ADDITIONAL TECHNICAL EXPERIENCE

### Development and Maintenance of Open-Source Tools

Responsible for creation, development, maintenance, and improvement/expansion of a variety of open-source tools in the systems/architecture community, including the [Ares](#) fault injection framework, a cross-stack design space exploration framework for non-volatile memory technologies ([NVM-Explorer](#) and [modifications to NVSim](#)), founding contributions to the [MLPerf Training Benchmarks](#), and the [Timeloop](#) infrastructure for exploring and evaluating accelerator designs.

### Willowire LLC

Software Development Intern

Walnut Creek, CA

November 2014 - June 2016

Extensive experience in front-end iOS design and work on various stages of app development for deployment in App Store at a small software design and development firm.

## AWARDS AND MEMBERSHIPS

[Cultural Competence in Computing \(3C\)](#) Fellows Program Cohort 2; Fall 2021 - Spring 2022

[Siebel Scholar](#) (1 of 5 Harvard CS awardees to fund final year of PhD study) Fall 2021 - Spring 2022

[EECS Rising Stars](#) (selected for intensive workshop on academic careers) October 2021

ADA Lynn Conway Research Award May 2021

Ivy+ Teaching Transformations Workshop May 2021

TECHCON 2020 Top 10 Best Student Presenter September 2020

Computer Architecture Student Association (CASA) Summer 2020 - Present

Harvard Graduate Womxn in Science and Engineering (HGWISE) Spring 2017 - Present

Laura Sanchis Award for Excellence in Research Spring 2016

Award for Excellence in Computer Science Spring 2016

Physics and Astronomy Alumni Award for Achievement in Physics Spring 2016

Edward P. Felt '81 Memorial Prize for Achievement in Computer Science Spring 2016

Phi Beta Kappa Daniel H. Saracino Prize for Scholarship of Exceptional Merit Spring 2016

CRA Outstanding Undergraduate Research Award, <i>Honorable Mention</i>	Fall 2015
Phi Beta Kappa National Honor Society, <i>Elected Member</i>	Fall 2015 - Present
Upsilon Pi Epsilon Computer Science Honor Society, <i>Invited Member</i>	Fall 2015 - Present
Association for Computing Machinery, <i>Student Member</i>	Summer 2015 - Present
Sigma Pi Sigma Physics Student Honor Society, <i>Invited Member</i>	Spring 2015 - Present
Dana Scholars Award for Academic Excellence and Community Leadership	Spring 2015
Edwin Foster Kingsbury Prize for Excellence in Physics	Spring 2014
American Physical Society, <i>Student Member</i>	Fall 2013 - Fall 2016
Alumni Memorial Scholars Program, <i>Scholar</i>	August 2012 - May 2016

## SELECTED PRESENTATIONS

<b>EMD Electronics</b> Invited Seminar Speaker “NVMEexplorer: A Framework for Cross-Stack Comparisons of Embedded NVMs”	Virtual Event October 2021
<b>Intel</b> Invited Student Presenter at Annual Review Meeting “NVMEexplorer: A Framework for Cross-Stack Comparisons of Embedded NVMs”	Virtual Event September 2021
<b>Taiwan Semiconductor Manufacturing Company</b> Invited for Series of Tutorials to Research Team “NVMEexplorer: A Framework for Cross-Stack Comparisons of Embedded NVMs”	Virtual Event July 2021
<b>Semiconductor Research Corporation TechCON 2020</b> Speaker “Analytically Modeling System Design Trade-Offs with Emerging NVMs”	Virtual Event September 2020
<b>Memory Systems Group Seminar</b> Invited Speaker “Enabling emerging heterogeneous memory systems”	NVIDIA Research July 2020
<b>Computer Architecture Seminar at UCSD</b> Invited Speaker “Enabling emerging heterogeneous memory systems: A case study in efficient, on-chip Deep Neural Network inference”	San Diego, CA March 2020
<b>Future of Computer Architecture Workshop (FOCA)</b> Invited Speaker “MaxNVM: Maximizing DNN Storage Density and Inference Efficiency with Sparse Encoding and Error Mitigation”	Yorktown Heights, NY October 2019
<b>MICRO 2019</b> Paper Presentation (and poster presentation) “MaxNVM: Maximizing DNN Storage Density and Inference Efficiency with Sparse Encoding and Error Mitigation”	Columbus, Ohio October 2019
<b>Science in the News (SITN) Public Lecture Series</b> Speaker (Accepted for presentation with Udit Gupta) “Designing AI-Enabled Technology for Society”	Cambridge, MA October 2018
<b>Semiconductor Research Corporation TechCON 2018</b>	Austin, TX

Speaker & Poster Presenter September 2018  
 “Ares: A Framework for Quantifying the Resilience of Deep Neural Networks”

**Microsoft Research** Future Silicon Systems Seminar Redmond, MA  
 Speaker August 2018  
 “Microarchitectural Analysis of DNN Performance: A Case Study with Transformer-Based Neural Machine Translation (NMT)”

**IBM T.J. Watson Research Center** Memory Systems Seminar Yorktown Heights, NY  
 Speaker July 2016  
 “Workload Characterization of CortexSuite, an Academic Benchmark Suite for Machine Learning, Compared to Standard CPU Workloads”

**Colgate University** Honors Thesis Research Symposium Hamilton, NY  
 Talk (Nominated Speaker) May 2016  
 “Detection of Macroscopic Quantum Tunneling in Josephson Junction Arrays”

**Syracuse University** Undergraduate Research Day Syracuse, NY  
 Talk (Nominated Speaker) November 2015  
 “Seeking Detection of Macroscopic Quantum Tunneling in Josephson Junction Arrays”

**Workshop on Hardware-Software Co-Design for HPC at SC15** Austin, TX  
 Talk (Paper Presentation) November 2015  
 “Accelerating Dynamically Typed Languages with a Virtual Function Cache”

**NY6 Upstate Undergraduate Research Conference** Hamilton, NY  
 Poster Presentation Summer 2015  
 “Development of a Virtual Function Cache”

**Colgate University** Student Summer Research Symposium Hamilton, NY  
 Poster Presentation Summer 2015  
 “Development of a Virtual Function Cache”

## SKILLS

*Languages:* C/C++, Python, MATLAB, JavaScript, SystemVerilog

*Operating Systems:* Linux, Mac OS X

*Other Skills:* D3, Tableau, HTML/CSS, Git, L<sup>A</sup>T<sub>E</sub>X, Assembly Programming (x86, MIPS)