

Objective: 4th-year Ph.D. candidate with a passion for using AI for social betterment and scientific discovery.

Education

University of Notre Dame

Ph.D. in Computer Science & Engineering
Exp. May 2024 | Notre Dame, IN
Cum. GPA: 4.0

Rochester Institute of Technology

M.S. in Computer Engineering
May 2019 | Rochester, NY
Cum. GPA: 4.0 | *magna cum laude*

B.S. in Computer Engineering
May 2019 | Rochester, NY
Cum. GPA: 3.7 | *magna cum laude*

Skills

Programming

Python • C/C++ • \LaTeX • Bash/Shell • Julia • Java • Verilog • VHDL • JS/HTML/CSS

Software Tools

PyTorch • TensorFlow • Keras • scikit-learn • OpenCV • SymPy • Git • SVN • Docker • Singularity • Matplotlib/Seaborn • MATLAB • ray • Django • ROS • SQL • Azure • AWS

Hardware

Cortex M0+/M4 MCU • Arduino • Spartan6/Virtex-7 FPGA

OS

Arch Linux • Ubuntu/Debian • CentOS • NixOS • Linux • Windows

Other

System admin • Project management • Web dev • Drumming • Tennis

Links

[GitHub](#) | @craymichael
[StackOverflow](#) | @craymichael
[LinkedIn](#) | @craymichael
[Google Scholar](#)

Service

- Computer Vision Foundation (CVF)
- NeurIPS
- IEEE Access
- IEEE Transactions on Comput-

Research Experience

Computer Vision Research Lab | Graduate Research Assistant

Aug 2019 - Now | University of Notre Dame, Notre Dame, IN

- Engaged in research on mitigating the AI black box via intrinsically interpretable neural networks, e.g., prototypical part neural networks and neuro-symbolic methods
- Conducted research demonstrating the infidelity of post hoc explanation methods for black box interpretation
- Developed an open-source symbolic framework that enables researchers to study feature attribution, interaction effects, & explanations of arbitrarily complex models

Mitsubishi Electric Research Lab (MERL) | PhD Research Intern

Jun 2022 - Sep 2022 | Boston, MA

- Conducted original research on intrinsically human-interpretable AI (prototypical part neural networks) under supervision of Dr. Mike Jones (full project details currently under NDA)
- Helped run a reading group for the state-of-the-art in computer vision

Lawrence Livermore National Lab (LLNL) | Graduate Student Intern

May 2021 - Aug 2021 | Remote

- Proposed a novel algorithm (XNAS) for the optimization of both accuracy and interpretability via multi-objective neural architecture search (NAS)
- Scaled XNAS to a cluster of >100 nodes using Ray and asynchronous algorithm design
- Employed a deep learning object detection pipeline for asteroids in Zwicky Transient Facility (ZTF) difference image data with detection accuracy >90%

Neuromorphic AI Lab | Research Fellow

Aug 2019 - May 2021 | University of Texas at San Antonio, San Antonio, TX

Jan 2018 - Aug 2019 | Rochester Institute of Technology, Rochester, NY

- Collaborated with epidemiologists & demographers in the modeling of COVID-19 infectious spread. Developed a live [online dashboard](#) for Texas state showcasing case data & forecasts
- Researched the accuracy-energy-latency trade-off of network compression via low-precision arithmetic & custom hardware architecture
- Improved efficiency of neural networks for time series forecasting upwards of 95% in size & training speed using randomness & compression for resource-constrained devices

Publications

H-Index: 7 | I-Index: 7 | Citations: 271

†Paper | §Oral Presentation | ‡Poster Presentation

†‡ Z. Carmichael, W. J. Scheirer. "Unfooling Perturbation-Based Post Hoc Explainers." In *Proceedings of the AAAI Conference on Artificial Intelligence*, Washington D.C., USA, 2023. [arXiv](#)

Z. Carmichael, W. J. Scheirer. "A Framework for Evaluating Post Hoc Feature-Additive Explainers." *Preprint (Under Review)*, -, 2022. [arXiv](#)

Z. Carmichael, T. Moon, S. A. Jacobs. "Learning Interpretable Models Through Multi-Objective Neural Architecture Search." *Preprint (Under Review)*, -, 2022. [arXiv](#)

†‡ W. Theisen, D. Gonzalez, Z. Carmichael, T. Weninger, W. J. Scheirer. "Motif Mining: Finding and Summarizing Remixed Image Content." In *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*, Waikoloa, Hawaii, USA, 2023. [arXiv](#)

†‡ J. Takeshita, Z. Carmichael, R. Karl, T. Jung. "TERSE: Tiny Encryptions and Really Speedy Execution for Post-Quantum Private Stream Aggregation." In *EAI International Conference on Security and Privacy in Communication Networks (SecureComm)*, Kansas City, USA, 2022. [IACR Cryptology ePrint Archive](#)

†§ S. Abraham, Z. Carmichael, S. Banerjee, R. VidalMata, A. Agrawal, M. N. Al Islam, W. Scheirer, J. Cleland-Huang. "Adaptive Autonomy in Human-on-the-Loop Vision-Based Robotics Systems." In *1st Workshop on AI Engineering – Software Engineering for AI (WAIN'21)*, Remote, 2021. [arXiv](#)

†‡ H. Langroudi, V. Karia, Z. Carmichael, A. Ziyarah, T. Pandit, J. L. Gustafson, D. Kudithipudi.

ers

- Czech Science Foundation
- IEEE TNNLS

“ALPS: Adaptive Quantization of Deep Neural Networks With Generalized PositS.” In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops*, Remote, 2021. [CVF Open Access](#)

† N. Soares, D. Chambers, **Z. Carmichael**, A. Daram, D. P. Shah, K. Clark, L. Potter, D. Kudithipudi. “SIRNet: Understanding Social Distancing Measures with Hybrid Neural Network Model for COVID-19 Infectious Spread.” In *Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI) Disease Computational Modeling Workshop*, Remote, 2020. [IJCAI DCM](#) | [arXiv \(out-of-date\)](#)

‡ —. “—.” In *Proceedings of the International Conference on Machine Learning (ICML) Machine Learning for Global Health Workshop*, Remote, 2020. [Poster](#)

†§ **Z. Carmichael**, D. Kudithipudi. “Stochastic Tucker-Decomposed Recurrent Neural Networks for Forecasting.” In *IEEE Global Conference on Signal and Information Processing (GlobalSIP 2019)*, Ottawa, Canada, 2019. [IEEE Xplore](#)

†§ **Z. Carmichael**. “Towards Lightweight AI: Leveraging Stochasticity, Quantization, and Tensorization for Forecasting.” Master’s Thesis (Won the 2019 RIT Outstanding Master’s Thesis Award), Department of Computer Engineering, Rochester Institute of Technology, 2019. [RIT Scholar Works](#)

†§ **Z. Carmichael**, H. F. Langroudi, C. Khazanov, J. Lillie, J. L. Gustafson, D. Kudithipudi. “Deep Positron: A Deep Neural Network Using the Posit Number System.” In *Proceedings of the IEEE Conference and Exhibition on Design, Automation and Test in Europe (DATE)*, Florence, Italy, March 25-29, 2019. IEEE, 1421–1426. [IEEE Xplore](#) | [arXiv](#)

†§ **Z. Carmichael**, H. F. Langroudi, C. Khazanov, J. Lillie, J. L. Gustafson, D. Kudithipudi. “Performance-Efficiency Trade-off of Low-Precision Numerical Formats in Deep Neural Networks.” In *Proceedings of the ACM Conference for Next Generation Arithmetic (CoNGA)*, Singapore, 2019. [ACM DL](#) | [arXiv](#)

H. F. Langroudi, **Z. Carmichael**, J. L. Gustafson, D. Kudithipudi. “Cheetah: Mixed Low-Precision Hardware & Software Co-Design Framework for DNNs on the Edge.” *arXiv*, Preprint, 2019. [arXiv](#)

†§ H. F. Langroudi, **Z. Carmichael**, J. L. Gustafson, D. Kudithipudi. “PositNN Framework: Tapered Precision Deep Learning Inference for the Edge.” In *Proceedings of the Twelfth IEEE Space Computing Conference (SCC 2019)*, Pasadena, CA, July 30-August 1, 2019. IEEE, 53–59. [IEEE Xplore](#)

†§ **Z. Carmichael**, H. Syed, D. Kudithipudi. “Analysis of Wide and Deep Echo State Networks for Multiscale Spatiotemporal Time Series Forecasting.” In *ACM International Conference Proceedings Series (ICPS) of the Neuro Inspired Computational Elements (NICE) Workshop*, Albany, NY, 2019. [ACM DL](#) | [arXiv](#)

†§ **Z. Carmichael**, B. Glasstone, F. Cwitkowitz, K. Alexopoulos, R. Relyea, R. Ptucha. “Autonomous Navigation Using Localization Priors, Sensor Fusion, and Terrain Classification.” In *Proceedings of IS&T International Symposium on Electronic Imaging: Autonomous Vehicles and Machines*, San Francisco, CA, 2019. [Ingenta Connect](#)

†‡ **Z. Carmichael**, H. Syed, S. Burtner, D. Kudithipudi. “Mod-DeepESN: Modular Deep Echo State Network.” In *Annual Conference on Cognitive Computational Neuroscience*, Philadelphia, PA, 2018. [CCN \(out-of-date\)](#) | [arXiv](#)

Grants & Fellowships

NSF Graduate Fellowships Research Program (GRFP) Honorable Mention 2020

University of Notre Dame Jack and Mary Ann Remick Fellowship in Engineering 2019-2024

University of Notre Dame Kilgallon Family Graduate Fellowship 2019-2024

Honors & Awards

RIT Outstanding M.S. Thesis Award 2019

Thesis: “Towards Lightweight AI: Leveraging Stochasticity, Quantization, and Tensorization for Forecasting”

UTSA Best Poster: Fundamental Research in AI (Ph.D.) 2019

Poster: "Cheetah: Mixed Low-Precision Hardware & Software Co-Design Framework for DNNs on the Edge"

RIT KGCOE Dean's List 2014-2019

RIT Presidential Scholarship 2014-2019

RIT BS/MS Tuition Award 2014-2019

RIT Excellence in Computing 2014

Projects

NFL Betting App with Betting AI Oct 2020

CNNs for Loop-Closure Detection in vSLAM Systems 2018-2019

Autonomous Golf Cart - "Tiger Taxi" 2018

Segmentation of Histopathological Images Using U-Net 2018

Experience

Computer Vision Foundation (CVF) | Web Manager

Sep 2019 - Now | Remote

- Position funds my PhD
- Rewrote, audited, & actively maintain [CVF Open Access](#) to better serve papers, talks, posters, & other open content from the CVPR, ICCV, ECCV, & WACV conferences to 500,000+ monthly visitors
- Automated synchronization of [CVF COVE](#) computer vision datasets & arXiv erratum retrieval with Open Access
- Discovered & mitigated several SQL security vulnerabilities

University of Notre Dame | Graduate Teaching Assistant

Aug 2019 - May 2020 | Notre Dame, IN

- Courses: *Advanced Topics in Machine Learning (ML)* (20+ students | Graduate CS); *Theory of Computing* (30+ students | Upper-level undergraduate CS)
- Taught students core CS & ML concepts in office hours, scoped assignments, held review sessions, & graded exams

Plexus Corp. | Digital Engineering Intern

Jun 2017 - Aug 2017 | Raleigh, NC

- Carried out RTL design of FPGA-agnostic module for evaluation of FPGA cooling systems, validated all test cases with digital engineering team
- Developed embedded software for a battery testing unit using the FRDM-K64F dev board, validated design & integration with mechanical, electrical, & software teams

CUBRC, Inc. | Research/Software Engineering Intern

Jun 2016 - Dec 2016 | Cheektowaga, NY

- Developed a machine learning framework to model surgery risk, patient mortality, & other analytics using TensorFlow & scikit-learn with automatic model search & hyperparameter optimization
- Worked with customers in the design of electronic health record-unifying database & interface

Membership

Institute of Electrical and Electronics Engineers (IEEE) Student Oct 2018 - Now

Tau Beta Pi - The Engineering Honor Society (TBPII) Oct 2018 - Now

The National Society of Leadership and Success (ΣΑΠΙ) Oct 2018 - Now

Sigma Xi Nomination (ΣΞ) Jun 2020