

Marco Apolinario

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About

PhD candidate in Electrical and Computer Engineering at Purdue University specializing in hardware-software co-design for brain-inspired AI systems. My research develops scalable and energy-efficient neuro-inspired learning algorithms and neuromorphic hardware for real-time, on-device AI. Broad expertise in deep learning, continual learning, spiking neural networks, and optimization for edge AI systems.

Research Interests

- Continual learning and efficient fine-tuning for large-scale and foundation models.
- Energy-efficient hardware-software co-design for brain-inspired artificial intelligence.
- Spiking neural networks and biologically inspired local learning rules.

Education

Jan 2021 – present **Purdue University**, PhD in Electrical and Computer Engineering – West Lafayette, IN, USA

- Working on hardware-software co-design for brain-inspired AI systems
- Advisor: Prof. Kaushik Roy - Expected graduation: December 2025

Mar 2013 – Dec 2017 **National University of Engineering (UNI)**, BS in Electronics Engineering – Lima, Peru

- GPA: 3.5/4.0, ranked 3rd out of 28 students
- Awards: Outstanding member of the IEEE Student Branch

Fellowships and Awards

2024 **NSF AccelNet NeuroPAC Fellowship**

Selective international fellowship supporting cross-border collaborations in neuromorphic computing; awarded to conduct research on digital on-chip learning hardware accelerators at TU Delft.

2020 **Graduate Peruvian Fellowship "Beca Generación del Bicentenario"**

Prestigious national fellowship fully funded by the Peruvian Ministry of Education; awarded to top scholars across Peru to pursue graduate studies abroad.

2017 **'Julio Urbina Arias' Award**

Recognition for outstanding research and leadership contributions as an active member of the IEEE Student Branch, National University of Engineering, Lima, Peru.

Experience

Aug 2021 – present **Graduate Research Assistant**, Purdue University - Nanoelectronics Research Laboratory (NRL) – West Lafayette, IN, USA

- Conduct research on neuro-inspired machine learning algorithms for emerging hardware technologies, with emphasis on scalability and energy efficiency in neuromorphic systems.
- Developed CODE-CL, a continual learning framework using conceptor-based gradient projection, enabling knowledge retention and forward transfer in sequential tasks.
- Designed an ADC-less in-memory computing hardware for Spiking Neural Networks, achieving 2–7× energy savings and 9–24× latency reduction over conventional architectures through HW/SW co-design.
- Proposed novel spatial, temporal, and fully local learning rules (LLS, S-TLLR, TESS), inspired by biologically plausible mechanisms such as STDP, synchronization, and

eligibility traces; matched backpropagation performance at significantly lower computational cost.

- Sept 2024 – Dec 2024 **Visiting Researcher**, Delft University of Technology (TU Delft) – Delft, Netherlands
- Conducted research on hardware-algorithm co-design with digital accelerators for on-device learning using local learning rules in artificial neural networks, supported by the NSF AccelNet NeuroPAC Fellowship.
- May 2023 – Aug 2023 **Systems Engineering Intern**, Texas Instruments - Kilby Labs – Dallas, TX, USA
- Researched hardware-aware neural architecture and quantization search using evolutionary optimization to deploy deep learning models on low-power devices.
 - Achieved 10× reduction in model search time and 5% performance improvement on keyword spotting tasks.
- July 2017 – Dec 2020 **Research Assistant in Computer Vision**, National Institute for Research and Training in Telecommunications (INICTEL-UNI) – Lima, Peru
- Developed energy-efficient machine learning models for diverse applications, including timber species identification, underwater acoustic inversion, satellite cloud segmentation, and river level estimation.
 - Integrated ML algorithms into low-power embedded systems, enabling real-time inference for precision agriculture applications.
 - Designed a lightweight CNN achieving >90% accuracy in timber species recognition under open-set conditions.
 - Secured three software copyrights in remote sensing and health monitoring.
 - Published one journal paper and three conference papers.

Publications

- 2025 **CODE-CL: Conceptor-Based Gradient Projection for Deep Continual Learning**
Marco Apolinario, Sakshi Choudhary, Kaushik Roy. International Conference on Computer Vision (ICCV) ([10.48550/arXiv.2411.15235](https://arxiv.org/abs/2411.15235))
- 2025 **TESS: A Scalable Temporally and Spatially Local Learning Rule for Spiking Neural Networks**
Marco Apolinario, Kaushik Roy, Charlotte Frenkel. International Joint Conference on Neural Networks (IJCNN) ([10.48550/arXiv.2502.01837](https://arxiv.org/abs/2502.01837))
- 2025 **LLS: Local Learning Rule for Deep Neural Networks Inspired by Neural Activity Synchronization**
Marco Apolinario, Arani Roy, Kaushik Roy. IEEE/CVF Winter Conference on Applications of Computer Vision (WACV) ([10.1109/WACV61041.2025.00758](https://arxiv.org/abs/2025.00758))
- 2025 **S-TLLR: STDP-inspired Temporal Local Learning Rule for Spiking Neural Networks**
Marco Apolinario, Kaushik Roy. Transactions on Machine Learning Research (TMLR) (openreview.net/forum?id=CNaiJRcX84)
- 2024 **Unearthing the Potential of Spiking Neural Networks**
Sayeed Chowdhury, Adarsh Kosta, Deepika Sharma, Marco Apolinario, Kaushik Roy. Design, Automation & Test in Europe Conference & Exhibition (DATE) ([10.23919/DATE58400.2024.10546699](https://arxiv.org/abs/2024.10546699))
- 2024 **HALSIE: Hybrid Approach to Learning Segmentation by Simultaneously Exploiting Image and Event Modalities**
Shristi Das Biswas, Adarsh Kosta, Chamika Liyanagedera, Marco Apolinario, Kaushik Roy. IEEE/CVF Winter Conference on Applications of Computer Vision (WACV) ([10.1109/WACV57701.2024.00586](https://arxiv.org/abs/2024.00586))
- 2023 **Hardware/Software Co-Design With ADC-Less In-Memory Computing Hardware for Spiking Neural Networks**
Marco Apolinario, Adarsh Kosta, Utkarsh Saxena, Kaushik Roy. IEEE Transactions on Emerging Topics in Computing ([10.1109/TETC.2023.3316121](https://arxiv.org/abs/2023.3316121))

2023

Live Demonstration: ANN vs SNN vs Hybrid Architectures for Event-based Real-time Gesture Recognition and Optical Flow Estimation

Adarsh Kosta, *Marco Apolinario*, Kaushik Roy. IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW) ([10.1109/CVPRW59228.2023.00436](https://doi.org/10.1109/CVPRW59228.2023.00436))

2020 **Method of Estimating River Levels with Reflective Tapes Using Artificial Vision Techniques**

Lidia Lopez, *Marco Apolinario*, Samuel Huaman. Proceedings of the 5th Brazilian Technology Symposium ([10.1007/978-3-030-57566-3_19](https://doi.org/10.1007/978-3-030-57566-3_19))

2019 **Open Set Recognition of Timber Species Using Deep Learning for Embedded Systems**

Marco Apolinario, Daniel Urcia, Samuel Huaman. IEEE Latin America Transactions ([10.1109/TLA.2019.9011545](https://doi.org/10.1109/TLA.2019.9011545))

2019 **Estimation of 2D Velocity Model using Acoustic Signals and Convolutional Neural Networks**

Marco Apolinario, Samuel Huaman, Giorgio Morales, Daniel Diaz. IEEE International Conference on Electronics, Electrical Engineering and Computing (INTERCON) ([10.1109/INTERCON.2019.8853566](https://doi.org/10.1109/INTERCON.2019.8853566))

2018 **Deep Learning Applied to Identification of Commercial Timber Species from Peru**

Marco Apolinario, Samuel Huaman, Gabriel Orellana. IEEE International Conference on Electronics, Electrical Engineering and Computing (INTERCON) ([10.1109/INTERCON.2018.8526457](https://doi.org/10.1109/INTERCON.2018.8526457))

Mentorship and Outreach

- 2025 – present **Talento Guía, PRONABEC (Peru National Scholarship Program)**
Mentor for incoming Peruvian graduate students abroad (Beca Generación del Bicentenario Fellows), providing academic, cultural, and professional guidance to support their transition to international graduate programs.
- 2021 – 2022 **Serendipity: Mentorship in Science Program**
Mentored Peruvian undergraduate students in STEM on career development, research opportunities, and pathways to graduate school.
- 2020 – present **Speaker - STEM Outreach**
Invited speaker at IEEE and university events in Peru, promoting undergraduate research and STEM engagement.
- 2016 – 2017 **Vice Chair, IEEE Signal Processing Society Student Chapter - UNI (Peru)**
Co-founded the first IEEE Signal Processing Society Student Chapter in Peru; promoted undergraduate-led research projects in signal and image processing.
- 2015 – 2016 **Research Director, IEEE Robotics and Automation Society Student Chapter - UNI (Peru)**
Led student research groups in robotics and computer vision; organized national robotics competitions, technical talks, and workshops.

Invited Talks

- Apr 2025 **Energy-Efficient Brain-Inspired Learning in Deep Neural Networks**
Presented online at the IEEE Signal Processing Society student chapter at the National University of Engineering, Lima, Peru.
- Nov 2024 **Local Learning for Deep Neural Networks**
Presented at Data Management and Biometrics Group, University of Twente, Netherlands.
- July 2024 **Neuromodulation on Brain and Machines (Co-presented with Dr. Kathryn Simone)**
Presented at 2024 Telluride Neuromorphic Cognition Engineering Workshop, Telluride, CO, USA.
- June 2024 **Hardware/Software Co-design with ADC-Less In-Memory Computing for SNNs**

Presented at In-Memory Computing Applications Workshop at DAC 2024, San Francisco, CA, USA.

Aug 2023 **Enabling High-Performance ADC-Less In-Memory Computing for Deploying SNNs Through Hardware-Aware Training**

Presented at Workshop on Modeling & Simulation of Systems and Applications (ModSim23) 2023, Seattle, WA, USA.

July 2021 **Experiencia estudiando un posgrado en EEUU - Becas y oportunidades**

Presented online at the IEEE Signal Processing Society student chapter at the National University of Engineering, Lima, Peru.

Professional Development

2024 **Telluride Neuromorphic Cognition Engineering Workshop**

Highly selective international workshop; participated in hands-on projects exploring neuromodulation mechanisms for synaptic plasticity and reinforcement learning.

2024 **SRC TECHCON**

Attended the Semiconductor Research Corporation's flagship annual conference in Austin, TX, engaging with industry leaders on advances in semiconductor and AI research.

2021 **Neuromatch Academy - Computational Neuroscience Summer School**

Intensive online summer school covering foundations of computational neuroscience; explored parallels between artificial neural networks and in-vivo brain responses to visual stimuli.

Academic Service

Reviewer for Journals: IEEE Transactions on Image Processing, IEEE Transactions on Cognitive and Developmental Systems, IEEE Transactions on Biomedical Circuits and Systems (TBioCAS), and IEEE Latin America Transactions

Reviewer for Conferences: International Conference on Machine Learning (ICML), International Conference on Computer Vision (ICCV), International Conference on Learning Representations (ICLR), Neural Information Processing Systems (NeurIPS), International Conference on Artificial Neural Networks (ICANN) and IEEE INTERCON

Skills

Programming and Hardware Description Languages: Python, C/C++, VHDL/Verilog, and Git

EDA tools: Cadence Virtuoso, Quartus Prime, and Eagle PCB

Machine Learning Frameworks: Pytorch, Tensorflow/Keras

Languages: English (fluent), Spanish (native)

Relevant Coursework

Graduate Electronics: AI Hardware, Computer Architecture, System-on-Chip Design, Analog CMOS Design, Advanced VLSI Design, MOS VLSI Design, Solid State Devices

Graduate Computer Science: Applied Quantum Computing, Optimization for Deep Learning, Computational Methods in Optimization, Artificial Intelligence