Emilio Paolini

Postdoctoral Researcher

Deep Learning | Wireless Networks
Scuola Superiore Sant'Anna
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Education

- **Ph.D. in Emerging Digital Technologies** - *Scuola Superiore Sant'Anna, Oct. 2021 – Nov. 2024*.
  - Joint Ph.D. Scholarship from **Scuola Superiore Sant'Anna**, **CNR IEIIT**, and **Sma-RTy Italia**. The thesis consideres the optimization of AI algorithms for constrained environments (e.g., neuromorphic photonic accelerators) and wireless networks. The research aimed at developing advanced AI methodologies capable of operating efficiently, with a particular focus related to the limited resources typical of wireless networks.
  - *Title*: AI in NextG Networks: From Neuromorphic Photonic Hardware to System-Level Optimization
  - *Supervisors*: **Prof. Luca Valcarenghi**, **Prof. Nicola Andriolli**, **Dr. Luca Maggiani**
- **M.Sc. in Artificial Intelligence and Data Engineering** - *Università di Pisa, Sept. 2019 – Sept. 2021*.
  - *Relevant courses:* Machine Learning & Deep Learning, Cybersecurity, Optimization Methods, Cloud Computing, Internet of Things
  - *Title*: Development of a Fixed-Point Neural Deep Networks Library in C++ and its use to validate Photonic Neuromorphic Accelerators.
  - *Supervisors*: Prof. Marco Cococcioni, Dr. Nicola Andriolli, Dr. Lorenzo De Marinis
  - *Grade:* 110/110 cum laude
- **B.Sc. in Computer Engineering** - *Università di Pisa, Sept. 2016 – July 2019*.
  - *Relevant courses:* Computer Programming & Architecture, Computer Networks, Digital Electronics, Electrotechnics, Mathematical Analysis & Algebra, Numerical Calculus, Operational Research
  - *Grade:* 110/110 cum laude

Professional Experience

- **Research Fellow** - *Pisa, Oct. 2024 – present*. Developing next-gen communication testbeds, focusing on Zero Touch Network and Service Management, programmable hardware acceleration, and AI to enhance network intelligence and efficiency.
- **Visiting PhD Scholar** - *St. Louis University, Sept. 2023 – Mar. 2024*. Conducted research on improving NextG Wireless Networks through the application of AI techniques at **Flavio Esposito's Lab**. I am the maintainer of the joint NextG Wireless testbed between Scuola Superiore Sant'Anna and Saint Louis University.

Awards, Fellowships, & Grants

- **Next Generation Internet (NGI) Enrichers Postdoc Fellowship** at the Networking Research Lab in Saint Louis University School of Science and Engineering for the project "Adaptive EdgeAI Deployments in NextG Wireless Networks". The project aims to enhance sustainability and reduce latency through innovative

strategies of distributed and accelerated AI with photonic technologies, tailored to dynamic network conditions.

- **Best Paper Award** for the paper: Bourenane, A., Paolini, E., Andriolli, N., & Valcarenghi, L. (2024, July). A Programmable 5G DU-RU SmartNIC Based on MPSoC FPGA. In IEEE International Conference on High Performance Switching and Routing (HPSR).
- **EuCNC & 6G Summit Travel Grants 2023** for the paper "Photonic-accelerated AI for cybersecurity in sustainable 6G networks"

Publications

Journals

Gatto, A., et al. (2024). Generalized Quantum-Assisted Digital Signature Service in an SDN-controlled Quantum-Integrated Optical Network. Journal of Optical Communications and Networking.

Roumpos, I., De Marinis, L., Kovaios, S., Kincaid, P. S., **Paolini, E.**, et al. (2024). Silicon integrated photonic-electronic neuron for noise-resilient deep learning. Optics Express.

Paolini, E., De Marinis, L., Scano, D., & Paolucci, F. (2024). In-Line Any-Depth Deep Neural Networks Using P4 Switches. IEEE Open Journal of the Communications Society.

Paolini, E., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2024). Real-Time Network Packet Classification Exploiting Computer Vision Architectures. IEEE Open Journal of the Communications Society.

Paolini, E., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2023). Real-time clustering based on deep embeddings for threat detection in 6G networks. IEEE Access.

Paolini, E., De Marinis, L., Maggiani, L., Cococcioni, M., & Andriolli, N. (2023). CHARLES: A C++ fixed-point library for Photonic-Aware Neural Networks. Neural Networks, 162, 531-540.

Paolini, E., De Marinis, L., Cococcioni, M., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2022). Photonic-aware neural networks. Neural Computing and Applications, 34(18), 15589-15601.

Conferences

Bourenane, A., **Paolini, E.**, Andriolli, N., & Valcarenghi, L. (2024, July). A Programmable 5G DU-RU SmartNIC Based on MPSoC FPGA. In IEEE International Conference on High Performance Switching and Routing (HPSR). IEEE.

Andriolli, N., **Paolini, E.**, Brunero, M., Martelli, P., Gatto, A., Ferrari, M., & Giorgetti, A. (2024, July). Software-defined control of integrated QKD and classical optical networks. In 2024 24th International Conference on Transparent Optical Networks (ICTON) (pp. 1-4). IEEE.

Paduanelli, G., et al. (2024, July). Quantum-assisted digital signature: a new service for future quantum-integrated optical networks. In 2024 24th International Conference on Transparent Optical Networks (ICTON) (pp. 1-4). IEEE.

Roumpos, I., De Marinis, L., Kincaid, P., **Paolini, E.**, et al. (2024, May). Silicon Integrated Photonic-Electronic Multiply-Accumulate Neurons. In Conference on Lasers and Electro-Optics (CLEO). Optica Publishing Group.

Paolini, E., De Marinis, L., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2024, March). Activation Stretching for Tackling Noise in Photonic Aware Neural Networks. In Optical Fiber Communication Conference (pp. Th2A-13). Optica Publishing Group.

De Marinis, L., **Paolini, E.**, Bakar, R. A., Cugini, F., & Paolucci, F. (2023, December). Cascaded Look Up Table Distillation of P4 Deep Neural Network Switches. In GLOBECOM 2023-2023 IEEE Global Communications Conference (pp. 2111-2116). IEEE.

Paolini, E., Perotto, G., Valcarenghi, L., Civerchia, F., Maggiani, L., & Andriolli, N. (2023, November). Protecting NextG Military Networks with Convolutional Neural Networks. In 2023 IEEE International Workshop on Technologies for Defense and Security (TechDefense) (pp. 209-213). IEEE.

Paolini, E., De Marinis, L., Contestabile, G., Gupta, S., Maggiani, L., & Andriolli, N. (2023, September). Validation of Photonic Neural Networks in Health Scenarios. In 2023 International Conference on Photonics in Switching and Computing (PSC) (pp. 1-3). IEEE.

Valcarenghi, L., Castoldi, P., Sgambelluri, A., **Paolini, E.**, & Pacini, A. (2023, July). A Flexible Forecasting Platform Enabling Zero Touch Networking and Digital Twinning. In 2023 23rd International Conference on Transparent Optical Networks (ICTON) (pp. 1-4). IEEE.

Paolini, E., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2023, June). Photonic-accelerated AI for cybersecurity in sustainable 6G networks. In 2023 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit) (pp. 341-346). IEEE.

Paolini, E., Civerchia, F., De Marinis, L., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2022, October). Photonic-aware Neural Networks for Packet Classification in Beyond 5G Networks. In 2022 13th International Conference on Network of the Future (NoF) (pp. 1-5). IEEE.

Paolini, E., De Marinis, L., Cococcioni, M., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2022, July). Photonic-Aware Neural Network: a fixed-point emulation of photonic hardware. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) (pp. 01-03). IEEE.

Paolini, E., De Marinis, L., Maggiani, L., & Andriolli, N. (2022, July). Accelerating Pooling Layers in Photonic Convolutional Neural Networks. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) (pp. 1-3). IEEE.

De Marinis, L., **Paolini, E.**, Contestabile, G., & Andriolli, N. (2022, June). Leveraging Lithium Niobate on Insulator Technology for Photonic Analog Computing. In 2022 Italian Conference on Optics and Photonics (ICOP) (pp. 1-4). IEEE.

Paolini, E., Civerchia, F., De Marinis, L., Valcarenghi, L., Maggiani, L., & Andriolli, N. (2022, June). Photonic-aware Neural Networks for Packet Classification in URLLC scenarios. In 2022 IEEE 23rd International Conference on High Performance Switching and Routing (HPSR) (pp. 218-223). IEEE.

Demo

Paolini, E. et al. (2024, June). Enabling Lightweight Federated Learning in NextG Wireless Networks. In *10th IEEE International Conference on Network Softwarization (NetSoft) 2024*.

Pacini, A. et al. (2024, May). Hierarchical Software-Defined Control for coordinated RAN and PON-based Transport Scaling. In 2024 IEEE Network Operations and Management Symposium (pp. 1-3). IEEE.

Giorgetti, A., et al. (2024, March). Quantum-Assisted Digital Signature in an SDN-controlled Optical Network. In Optical Fiber Communication Conference (pp. M3Z-6). Optica Publishing Group.

Paolini, E. et al. (2023, October). Integrating QKD and classical optical networks: an SDN control approach. In European Conference on Optical Communications (ECOC), 2023.

Sgambelluri, A. et al. (2022, September). Exploiting Forecasting for Automatic Network Service Operations in Digital Twin Applications. In IEEE International Conference on Sensing, Communication, and Networking (SECON), Virtual Conference, 2022.

Teaching Activities

- **Computer Security – Avanzato** Fondo per la Repubblica digitale - Prove tecniche di futuro. (Oct. 2024 - Nov. 2024).
- **Computer Security – Base** Fondo per la Repubblica digitale - Prove tecniche di futuro. (July 2024).
- **Foundations of AI & AI for Radio Access Network.** ARTIST Seasonal School. (2023 - now).
- **Lecture about quantization techniques in Neural Networks.** FPGA school, ICTP-IAEA. (2023)
- **Introduction to Photonic-Aware Neural Networks and their impacts on real-world applications.** Seminar, University of Pisa. (2023)

Research Mentorship and Student Supervision

M.Sc. Students

- *Giovanni Paolini*, "Enhancing Neuromorphic Photonic Hardware Performance through Neural Architecture Search"

B.Sc. Students

- *Andrea Di Matteo*, "Federated Learning for Attack Detection in 6G/NextG Wireless Networks"
- *Gabriele Caioli*, "Sviluppo di una Key Management Entity per Quantum Key Distribution"

Research Projects

Involved in the activities of several international projects, including:

- **SMARTY** - "Scalable and Quantum Resilient Heterogeneous Edge Computing enabling Trust worthy AI (SMARTY)", HORIZON EUROPE, HORIZON-KDT-JU-2023-1-IA-Focus-Topic-3 on Integration of trustworthy Edge AI technologies in complex heterogeneous components and systems (IA), project ID 101140087
- **CLEVER** - CLEVER: Collaborative edge-cLoud continuum and Embedded AI for a Visionary industry of thE futuRe", HORIZON-KDT-JU-2021-2-RIA-Focus Topic 1-Processing solutions for AI at the edge addressing the design stack and middleware, project ID 101097560
- **BRAINE** - BRAINE: Big data pRocessing and Artificial Intelligence at the Network Edge (BRAINE)", H2020-ECSEL-2019-2-RIA project ID 876967
- **Optimizing iPerf for low-energy CPUs** - Comcast Innovation Fund 2024 Grant Year, co-PIs: Flavio Esposito and Luca Valcarenghi

Professional Activities

- **Conference and Journal Refereeing Experience** - Peer reviewer for International Conferences and Workshops organized by IEEE, IFIP (e.g., ICC, GlobeCom, European Conference on Networks and Communications (EUCNC) & 6G Summit, IFIP ONDM, IFIP/IEEE Networking), for Journal and Magazines published by IEEE, Elsevier, Optica (e.g., IEEE Communications Magazine, IEEE Transactions on Green Communications and Networking, IEEE Transactions on Services Computing, Neurocomputing, Journal of Lightwave Technology, Computer Networks)
- **Organizing Committee Member & Sponsor-Chair** - *IEEE Hot Interconnects*: Responsible for securing sponsorships and strengthening partnerships to support the conference. (2025 - Present)
- **Organizing Committee Member & Web-Chair** - *International Conference on Optical Network Design and Modelling (ONDM)*: Responsible for overseeing the online presence of the conference, including the management and updating of the conference website. (2025 - Present)
- **Organizing Committee Member & Web-chair** - *IEEE Hot Interconnects*: Responsible for overseeing the online presence of the conference, including the management and updating of the conference website. (2023 - 2024)
- **Dissemination and Outreach:**
  - Robotics Festival (2023), Exhibitor, Pisa.
  - Internet Festival (2024), Exhibitor, Pisa.

Professional Memberships

IEEE ComSoc Student Member