Mauro Belgiovine

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PhD student in Electrical and Computer Engineering at Northeastern University. Expertise in Deep Learning applications for Wireless Communication systems. Proficient in custom Deep Learning model design, simulation of wireless communication systems (PHY, MAC layers), data analysis and data manipulation. Other research interest includes mobile and distributed system, swarm intelligence, heterogeneous computing.

Research Areas

- **Machine and Deep Learning for Wireless Comm.**: Modeling and design of Deep Learning (DL) architectures, specifically for Wireless Comm. at PHY layer, such as RF Fingerprinting, Channel Estimation, Hybrid Beamforming, Traffic Classification. Good understanding of traditional Machine Learning and Bayesian estimation. Experience in building Supervised, Unsupervised and Reinforcement Learning (RL) models with Python based frameworks (TensorFlow/Pytorch), data analysis and input/output data pipelines for synthetically generated datasets, via simulation, or real transmissions. Experience with Software Defined Radio (SDR) real-time deployment of neural network models for edge devices.
- **Digital Twins for Wireless Communication and Networking Simulation**: Experience with NVIDIA's Digital Twins for Wireless Comm. (i.e. SionnaRT differentiable RayTracer and Aerial Omniverse Digital Twin). Expertise on simulation of local (802.11a/b/g/n/ac/ax WiFi protocols) and cellular networks (5G NR) at PHY/MAC layers for sub 6 GHz and mmWave bands using Matlab and Omnet++. Experience with simulation of analog/digital/hybrid beamforming process for SU/MU-MIMO communication. Experience with O-RAN experimental testbed (i.e., Colosseum at Northeastern University) for data collection and Machine Learning models deployment.
- **Parallel and Heterogeneous Computing:** Expertise with concurrent, parallel and distributed computing. Expertise with hardware accelerators, such as multi-core and General Purpose GPU (GPGPU) computing for parallel and massively parallel computing applications.
- **Software Architectures and Algorithm design**: Expertise in object oriented programming and design patterns. Algorithm design and complexity analysis. Extensive experience with code reviews for large code bases, debugging tools, code sub-versioning and coding tasks management.

Work Experience

SR. SOFTWARE ENGINEER, NVIDIA CORPORATION; SANTA CLARA, CA – MAR 2025 - PRESENT

Prototyping and testing of Deep Learning and Machine Learning applications for Wireless Communications and Future Cellular Networks.
Supervisor: Chris Dick

R&I INTERN, NVIDIA CORPORATION; SANTA CLARA, CA – MAY 2024 - AUG 2024

Study of a *Multiverse of Twins* system to combine data and functionalities from multiple Digital Twins to achieve unified objectives. Proposed system consisted of two NVIDIA's Digital Twin products designed for wireless applications, namely SionnaRT differentiable RayTracer and Aerial Omniverse Digital Twin (AODT). Study case involved optimization of Airborne Base Stations (ABSs) deployments through gradient-descent techiniques, using SionnaRT differentiable RayTracer for optimization and AODT simulations for validation.
Supervisor: Chris Dick, Tommaso Balercia

R&I INTERN, NVIDIA CORPORATION; SANTA CLARA, CA – MAY 2022 - AUG 2022

Study and implementation of a Deep Reinforcement Learning method for Beam Management in 5G NR standard (patent pending) based on real-world wireless channel measurements collected through RENEW programmable massive MIMO platform.
Supervisor: Chris Dick, Xingqin Lin, Christian Ibars.

R&I INTERN, INTERDIGITAL, INC.; CONSHOHOCKEN, PA – FEB 2021 - JUL 2021

Development, analysis and simulation of AI/ML algorithms for massive MIMO Hybrid Beam Forming in mmWave band. Simulated algorithms in both Matlab and Python environments included:
- Codebook/beam-sweeping approaches
- Orthogonal Matching Pursuit (OMP)
- Manifold Optimisation (MO-Altmin), Phase Extraction (PE-AltMin)
- x2 DL based solution from literature (details available upon request)
Supervisor: Miki Beluri, Arnab Roy.

RESEARCH ASSISTANT GRAD. STUDENT, NORTHEASTERN U.; BOSTON, MA – JAN 2018 - MAR 2025

Researcher at Genesys Lab and WIoT in the field of Deep Learning applied to next generation Wireless Communication Systems. Current investigations involve applications of RL in context of 5G NR Hybrid Beamforming and Transformer-based traffic classification for UE slicing in O-RAN. Reviewer for several top-tier journals and conferences, including IEEE Transactions on Mobile Computing, IEEE Transactions on Wireless Communications, IEEE InfoCom, IEEE DySPAN. Contributor in multiple funding proposals in programs sponsored by NSF, DARPA and IARPA agencies, ultimately awarded by our lab.
Supervisor: Prof. Kaushik Chowdhury.

SOFTWARE ENGINEER INTERN, DATALOGIC ADC; PASADENA, CA – AUG 2016 - JAN 2017

Analysis and development of industrial OCR applications using Demonising AutoEncoders (DAE) DL architectures implemented in TensorFlow:
- Image based digit detector (I-layer classifier) intended to be used on pictures of expiration dates on boxes.
- False Positive detector (II-layer classifier) used to sanitise output of the digit detector.
Project's documentation has contributed to the content of my Master Degree Thesis in Computer Science and resulted in a patent filing by the company [8].
Supervisor: Luis Goncalves.

SOFTWARE ENGINEER, INFN - NATIONAL INST. OF NUCLEAR PHYSICS; BOLOGNA, IT – AUG 2012 - NOV 2014

C/C++/CUDA/OpenCL developer in the field of General Purpose computing on GPU (GPGPU), Heterogeneous Computing and HPC. Part of my work has been presented at TIPP14 (Amsterdam) and GPUHEP2014 (Pisa) conferences (details available upon request).
Supervisor: Lorenzo Rinaldi, Antonio Sidoti, Mauro Villa.

Relevant Publications

1. ***M. Belgiovine****, J. Groen, M. Sirera, C. Tassie, S. Trudeau, S. Ioannidis, and K. Chowdhury, "T-prime: Transformer-based protocol identification for machine-learning at the edge," IEEE INFOCOM 2024, Vancouver, Canada, May 2024 (accepted)*
2. ***M. Belgiovine****, K. Chowdhury, "Improve your Aim: a Deep Reinforcement Learning approach for 5G NR mmWave beam refinement", IEEE ICC 2023 (May 2023)*
3. ***M. Belgiovine****, K. Sankhe, C. Bocanegra, D. Roy, K. Chowdhury, "Deep Learning at the Edge for Channel Estimation in Beyond-5G Massive MIMO", IEEE Wireless Communication Magazine (April 2021).*
4. *N. Soltani, H. Cheng,* ***M. Belgiovine*** *et al., "Neural Network-based OFDM Receiver for Resource Constrained IoT Devices", IEEE Internet of Things Magazine, Vol. 5 Issue 3, September 2022*
5. *B. Salehi,* ***M. Belgiovine****, S. Sanchez, J. Dy, S. Ioannidis, and K. R. Chowdhury, " Machine Learning on Camera Images for Fast mmWave Beamforming," IEEE International Conference on Mobile Ad Hoc and Sensor Systems (MASS), 2020*
6. *K. Sankhe,* ***M. Belgiovine****, F. Zhou, S. Riyaz, S. Ioannidis, K. Chowdhury, "ORACLE: Optimized Radio clAssification through Convolutional neuraL nEtworks", Proceedings of IEEE INFOCOM 2019*
7. *K. Sankhe,* ***M. Belgiovine****, F. Zhou, L. Angioloni, F. Restuccia, S. D'Oro, et al., "No Radio Left Behind: Radio Fingerprinting Through Deep Learning of Physical-Layer Hardware Impairments", IEEE Transactions on Cognitive Communications and Networking 2019*
8. *F. Restuccia, S. D'Oro, A. Al-Shawabka,* ***M. Belgiovine****, L. Angioloni, et. al. "DeepRadioID: Real-Time Channel-Resilient Optimization of Deep Learning-based Radio Fingerprinting Algorithms", Proceedings of ACM MobiHoc 2019*

Patents

1. *Wireless signal beam management using reinforcement learning*, **M. Belgiovine**, C. H. Dick - US Patent App. 18/198,208, 2024
2. *Systems and methods for robust industrial optical character recognition,* L. Goncalves, **M. Belgiovine** - US Patent 10,810,465, 2020

Education

Northeastern University, Boston MA – January 2025 (Estimated)
PhD in Computer Engineering
University of Bologna, Bologna IT – July 2017
Master's Degree in Computer Science - Wireless Systems and Networking
Final evaluation: 110 / 110 cum laude
University of Bologna, Bologna IT – March 2013
Bachelor's Degree in Computer Science

References

Kaushik Chowdhury, Professor in Electrical and Computer Engineering department at Northeastern University, Boston (MA). krc@ece.neu.edu

Technical Skills & Relevant courses

- Deep Learning (Pytorch, Keras/TensorFlow), Machine Learning, Wireless communication, O-RAN, HPC, Distributed Computing, Mobile Systems, System simulation, Computer Security.
- ESC13 "*Fifth INFN International School on Architectures, tools and methodologies for developing efficient large scale scientific computing applications*".
- Programming languages: Python, C/C++, CUDA, OpenCL, Java, Arduino, Omnet++, Bash, MPI.