

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.

Specialized research areas

- **Wireless Communication and Networking simulation:** Simulation of traditional WiFi protocols (802.11a/b/g/n/ac/ax), vehicular and cellular protocols at PHY/MAC layers for sub 6 GHz and mmWave bands using different tools, such as Matlab and Omnet++. Good understanding of OFDM based communication and analog/digital/hybrid beamforming process for SU/MU-MIMO communication.
- **Machine and Deep Learning for Wireless Comm.:** Modelling and design of Deep Learning (DL) architectures, specifically for Wireless Comm. at PHY layer, such as RF Fingerprinting, Channel Estimation and Hybrid beamforming. 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.
- **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 with coding using design patterns. Algorithm design and complexity analysis. Extensive experience with code reviews for large code bases, debugging tools, code sub-versioning and programming team management.

Working Experience

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 - NOW

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 UE tracking in O-RAN architecture. 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.

Selected projects:

- **ORACLE - CNN-BASED CLASSIFIER FOR RF FINGERPRINTING**

This model was developed during the RFMLS challenge [3,4,5], sponsored by DARPA. The architecture was tested on a wide range of transmissions, including a dataset of ~500 WiFi devices captured transmissions provided by DARPA and in-house generated dataset using software defined radios.

- **MLP M-MIMO CHANNEL ESTIMATOR - DEEP LEARNING BASED CHANNEL ESTIMATOR FOR MASSIVE MIMO-OFDM COMM.**

An edge oriented architecture that provides higher accuracy and lower computing overhead compared to traditional LS and LMMSE estimators [1]. This work has also contributed as the main channel estimator in SPiNN project [7].

- **VISION-AIDED FAST BEAMFORMING - CNN-BASED IMAGE FEATURE EXTRACTION AND BEAM PREDICTION**

Computer Vision approaches aiming to use visual information to guide beamforming and perform fast beam sweeping in analog and hybrid beamforming [2].

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 [6].

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**, 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).
2. 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
3. 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*
4. 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
5. 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*
6. L. Goncalves, **M. Belgiovine**, "Systems and Methods For Robust Industrial Optical Character Recognition", *USAN: 16/024,910, Datalogic ADC Patent*
7. 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

Education

Northeastern University, Boston MA – June 2023 (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, Networking, 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".
- Software development in Unix (Linux, Mac OS X) environment. Programming languages: Python, C/C++, CUDA, OpenCL, Java, Arduino, Omnet++, Bash, MPI.