Dr. Antonio Macaluso

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Profile Summary

I am Senior Researcher at the German Research Center for Artificial Intelligence (DFKI), head of the Quantum Artificial Intelligence (QAI) team, part of the Intelligent Information Systems (IS2) research group (ASR dept.). My research investigates the potential benefit of quantum algorithms in the following AI areas: supervised learning, reinforcement learning, multi-agent systems, planning and scheduling.

Beyond my research pursuits, I am engaged in funding acquisition activities and teaching with a focus on delivering quantum-related topics to computer science students. Additionally, I contribute to editorial reviews for numerous journals and peer-reviewed conferences. My past experience also encompasses working in the industry.

Education

2017 – 2020 — **PhD in Computer Science and Engineering**
University of Bologna · Bologna, Italy
Thesis: *A Novel Framework for Quantum Machine Learning* (PhD thesis).

2014 – 2017 — **MSc in Statistical Sciences – 110/110 L**
University of Bologna · Bologna, Italy
Thesis: *Evaluating the efficacy of drugs in tumor cells through Machine Learning.*

2015 – 2016 — **Advanced Master in Data Science – 28/30**
Bologna Business School (BBS), University of Bologna · Bologna, Italy
Final project report on machine learning applications for Industry 4.0.

2011 – 2014 — **BSc in Statistical Sciences – 110/110 L**
University of Bologna · Bologna, Italy
Thesis: *Data Mining for Pattern Analysis of University Students.*

Working Experience

2022–2023 — **Senior Researcher**
German Research Center for Artificial Intelligence (DFKI) · Saarbruecken, Germany
Lead of the Quantum AI research unit in the IS2 team of the Agent and Simulated Reality Dept. (DFKI).

2021–2022 — **Researcher**
German Research Center for Artificial Intelligence (DFKI) · Saarbruecken, Germany
Research on Quantum Artificial Intelligence.

2016–2019 — **Data Scientist**
Cineca · Bologna, Italy
Machine Learning for industry 4.0 applications.

2016–2019 — **Machine Learning Engineer**
Menarini Silicon Biosystems · Bologna, Italy
Machine Learning for data analysis of in vitro diagnostic medical devices.

Invited Talks

2024 **Introduction to Quantum Machine Learning** - **International Winter School on Quantum Machine Learning**, *RPTU, Kaiserslautern, Germany*

2023 **Quantum Computing: A Classical Perspective** - Quantum Computers: from Basics to Compilers, *Saarland University, Saarbruecken, Germany* (QuCoLiMa project)

2022 **Quantum Computing for AI Applications** - Focus Semester on Quantum Information, *Saarland University, Saarbruecken, Germany*

Research

Google scholar statistics: (20/03/2024)

6	10	6
Journal Publications	*Peer-reviewed Conference Papers*	*h-index*

Teaching

A.Y. 2023/24 — **Quantum Artificial Intelligence**
Saarland Informatics Campus, Saarland University · Saarbrücken, Germany
LSF 146584, Evaluation (with PD Matthias Klusch).

A.Y. 2022/23 — **Quantum Computing for NP-hard Problems and AI**
Department of Computer Science and Engineering, University of Bologna · Bologna, Italy
Course for Ph.D. students, Syllabus)

A.Y. 2022/23 — **Quantum Artificial Intelligence**
Saarland Informatics Campus, Saarland University · Saarbrücken, Germany
LSF 139530, Evaluation (with PD Matthias Klusch)

A.Y. 2021/22 — **Quantum Machine Learning Seminar**
Saarland Informatics Campus, Saarland University · Saarbrücken, Germany
LSF 136315, 7 CPs (with PD Matthias Klusch)

(Co)Supervision of Graduates

2024 Alessandro Rizzo, "Quantum Convolutional Neural Networks for the Detection of Gamma-Ray Bursts", *MSc in Artificial Intelligence, University of Bologna, Italy* (with Prof. Claudio Sartori).

2023 Akash Shina, "Quantum Deep Reinforcement Learning for Collision-Free Navigation of Self-Driving Cars", *Master of Science, Saarland University*, Germany (with PD Matthias Klusch).

2023 Francesco Aldo Venturelli, "Quantum Convolutional Neural Networks for Data-Efficient Image Classification", *Master's Degree in Physics, University of Bologna, Italy* (with Prof. Stefano Lodi)

2023 Lorenzo Cellini, "QAL-BP: Quantum Augmented Lagrangian Approach to the Bin Packing", *MSc in Artificial Intelligence, University of Bologna, Italy* (with Prof. Michele Lombardi).

2022 Supreeth Mysore Venkatesh, "On Quantum Coalition Structure Generation", *MSc in Mathematics and Computer Science, Saarland University*, Germany (with PD Matthias Klusch).

2022 Matteo Antonio Inajetovic, "Variational Q-Splines: Beyond Linearity for Quantum Activation Functions", *MSc in Artificial Intelligence, University of Bologna, Italy* (with Prof. Claudio Sartori).

2021 Filippo Orazi, "Development and evaluation of the Multiple Aggregator Quantum Algorithm", *MSc in Artificial Intelligence, University of Bologna, Italy* (with Prof. Claudio Sartori).

Certifications

2021 **IBM Certified Associate Quantum Developer** (badge) - Provided by IBM Professional Certification

2020 **IBM Quantum Qiskit Advocate** (badge) - Provided by IBM Professional Certification

Awards

2021 **IBM Quantum Researchers Program Award** for accessing high-quality quantum hardware (Provided by IBM Quantum, USA)

2015 **Full-tuition scholarship** (14.000 euro) for attendance to the Master in Data Science at the Bologna Business School

Publications

Preprints (Quantum AI)

[9] Akash Sinha, **Antonio Macaluso**, and Matthias Klusch. "Nav-Q: Quantum Deep Reinforcement Learning for Collision-Free Navigation of Self-Driving Cars". In: *arXiv preprint arXiv:2311.12875* (2023).

[12] Supreeth Mysore Venkatesh, **Antonio Macaluso**, Marlon Nuske, Matthias Klusch, and Andreas Dengel. "Q-Seg: Quantum Annealing-based Unsupervised Image Segmentation". In: *arXiv preprint arXiv:2311.12912* (2023).

Quantum AI

[1] Lorenzo Cellini, **Antonio Macaluso**, and Michele Lombardi. "QAL-BP: an augmented Lagrangian quantum approach for bin packing". In: *Scientific Reports* 14.1 (2024), p. 5142. DOI: doi.org/10.1038/s41598-023-50540-3.

[3] **Antonio Macaluso**, Luca Clissa, Stefano Lodi, and Claudio Sartori. "An efficient quantum algorithm for ensemble classification using bagging". In: *IET Quantum Communication* (2024). DOI: doi.org/10.1049/qtc2.12087.

[5] Matteo Antonio Inajetovic, Filippo Orazi, **Antonio Macaluso**, Stefano Lodi, and Claudio Sartori. "Enabling Non-linear Quantum Operations Through Variational Quantum Splines". In: *Computational Science – ICCS 2023*. Cham: Springer Nature Switzerland, 2023, pp. 177–192. DOI: doi.org/10.1007/978-3-031-36030-5_14.

[6] **Antonio Macaluso**, Matthias Klusch, Stefano Lodi, and Claudio Sartori. "MAQA: a quantum framework for supervised learning". In: *Quantum Information Processing* 22.3 (2023), p. 159. DOI: doi.org/10.1007/s11128-023-03901-w.

[7] **Antonio Macaluso**, Filippo Orazi, Matthias Klusch, Stefano Lodi, and Claudio Sartori. "A Variational Algorithm for Quantum Single Layer Perceptron". In: *Machine Learning, Optimization, and Data Science*. Springer Nature Switzerland, 2023, pp. 341–356. DOI: doi.org/10.1007/978-3-031-25891-6_26.

[10] Supreeth Mysore Venkatesh, **Antonio Macaluso**, and Matthias Klusch. "Gcs-q: Quantum graph coalition structure generation". In: *International Conference on Computational Science*. Springer. 2023, pp. 138–152. DOI: doi.org/10.1007/978-3-031-36030-5_11.

[11] Supreeth Mysore Venkatesh, **Antonio Macaluso**, and Matthias Klusch. "QuACS: Variational Quantum Algorithm for Coalition Structure Generation in Induced Subgraph Games". In: *Proceedings of the 20th ACM International Conference on Computing Frontiers*. CF '23. Bologna, Italy, 2023, pp. 197–200. DOI: doi.org/10.1145/3587135.3592192.

[13] Supreeth Mysore Venkatesh, **Antonio Macaluso**, and Matthias Klusch. "BILP-Q: quantum coalition structure generation". In: *Proceedings of the 19th ACM International Conference on Computing Frontiers*. 2022, pp. 189–192. DOI: doi.org/10.1145/3528416.3530235.

[14] **Antonio Macaluso**. "A Novel Framework for Quantum Machine Learning". PhD thesis. alma, May 2021. DOI: 10.48676/unibo/amsdottorato/9791.

[17] **Antonio Macaluso**, Luca Clissa, Stefano Lodi, and Claudio Sartori. "A Variational Algorithm for Quantum Neural Networks". In: *International Conference on Computational Science*. Springer. 2020, pp. 591–604. DOI: doi.org/10.1007/978-3-030-50433-5_45.

[18] **Antonio Macaluso**, Luca Clissa, Stefano Lodi, and Claudio Sartori. "Quantum splines for non-linear approximations". In: *Proceedings of the 17th ACM International Conference on Computing Frontiers*. 2020, pp. 249–252. DOI: doi.org/10.1145/3387902.3394032.

[19] **Antonio Macaluso**, Stefano Lodi, and Claudio Sartori. "Quantum Algorithm for Ensemble Learning". In: *Proceedings of the 21st Italian Conference on Theoretical Computer Science*. 2020.

Applied Machine Learning

[2] Luca Clissa, **Antonio Macaluso**, Roberto Morelli, Alessandra Occhinegro, Emiliana Piscitiello, Ludovico Taddei, Marco Luppi, Roberto Amici, Matteo Cerri, Timna Hitrec, et al. "Fluorescent Neuronal Cells v2: multi-task, multi-format annotations for deep learning in microscopy". In: *Scientific Data* 11.1 (2024), p. 184. DOI: doi.org/10.1038/s41597-024-03005-9.

[4] Luca Clissa, **Antonio Macaluso**, and Antonio Zoccoli. "Optimizing Deep Learning Models for Cell Recognition in Fluorescence Microscopy: The Impact of Loss Functions on Performance and Generalization". In: *International Conference on Image Analysis and Processing*. Springer. 2023, pp. 179–190. DOI: doi.org/10.1007/978-3-031-51023-6_16.

[8] N Parmiggiani, A Bulgarelli, A Ursi, **A Macaluso**, A Di Piano, Valentina Fioretti, A Aboudan, L Baroncelli, A Addis, Marco Tavani, et al. "A Deep-learning Anomaly-detection Method to Identify Gamma-Ray Bursts in the Ratemeters of the AGILE Anticoincidence System". In: *The Astrophysical Journal* 945.2 (2023), p. 106. DOI: 10.3847/1538-4357/acba0a.

[15] Ricardo Ñanculef, Francisco Mena, **Antonio Macaluso**, Stefano Lodi, and Claudio Sartori. "Self-supervised Bernoulli autoencoders for semi-supervised hashing". In: *Progress in Pattern Recognition, Image Analysis, Computer Vision, and Applications: 25th Iberoamerican Congress, CIARP 2021, Porto, Portugal*. Springer. 2021, pp. 258–268. DOI: doi.org/10.1007/978-3-030-93420-0_25.

[16] N Parmiggiani, A Bulgarelli, V Fioretti, A Di Piano, A Giuliani, F Longo, F Verrecchia, M Tavani, D Beneventano, and **A Macaluso**. "A deep learning method for AGILE-GRID gamma-ray burst detection". In: *The Astrophysical Journal* 914.1 (2021), p. 67. DOI: 10.3847/1538-4357/abfa15.