Paolo Joseph Baioni

Curriculum Vitae

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Professional Summary

PhD in Mathematical Models and Methods in Engineering, with strong expertise in C++20, CUDA, ROCm, and libraries for HPC on CPUs and GPUs. Extensive experience developing performance-portable scientific software across multiple libraries and hardware platforms, including NVIDIA and AMD GPUs, as well as in optimisation and benchmarking within Linux-based distributed environments. Passionate about accelerators, heterogeneous and distributed computing, physics, research, teaching, and dissemination. Implemented advanced GPU simulation codes in C++20/CUDA-C and a DNN implementation from scratch in C++14 using Eigen. MSc degrees in Applied Mathematics and Nuclear Engineering. Demonstrated ability in R&D software development, including code reviews and issue-driven development within Git-based workflows. Strong communication and teamwork skills, further developed through experience in teaching, especially on numerical methods via advanced C++, industry collaborations, co-organising scientific mini-symposia, and delivering scientific talks. Recently began acting as a co-supervisor for MSc and PhD theses on HPC topics (Alpaka vs CUDA-C for matrix operations, mixed precision on GPUs, Thrust-based PIC-MPMs for FSI). Currently Technical Manager at the MOX Laboratory (Modelling and Scientific Computing), Politecnico di Milano; responsible for Linux HPC system configuration (HW, OS) and deployment (OpenPBS, Spack, Apptainer).

Education

11/2021 – 02/2025	**PhD in Mathematical Models and Methods in Engineering**, *Laboratory for Modelling and Scientific Computing (MOX)*, Mathematics Department, Politecnico di Milano Design and development of C++20 code for GPUs and CPUs (Thrust, std::execution/TBB, CUDA, HIP). **PhD Thesis**: *"Material Point Method for Compressible Flows: a Portable, Massively Parallel Implementation for High-Performance Computing Architectures"* Supervisor: prof. Carlo de Falco, carlo.defalco@polimi.it
2021	**National Habilitation**, Senior Nuclear Engineer
10/2020 – 10/2021	**MSc in Nuclear Eng.**, Nuclear System Physics, *Politecnico di Milano*, 107/110
09/2017 – 10/2020	**MSc in Math. Eng.**, Computational Sciences and Engineering, *Politecnico di Milano*, 110/110
09/2013 – 07/2017	**BSc in Ingegneria Matematica**, *Politecnico di Milano*, 110/110

Professional Experience

12/2023 – present (Permanent Position)	**Technical Manager - MOX Laboratory for Modelling and Scientific Computing**, Mathematics Department, Politecnico di Milano

- ○ Lead the design, implementation, and maintenance of distributed computing systems tailored for scientific research, ensuring optimal performance and reliability in high-demand environments.
- ○ Development and optimisation of scientific software, with a strong emphasis on modern C++, GPU porting, refactoring, testing and integration with AI frameworks, while fostering productive collaborations between academia and industry.
- ○ Principal Investigator (PI) of the "MatBa" project, providing access to CINECA HPC resources for DMAT researchers, as well as finding optimal solutions specific to scientific computing needs.
- ○ Lead a project to renew an outdated HPC infrastructure, securing funding to acquire modern, energy-efficient and highly parallel servers.
- ○ Supervision of technical staff for Linux system administration and deployment.
- ○ Co-supervision of MSc/PhD students on GPU/HPC software (PhD: gasdynamics/FSI with Thrust & PIC-MPM on clusters; MSc project: CUDA-C vs Alpaka for matrix ops; MSc thesis: GPU-aware mixed precision optimisations, nanobind data sketches).

2022 – present	**Teaching Assistant - Scientific Computing MSc Courses**, Politecnico di Milano

- ○ Delivered advanced C++/numerical methods labs at MSc level — github.com/pacs-course/pacs-Labs/tree/main/Labs/2025/ and github.com/HPC-Courses/AMSC-Labs/tree/main/Labs/2025-26
- ○ Covered technical topics such as C++23, MPI, OpenMP, Octave, Bash, Make, Docker/Podman, Singularity/Apptainer, Spack, gdb, lcov, valgrind, CMake, and pybind11, as well as C++ libraries such as Eigen and Boost, and parallel abstraction layers including NVIDIA Thrust, ROCm Thrust, the C++ Parallel STL with oneTBB backend, and NVIDIA stdpar for multicore and GPU execution
- ○ Managing graduate student teams, providing guidance and support to enhance their understanding of complex scientific computing concepts.

Key Technical Skills

Programming	C++20/23, CUDA-C, HIP, ROCm, MPI, Eigen, Boost, (roc)Thrust, std::execution/TBB, C, Make, gdb, lcov, valgrind, Nsight Systems, shell, Octave/Matlab, Python (scripting), pybind11 and Numba
Software Tools	git/GitHub, Docker/Podman, Singularity/Apptainer, Spack, CMake, Doxygen, SLURM/PBS
Numerical Methods	FEM, DG, PIC/MPM, Numerical Linear Algebra, Symplectic Integrators, Runge-Kutta methods
OS & Management	Linux (Debian, Arch and RHEL based systems), MS Windows, Virtualisation tools; iDRAC, iLO
Scientific research software usage	○ SOLPS-ITER, coupled Finite Volumes and Monte Carlo code for the simulation of boundary plasma in magnetic confinement fusion devices, including B2.5 (plasma) and EIRENE (WCU MC);
	○ PyFR, solver for advection–diffusion using Flux Reconstruction, designed for performance portability across multiple backends (CPU/GPU) via a Python based domain-specific templating layer.

Professional Development

Red Hat Courses	Ansible (2025-2026).
NVIDIA Courses	Scaling Workloads Across Multiple GPUs with CUDA C++, GPU Acceleration with the C++ Standard Library, Building Container Images for HPC, Accelerated Computing with CUDA Python, Accelerating CUDA C Applications with Concurrent Streams, and more (2024-2025).
CINECA Courses	Build Systems and Package Managers in HPC, Parallel Computing on Traditional Core-Based and Emerging GPU-Based Architectures, Numerical Methods for Parallel CFD (2021-2023).
Conferences and Workshops	Continuous learning through attendance at various industry workshops, EuroHPC hackathons, and scientific conferences on HPC, AI, Scientific Machine Learning, Quantum Computing.

Publications and Conferences

2025	**Workshop Poster (selected)**, *Portable Parallel Computing: C++ Strategies for Cross-Architecture Performance*, Baioni P.J., Benacchio T., Capone L., de Falco C., E4: AI, HPC & QUANTUM 2025
2024	**Journal Paper**, *Portable, massively parallel implementation of a material point method for compressible flows*, Baioni P.J., Benacchio T., Capone L., de Falco C., Computational Particle Mechanics, Springer. DOI: 10.1007/s40571-024-00864-2, full text https://rdcu.be/d20u2
2024	**Review activity**, Reviewer for the Journal of Computational Particle Mechanics, Springer
2023	**Proceedings of Eccomas - Particles 2023**, *GPUs Based Material Point Method for Compressible Flows*, Baioni P.J., Benacchio T., Capone L., de Falco C. VIII International Conference on Particle-Based Methods, DOI: 10.23967/c.particles.2023.026
2023	**Proceedings of SIMAI 2023**, *MS08 - Particle-Based Methods In Applied And Industrial Sciences*, Baioni P.J., Crescenzio N., Fois M., Moreno Martinez L. The XVI biannual congress of SIMAI, link: https://web.unibas.it/simai2023/BookOfAbstracts.pdf
2023	**Proceedings of SIMAI 2023**, *Material Point Method for Compressible CFD on GPUs*, Baioni P.J., Benacchio T., Capone L., de Falco C., Pellegrino E. The XVI biannual congress of SIMAI

FOSS Software

2020	Development of a C++14 code for a numerical methods and programming university course project, implementing a Deep Neural Network (DNN) from scratch, relying on the C++ Standard Library and Eigen; code available at https://github.com/pjbaioni/neural-net

Professional Memberships

2023 – present	Member of INdAM, National Scientific Computing Group (GNCS)
2023 – present	Member of Italian Society for Applied and Industrial Mathematics (SIMAI)
2022 – present	Enrolled in the Order of Engineers of the Metropolitan City of Milan

Languages

Italian	Native speaker
English	C1 (TOEIC 2016); teaching MSc courses in English since 2022

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