europass Curriculum vitae

PERSONAL INFORMATION

Davide Murari

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Gender Male | Date of birth 22 May 1996 | Nationality Italian

PERSONAL STATEMENT

Postdoctoral Research Associate exploring the interplay between neural networks, dynamical systems, and structure-preserving numerical analysis.

MAIN PUBLICATIONS

The papers listed here and in the preprint section are those to which I have substantially contributed. Most of them follow alphabetical author ordering. The year on the left is written in bold for those where I am the main author.

2025 Celledoni, Elena, Ergys Çokaj, Andrea Leone, Sigrid Leyendecker, **Davide Murari**, Brynjulf Owren, Rodrigo T. Sato Martín de Almagro, and Martina Stavole. "Neural networks for the approximation of Euler's elastica." Computer Methods in Applied Mechanics and Engineering 435 (2025): 117584.

2024 Eliasof, Moshe, **Davide Murari**, Ferdia Sherry, and Carola-Bibiane Schönlieb. "Resilient Graph Neural Networks: A Coupled Dynamical Systems Approach ." ECAI - 27TH European Conference on Artificial Intelligence (2024): 1607-1614.

2024 Sherry, Ferdia, Elena Celledoni, Matthias J. Ehrhardt, **Davide Murari**, Brynjulf Owren, and Carola-Bibiane Schönlieb. "Designing stable neural networks using convex analysis and ODEs." Physica D: Nonlinear Phenomena 463 (2024): 134159.

2023 Celledoni, Elena, **Davide Murari**, Brynjulf Owren, Carola-Bibiane Schönlieb, and Ferdia Sherry. "Dynamical Systems–Based Neural Networks." SIAM Journal on Scientific Computing 45, no. 6 (2023): A3071-A3094.

2023 Celledoni, Elena, Andrea Leone, **Davide Murari**, and Brynjulf Owren. "Learning Hamiltonians of constrained mechanical systems." Journal of Computational and Applied Mathematics 417 (2023): 114608.

2021 Celledoni, Elena, Ergys Çokaj, Andrea Leone, **Davide Murari**, and Brynjulf Owren. "Lie group integrators for mechanical systems." International Journal of Computer Mathematics 99, no. 1 (2022): 58-88.

MAIN PREPRINTS

2024 Canizares, Priscilla, **Davide Murari**, Carola-Bibiane Schönlieb, Ferdia Sherry, and Zakhar Shumaylov. "Symplectic Neural Flows for Modeling and Discovery." arXiv preprint arXiv:2412.16787 (2024).

2024 Betcke, Marta M., Lisa Maria Kreusser, and **Davide Murari**. "Parallel-in-Time Solutions with Random Projection Neural Networks." arXiv preprint arXiv:2408.09756 (2024).

2024 Celledoni, Elena, James Jackaman, **Davide Murari**, and Brynjulf Owren. "Predictions Based on Pixel Data: Insights from PDEs and Finite Differences." arXiv preprint arXiv:2305.00723 (2024).

RESEARCH POSITIONS

1st October 2024 - Current date Postdoctoral Research Associate in the Cambridge Image Analysis group of Professor Carola-Bibiane Schönlieb, Department of Applied Mathematics and Theoretical Physics, University of Cambridge. The position is funded by an EPSRC programme grant in 'The Mathematics of Deep Learning' under the project EP/V026259/1.

EDUCATION

2020-September 2024 PhD in Numerical Analysis, Norwegian University of Science and Technology, supervised by Professors Elena Celledoni and Brynjulf Owren. Thesis title: "*Neural Networks, Differential Equations, and Structure Preservation*".

2018-2020 Master in Mathematics (L-40), University of Verona, Italy. Thesis title: "*Integrable Non-Hamiltonian Systems: From B-Integrability to Euler-Jacobi Theorem and Back*", supervised by Professor Nicola Sansonetto. Final mark: 110/110 cum laude.

2015-2018 Bachelor in Applied Mathematics (L-35), University of Verona, Italy. Thesis title translating to "*An Overview of Ergodic Theory and Dynamical Billiards*", supervised by Professor Nicola Sansonetto. Final mark: 110/110 cum laude.

PEER REVIEW

Reviewer for the following scientific journals:

- Calcolo
- Journal of Computational and Applied Mathematics
- IMA Journal of Applied Mathematics
- IMA Journal of Numerical Analysis
- SIAM Journal of Scientific Computing

ORGANISED MINI-SYMPOSIA

Collaborated on the organisation of two mini-symposia:

- Mini-symposium at SciCADE 2024, Singapore, July 15 2024 - July 19 2024. Title of the mini-symposium: "Dynamical systems, structure preservation and deep learning".
- Mini-symposium at Geometric Science of Information (GSI), St. Malo, France, August 30 2023 - September 1 2023. Title of the mini-symposium: "Deep Learning: Methods, Analysis and Applications to Mechanical systems".

EDITORIAL WORK

2021-2022 Guest editor for the ECMI Annual reports of the years 2021 and 2022.

SELECTED FUNDING SOURCES

January 2024 Trond Mohn Foundation (TMS) grants: Support for attending the Geilo Winter School "Graphs and Applications", from the 21st to the 26th of January 2024. The funding has been of 12,000.00 NOK, currently valued at about £845.00.

March-April 2023 Simons visiting fellowship: Support for participating in the thematic semester "The mathematical and statistical foundation of future data-driven engineering" during the days from the 7th of March 2023 to the 2nd of May 2023. The funding has been £1,400.00.

October 2021 Isaac Newton Institute: Support for participating in the thematic semester titled "Mathematics of deep learning" during the days from the 8th to the 30th of October 2021. The funding has been £330.00.

TEACHING EXPERIENCE

January - March 2025 Teaching the graduate course "Geometric Numerical Analysis and Deep Learning" at the University of Cambridge.

November 2024 Teaching the master-level mini-course "Geometric Methods for Differential Equations and Learning Applications" at the University of Verona.

Fall 2023 Assistant for the course "Numerical Solution of Partial Differential Equations Using Element Methods - TMA4220" at NTNU.

Fall 2022 Assistant for the course "Numerical Solution of Partial Differential Equations Using Element Methods - TMA4220" at NTNU.

Spring 2022 Assistant for the course "Optimization 1 - TMA4180" at NTNU.

Fall 2021 Assistant for the course "Numerical Solution of Partial Differential Equations Using Element Methods - TMA4220" at NTNU.

Spring 2021 Assistant for the course "Differential Equations and Dynamical Systems - TMA4165" at NTNU.

Spring 2020 Assistant for the course "Dynamical Systems" at the University of Verona.

SELECTED INVITED TALKS

October 2024 Workshop “Deep Learning for PDE-based Inverse Problems”, Oberwolfach, Germany. Talk title: “Dynamical systems-based structured networks”

October 2024 SIAM Conference on Mathematics of Data Science (MDS24), Atlanta, USA. Talk title: “Structure-Preserving Solutions of Hamiltonian Systems Based on Neural Networks”

February 2024	BIRS Workshop "Structured Machine Learning and Time–Stepping for Dynamical Systems", Banff, Canada. Talk title: "Improving the robustness of Graph Neural Networks with coupled dynamical systems".
August 2023	ICIAM 2023, Tokyo, Japan. Talk title: "Structured neural networks and some applications".
June 2023	ECMI Conference 2023, Wroklav, Poland. Talk title: "Learning Hamiltonians of constrained mechanical systems".
June 2023	FoCM 2023, Paris, France. Talk title: "Structured neural networks and some applications to dynamical systems".
February 2023	SIAM CSE, Amsterdam, Netherlands. Talk title: "Structured neural networks and their relevance for mechanical systems".
December 2022	Theoretical and Computational aspects of Dynamical Systems (HB60), Trysil, Norway. Talk title: "Dynamical systems-based neural networks".
July 2022	SciCADE, Reykjavík, Iceland. Talk title: "Structure preserving neural networks coming from ODE models".
May 2022	Machine Learning and Dynamical Systems Seminar of the Alan Turing Institute, Online. Talk title: "Learning Hamiltonians of constrained mechanical systems".
November 2021	Computational Mathematics and Machine Learning Workshop, Leiden, Netherlands. Talk title: "Learning the Hamiltonian of some constrained mechanical systems"

PRESENTED POSTERS

January 2024	Geilo Winter School, Geilo, Norway. Poster titled "Contractive Systems Improve Graph Neural Networks Against Adversarial Attacks".
December 2022	The Symbiosis of Deep Learning and Differential Equations (DLDE) - II, NeurIPS Workshop. Poster titled "Structure preserving neural networks based on ODEs".

LANGUAGE SKILLS

Mother tongue: Italian

Other languages

English	Full professional proficiency
Norwegian (Bokmål)	Intermediate

HOBBIES AND INTERESTS

Interested in communicating mathematics, sharing content about various topics in this field with an ongoing outreach project in Italian:

- in written format on the blog: https://www.mathone.it/
- in video format on the YouTube channel: https://www.youtube.com/@MathoneVideo.

Long-distance running: I have completed three marathons and several half-marathons.