Department of Mechanical Engineering
University of Washington
Stevens Way NE
Seattle, WA 98195, USA
+1 206 543 5090
sfresca@uw.edu
stefaniafresca.com
in *stefania-fresca-505447161*
stefaniafresca
DLROM-hub

STEFANIA FRESCA, Ph.D.

Assistant Professor

Scientific Interests

- **Scientific Machine Learning:** reduced order modeling (data dimensionality reduction), surrogate modeling, structure preserving deep learning, multi-scale deep learning, deep reinforcement learning, neural networks' approximation theory
- **Scientific Computing:** partial differential equations, multiphysics and multis-cale modeling, numerical methods, physics-based simulations, optimal control
- **Applications:** life sciences (cardiac electrophysiology), computational mechanics, MEMS devices

Academic Positions

Sep. 2025 - ongoing **Tenure-track Assistant Professor in Physics-based Machine Learning**, *Department of Mechanical Engineering, University of Washington*

Apr. 2025 - ongoing **Visiting Assistant Professor**, *Department of Computer Science and Technology, University of Cambridge*

Feb. 2023 - Aug. 2025 **Junior Assistant Professor (RTD-A) in Numerical Analysis**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*
- Led 2 WPs task of Spoke "Adaptive AI" in the Future Artificial Intelligence Research (FAIR) Project funded by the NextGenerationEU program within the PNRR-PE-AI scheme, PI: N. Gatti.

Nov. 2020 - Feb. 2023 **Post-doc Research Fellow**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*

Nov. 2017 - Nov. 2020 **Ph.D. Student**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*
- Carried out within the European Research Council (ERC) Advanced Grant Project "iHEART: an integrated heart model for the simulation of the cardiac function", PI: A. Quarteroni.

Industry Positions

Apr. 2024 - July 2025 **Scientific Advisor**, *Corintis SA*, EPFL Innovation Park, Lausanne, Switzerland
- Provided input, advice, guidance, and actionable feedback on scientific machine learning topics relevant to the company's work.

June 2017 - Oct. 2017 **Risk Advisory Intern**, *Ernst & Young*, Milano
- Supported the design of a Datamart, for accounting and reporting information, to be used by the entire bank branch.
- Performed activities of data extraction, through SQL tool, analysis and reporting.
- Developed fully-automated data quality processes tool, through Access and VBA, used by the whole reporting team.

Qualifications

Mar. 2025 - ongoing **National Scientific Qualification of Associate Professor**, Italy
Sector: 01/A5 - Numerical Analysis

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Education

Nov. 2017 - Feb. 2021 **Ph.D. in Mathematical Models and Methods in Engineering**, *Politecnico di Milano*, Italy
Ph.D. Thesis: *Deep learning-based reduced order models for nonlinear parametrized PDEs: application to cardiac electrophysiology.*
Advisors: Alfio Quarteroni, Andrea Manzoni, Luca Dede' (Politecnico di Milano).

Sep. 2015 - Mar. 2016 **Exchange Program**, *Université Pierre et Marie Curie (Sorbonne Universités)*, Paris, France

Mar. 2014 - Apr. 2017 **M.Sc. in Mathematical Engineering - Computational Science and Engineering**, *Politecnico di Milano*, Italy
Master Thesis: *Goal-Oriented mesh adaptivity for topology optimization*.
Advisors: Simona Perotto, Stefano Micheletti (Politecnico di Milano).

Sep. 2010 - Dec. 2013 **B.Sc. in Mathematical Engineering**, *Politecnico di Milano*, Italy
Final Dissertation: *Well-balanced and energy stable schemes for the shallow water equations*.
Advisor: Edie Miglio (Politecnico di Milano).

Publications

Google Scholar: `https://scholar.google.com/citations?user=HGeGJpcAAAAJ&hl=it`
ResearchGate: `https://www.researchgate.net/profile/Stefania-Fresca`
ORCID: `https://orcid.org/0000-0001-8599-6588`
Scopus: `https://www.scopus.com/authid/detail.uri?authorId=57219325205`

Journal Papers

- S. Brivio, S. Fresca, A. Manzoni. Handling geometrical variability in nonlinear reduced order modeling through Continuous Geometry-Aware DL-ROMs. *Computer Methods in Applied Mechanics and Engineering*, 442, 117989, 2025.
  `https://doi.org/10.1016/j.cma.2025.117989`
- N. Farenga, S. Fresca, S. Brivio, A. Manzoni. On latent dynamics learning in nonlinear reduced order modeling. *Neural Networks*, 185, 107146, 2025.
  `https://doi.org/10.1016/j.neunet.2025.107146`
- S. Brivio, S. Fresca, A. Manzoni. PTPI-DL-ROMs: pre-trained physics-informed deep learning-based reduced order models for nonlinear parametrized PDEs. *Computer Methods in Applied Mechanics and Engineering*, 432, 117404, 2024.
  `https://doi.org/10.1016/j.cma.2024.117404`
- S. Brivio, S. Fresca, N. R. Franco, A. Manzoni. Error estimates for POD-DL-ROMs: a deep learning framework for reduced order modeling of nonlinear parametrized PDEs enhanced by proper orthogonal decomposition. *Advances in Computational Mathematics*, 50, 33, 2024.
  `https://doi.org/10.1007/s10444-024-10110-1`
- L. Cicci, S. Fresca, A. Manzoni, A. Quarteroni. Efficient approximation of cardiac mechanics through reduced order modeling with deep learning-based operator approximation. *International Journal for Numerical Methods in Biomedical Engineering*, e3783, 2024.
  `https://doi.org/10.1002/cnm.3783`
  Wiley Top Viewed Paper - received enough views to rank within the top 10% of papers published in International Journal for Numerical Methods in Biomedical Engineering between 1st January 2023 - 31st December 2023.
- N. R. Franco, S. Fresca, F. Tombari, A. Manzoni. Deep Learning-based surrogate models for parametrized PDEs: handling geometric variability through graph neural networks. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 33(12): 12312, 2023.
  `https://doi.org/10.1063/5.0170101`
- L. Cicci, S. Fresca, M. Guo, A. Manzoni, P. Zunino. Uncertainty quantification for nonlinear solid mechanics using reduced order models with Gaussian process regression. *Computers and Mathematics with Applications*, 149, 1-23, 2023.
  `https://doi.org/10.1016/j.camwa.2023.08.016`
- S. Fresca, F. Fatone, A. Manzoni. Long-time prediction of nonlinear parametrized dynamical systems by deep learning-based reduced order models. *Mathematics in Engineering*, 5(6):1-36, 2023.
  `https://doi.org/10.3934/mine.2023096`
- G. Gobat, A. Baronchelli, S. Fresca, A. Frangi. Modeling the periodic response of Micro-Electromechanical Systems through deep learning-based approaches. *Actuators*, 12, 278, 2023.
  `https://doi.org/10.3390/act12070278`
- P. Conti, G. Gobat, S. Fresca, A. Manzoni, A. Frangi. Reduced order modeling of parametrized systems through autoencoders and SINDy approach: continuation of periodic solutions. *Computer Methods in Applied Mechanics and Engineering*, 411, 116072, 2023.
  `https://doi.org/10.1016/j.cma.2023.116072`
- G. Gobat, S. Fresca, A. Manzoni, A. Frangi. Reduced order modelling of nonlinear vibrating multiphysics microstructures with deep learning-based approaches. *Sensors*, 23(6), 3001, 2023.
  `https://doi.org/10.3390/s23063001`
- N. R. Franco, S. Fresca, A. Manzoni, P. Zunino. Approximation bounds for convolutional neural networks in operator learning. *Neural Networks*, 161, 129-141, 2023.
  `https://doi.org/10.1016/j.neunet.2023.01.029`
- L. Cicci, S. Fresca, A. Manzoni. Deep-HyROMnet: A deep learning-based operator approximation for hyper-reduction of nonlinear parametrized PDEs. *Journal of Scientific Computing*, 93:57, 2022.

https://doi.org/10.1007/s10915-022-02001-8

- S. Fresca, G. Gobat, P. Fedeli, A. Frangi, A. Manzoni. Deep learning-based reduced order models for the real-time simulation of the nonlinear dynamics of microstructures. *International Journal for Numerical Methods in Engineering*, 123(20):4749-4777, 2022.
  https://doi.org/10.1002/nme.7054
  Wiley Top Cited Paper - one of WILEY top 10 most-cited papers published between 1st January 2022 - 31st December 2022.
  Wiley Top Downloaded Paper - received enough downloads to rank within the top 10% of papers published in International Journal for Numerical Methods in Engineering between 1st January 2022 - 31st December 2022.
- L. Cicci, S. Fresca, S. Pagani, A. Manzoni, A. Quarteroni. Projection-based reduced order models for parameterized nonlinear time-dependent problems arising in cardiac mechanics. *Mathematics in Engineering, 5(2):1-38*, 2022.
  https://doi.org/10.3934/mine.2023026
- G. Gobat, A. Opreni, S. Fresca, A. Manzoni, A. Frangi. Reduced order modeling of nonlinear microstructures through Proper Orthogonal Decomposition. *Mechanical Systems and Signal Processing*, 171, 108864, 2022.
  https://doi.org/10.1016/j.ymssp.2022.108864
- S. Fresca, A. Manzoni. POD-DL-ROM: enhancing deep learning-based reduced order models for nonlinear parametrized PDEs by proper orthogonal decomposition. *Computer Methods in Applied Mechanics and Engineering, 388, 114181*, 2022.
  https://doi.org/10.1016/j.cma.2021.114181
  Most Downloaded Articles - among the most downloaded articles from Computer Methods in Applied Mechanics and Engineering in the last 90 days (last accessed: 09-2023).
- S. Fresca, A. Manzoni, L. Dede', A. Quarteroni. POD-enhanced deep learning-based reduced order models for the real-time simulation of cardiac electrophysiology in the left atrium. *Frontiers in Physiology, 12, 1431*, 2021.
  https://doi.org/10.3389/fphys.2021.679076
- S. Fresca, A. Manzoni. Real-time simulation of parameter-dependent fluid flows through deep learning-based reduced order models. *Fluids, 6(7), 259*, 2021.
  https://doi.org/10.3390/fluids6070259
- S. Fresca, A. Manzoni, L. Dede'. A comprehensive deep learning-based approach to reduced order modeling of nonlinear time-dependent parametrized PDEs. *Journal of Scientific Computing, 87(2):1-36*, 2021.
  https://doi.org/10.1007/s10915-021-01462-7
  Based on Web of Science: *Highly Cited Paper* - as of March/April 2023, this paper received enough citations to place it in the top 1% of the academic field of Mathematics based on a highly cited threshold for the field and publication year (last accessed: 09-2023).
  Hot Paper - this paper was published in the past two years and received enough citations in May/June 2022 to place it in the top 0.1% of papers in the academic field of Mathematics (last accessed: 09-2022).
- S. Fresca, A. Manzoni, L. Dede', A. Quarteroni. Deep learning-based reduced order models in cardiac electrophysiology. *PLOS ONE, 15(10):1-32*, 2020.
  https://doi.org/10.1371/journal.pone.0239416

Conference Papers (with review)

- N. Perrone, F. Lehmann, H. Gabrielidis, S. Fresca, F. Gatti. Integrating Fourier neural operators with diffusion models to improve spectral representation of synthetic earthquake ground motion response. *28th International Conference on Structural Mechanics in Reactor Technology (SMIRT28)*, 2025.
- N. Grillo, A. Toccaceli, B. Estermann, J. Mathys, S. Fresca, R. Wattenhofer. Beyond Interpolation: Extrapolative reasoning with reinforcement learning and graph neural networks. *1st Workshop on Neural Reasoning and Mathematical Discovery – An Interdisciplinary Two-Way Street, NEURMAD@AAAI'25 [nju: mæd 'ei'ai]*, 2025.
  https://openreview.net/pdf?id=ocSvfbIjet
- N. Farenga, S. Fresca, A. Manzoni. Neural latent dynamics models. *The Symbiosis of Deep Learning and Differential Equations, 36th Conference on Neural Information Processing Systems (NeurIPS)*, 2022.
  https://openreview.net/pdf?id=Yk_I37Ca8Q
- S. Fresca, A. Manzoni, L. Dede', A. Quarteroni. Deep learning-based reduced order models in cardiac electrophysiology. *7th International Conference on Computational and Mathematical Biomedical Engineering*, 2022.
  https://www.compbiomed.net/2024/cmbe-proceedings.htm
- S. Fresca, F. Fatone, A. Manzoni. Long-time prediction of nonlinear parametrized dynamical systems by deep learning-based ROMs. *The Symbiosis of Deep Learning and Differential Equations, 35th Conference on Neural Information Processing Systems (NeurIPS)*, 2021.
  https://openreview.net/pdf?id=kQ_PIYH3NsF

Chapters in Books

- S. Fresca, L. Dede', A. Manzoni. Big data analysis and artificial intelligence for medical sciences. *Publisher: Wiley, Editors: B. Carpentieri, P. Lecca*, 2024.

- L. Cicci, S. Fresca, E. Zappon, S. Pagani, F. Regazzoni, L. Dede', A. Manzoni, A. Quarteroni. Reduced order models for the biomechanics of living organs. *Publisher: Elsevier, Editors: F. Chinesta, E. Cueto, Y. Payan, J. Ohayon*, 403-433, 2023.

Preprints

- N. Grillo, J. Rowbottom, P. Lio, C. B. Schönlieb, S. Fresca. HypeR adaptivity: Joint hr-adaptive meshing via hypergraph multi-agent deep reinforcement learning. *arXiv preprint arXiv:2512.10439*, 2025.
- A. Ragonesi, S. Fresca, K. Gillette, S. Kurath-Koller, G. Plank, E. Zappon. Explainable deep learning-based classification of Wolff-Parkinson-White electrocardiographic signals. *arXiv preprint arXiv:2511.05973*, 2025.
- J. Rowbottom, S. Fresca, P. Lio, C. B. Schönlieb, N. Boullé. Multi-level Monte Carlo training of neural operators. *arXiv preprint arXiv:2505.12940*, 2025.
- N. Botteghi, S. Fresca, M. Guo, A. Manzoni. HypeRL: Parameter-informed reinforcement learning for parametric PDEs. *arXiv preprint arXiv:2501.04538*, 2025.

Theses

- S. Fresca. Deep learning-based reduced order models for nonlinear parametrized PDEs: application to cardiac electrophysiology. *Ph.D. Thesis*, 2021.
- S. Fresca. Goal-oriented mesh adaptivity for topology optimization. *Master Thesis*, 2017.

Software Libraries

- DL-ROM-Meth: github.com/stefaniafresca/DL-ROM-Meth, Python/Tensorflow.
- DL-ROM: github.com/stefaniafresca/DL-ROM, Python/Tensorflow.
- POD-DL-ROM: github.com/stefaniafresca/POD-DL-ROM, Python/Tensorflow.
- DLROM-hub: github.com/DLROM-hub, Python/Tensorflow/PyTorch.

Talks and Seminars

Invited Seminars

Breakfast Club Seminars, *University of Washington*, 26 Feb. 2026, Seattle, US, hosted by P. Boyle

Applied Math Seminars, *University of Washington*, 19 Feb. 2026, Seattle, US, hosted by B. Hosseini

Data-Driven Science and Engineering Seminars, *University of Washington*, 16 Oct. 2025, Seattle, US, hosted by N. Kutz

Laboratoire de Mécanique de Paris-Saclay (équipe OMEIR) Seminar, *Université Paris-Saclay*, 5 June 2025, Paris, France, hosted by P. Gautier

NCTS Webinar on Scientific Computing, *National Center for Theoretical Sciences (Mathematics Division)*, 20 Nov. 2024, Taipei, Taiwan, hosted by M. Shiue

Cambridge Image Analysis Group Seminar, *Cambridge University*, 4 Oct. 2024, Cambridge, UK, hosted by C. Schönlieb

SImulations in Medicine, BIOtechnology and ToXicology of multicellular systems (SIMBIOTX) Weekly Meeting, *INRIA Paris-Saclay*, 8 Apr. 2024, Paris, France, hosted by I. Vignon-Clémentel

Computational Cardiology Lab Seminar, *Medical University of Graz*, 8 Nov. 2023, Graz, Austria, hosted by G. Plank

UQSay Seminar, *Université Paris-Saclay*, 19 Oct. 2023, Paris, France, hosted by F. Gatti

PDE Seminar, *Institut de Recherche Mathématique Avancée (IRMA), INRIA*, 31 Jan. 2023, Strasbourg, France, hosted by V. Michel-Dansac

Machine Learning and Data Analytics Seminar, *Interdisciplinary Center for Machine Learning and Data Analytics (IZMD), University of Wuppertal*, 5 Dec. 2022, Wuppertal, Germany, hosted by M. Ehrhardt

Machine Learning + X Seminar, *CRUNCH Group, Brown University*, 16 Sep. 2022, Providence, U.S., hosted by G. Karniadakis

Seminar for Machine Learning and UQ in Scientific Computing, *Centrum Wiskunde & Informatica (CWI)*, 1 Sep. 2022, Amsterdam, The Netherlands, hosted by B. Sanderse

Cardiac Modeling (CaMo) Seminar, *KIT Institute of Biomedical Engineering*, 13 Jan. 2022, Karlsruhe, Germany, hosted by A. Loewe

Lectures in International Schools

TorchPhysics: Deep Learning for Partial Differential Equations - KoMSO Academy 2025, *Robert Bosch GmbH*, 20 Nov. 2025, Renningen, Germany

ELLIS AI Lecture Series, *Institut für Neuroinformatik, Ruhr-Universität Bochum*, 10 July 2025, Bochum, Germany

Data Driven & Reduced Order Models in Biomechanics, *Universitat Politècnica de Catalunya*, 7-11 Apr. 2025, Barcelona, Spain

3rd Inria-DFKI European Summer School on AI (IDESSAI 2023), *Inria*, 4-8 Sep. 2023, Sophia Antipolis, France

Keynote Invited Talks

Mathematical Foundation of Digital Twins, *Mathematisches Forschungsinstitut Oberwolfach*, 21-26 June 2026, Oberwolfach, Germany

Neural Reasoning for Scientific and Mathematical Discovery Workshop, *University of Cambridge*, 23-24 March 2026, Cambridge, UK

Digital Twins in Various Fields Including Railway Infrastructures: State of the Art, Needs, sSynergies Workshop, *Paris-Saclay University - CentraleSupélec*, 28 Oct. 2025, Paris, France

Reduced Order and Surrogate Modeling for Digital Twins Workshop, *Institute for Mathematical and Statistical Innovation (IMSI), University of Chicago*, 10-14 Nov. 2025, Chicago, U.S.

3rd Workshop of UMI Group Mathematics for Artificial Intelligence and Machine Learning, *University of Bari Aldo Moro*, 29-31 Jan. 2025, Bari, Italy

Scientific Machine Learning: Bridging Computational Physics and Machine Learning Workshop, *Centrum Wiskunde & Informatica (CWI)*, 6-8 Dec. 2023, Amsterdam, The Netherlands

Biophysics-based Modeling and Data Assimilation in Medical Imaging Workshop, *Weierstrass Institute for Applied Analysis and Stochastics (WIAS)*, 30 Aug.-1 Sep. 2023, Berlin, Germany

Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology, IACM Conference, 27-29 Sep. 2021, San Diego, California, U.S.
Minisymposium: Advanced Computational Technologies Enabling Digital Twins

Invited Talks in MS/Session

17th World Congress on Computational Mechanics and 10th European Congress on Computational Methods in Applied Sciences and Engineering (WCCM-ECCOMAS2026), 19-24 July 2026, Munich, Germany
Minisymposium: Neural Network Solvers for PDEs - Bridging Theory and Practice in Scientific Computing

Scientific Computing and Differential Equations (SciCADE 2026), 29 June-3 July 2026, Edinburgh, UK
Minisymposium: Dynamical Systems Meets Deep Learning

3rd IACM Digital Twins in Engineering Conference (DTE 2025) & 1st ECCOMAS Artificial Intelligence and Computational Methods in Applied Science (AICOMAS 2025), 17-21 Feb. 2025, Paris, France
Minisymposium: Autoencoders for Fluid Mechanics and MORE

9th European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS CONGRESS 2024, 3-7 June 2024, Lisbon, Portugal
Minisymposium: Exploring New Avenues for the Interaction of Numerical Methods for PDEs and Deep Learning

2024 SIAM Conference on Uncertainty Quantification, 27 Feb.-1 March 2024, Trieste, Italy
Minisymposium: Advances in Data-enhanced Modeling and Applications

Math 2 Product Conference 2023, 30 May-1 June 2023, Taormina, Italy
Minisymposium: Advanced Numerical Methods for Predictive Digital Twins

2023 SIAM Conference on Computational Science and Engineering, 26 Feb.-3 March 2023, Amsterdam, The Netherlands
Minisymposium: Advances in Latent Representation Learning for Scientific Applications

MCF2022 - Modelling the Cardiac Function, iHEART Congress, 29 Sep.-2 Oct. 2022, Cetraro, Italy

GIMC-SIMAI YOUNG 2022, 29-30 Sep. 2022, Pavia, Italy
Minisymposium: Physics-based Machine Learning for Engineering Simulation and Digital Twin

Recent Developments in Machine Learning Techniques for PDEs, *Imperial College Workshop*, 6-8 Sep. 2022, London, UK

7th International Conference on Computational and Mathematical Biomedical Engineering, 27-29 June 2022, Milano, Italy
Minisymposium: Machine Learning, Reduced Order Modeling and Uncertainty Quantification in Biological Systems

8^{th} European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS Congress 2022, 5-9 June 2022, Oslo, Norway
Minisymposium: Reduced Order Modeling of Dynamical Systems through Deep Learning Techniques

LYNUM: Lombardy Young NUmerical analysts Meeting, 10 May 2022, Como, Italy

SIMAI 2020+2021 Congress, 30 August-2 Sep. 2021, Parma, Italy
Minisymposium: Numerical Modeling of Cardiac Function and Vascular Circulation

2021 SIAM Conference on Computational Science and Engineering, 1-5 March 2021, Fort Worth, Texas, U.S.
Minisymposium: Advances in Data-enhanced Predictive Modeling in Simulation Science

VPH2020: Virtual Physiological Human, 24-28 August 2020, Paris, France
Session: Methods - Big Data & Learning

Contributed Talks

Mathematics for Artificial Intelligence and Machine Learning, 24 Nov.-25 Nov. 2022, Torino, Italy

Model Reduction and Surrogate Modeling (MORE) Conference, 19-23 Sep. 2022, Berlin, Germany

Synergies between Data Science and PDE Analysis, *HCM Workshop*, 13-17 June 2022, Bonn, Germany

First UMI meeting of PhD students, 100 UMI - 800 UniPD Conference, 26-27 May 2022, Padova, Italy

Mathematics of Deep Learning, *Deep Learning and Partial Differential Equations Workshop*, Isaac Newton Institute, 15-19 November 2021, Cambridge, UK

MCF2021 - Modelling the Cardiac Function: Theory, Numerical Methods, Clinical Applications, iHEART Congress, 1-3 July 2021, Milano, Italy

International Conference on Computational Methods for Coupled Problems in Science and Engineering, *COUPLED PROBLEMS 2021*, 13-16 June 2021, Cagliari, Italy
Minisymposium: Recent Advances in Model and Complexity Reduction for Coupled Problems

MCF2020 - Modelling the Cardiac Function, iHEART Congress, 31 August-2 Sep. 2020, Milano, Italy

MCF - Modelling the Cardiac Function, RISM Congress, 22-24 July 2019, Varese, Italy

Posters

The Symbiosis of Deep Learning and Differential Equations Workshop, 35^{th} Conference on Neural Information Processing Systems (NeurIPS), 6-14 Dec. 2021, San Diego, U.S.

International CAE Conference and Exhibition, 17-18 Nov. 2021, Vicenza, Italy

Workshop on Mathematical Machine Learning and Application, CCMA 2020, 14-16 Dec. 2020, Penn State, U.S.

Memberships of Scientific Committees

7^{th} International Workshop on Model Order Reduction Techniques (MORTech 2025), 26-28 Nov. 2025, Zaragoza, Spain

Workshop/Minisymposia Organization

17^{th} World Congress on Computational Mechanics and 10^{th} European Congress on Computational Methods in Applied Sciences and Engineering (WCCM-ECCOMAS2026), 19-24 July 2026, Munich, Germany
Minisymposium: Large-scale applications in Scientific Machine Learning
Organizers: F. Lehmann (ETH, Zurich), F. Gatti (CentraleSupélec, Paris), S. Fresca (University of Washington, Seattle)

3^{rd} IACM Digital Twins in Engineering Conference (DTE 2025) & 1^{st} ECCOMAS Artificial Intelligence and Computational Methods in Applied Science (AICOMAS 2025), 17-21 Feb. 2025, Paris, France
Minisymposium: Deep Learning-based Reduced Order Models in Scientific Computing
Organizers: N. R. Franco (Politecnico di Milano, Italy), S. Fresca (Politecnico di Milano, Italy), C. Marcati (Università di Pavia, Italy), F. Pichi (SISSA, Italy)

9^{th} European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS CONGRESS 2024), 3-7 June 2024, Lisbon, Portugal
Minisymposium: Recent Advances in Deep Reinforcement Learning of Complex Dynamical Systems
Organizers: N. Botteghi (University of Twente, The Netherlands), S. Fresca (Politecnico di Milano, Italy)

9^{th} European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS CONGRESS 2024), 3-7 June 2024, Lisbon, Portugal
Minisymposium: Deep Learning and Reduced Order Modeling for Differential Equations
Organizers: N. R. Franco (Politecnico di Milano, Italy), F. Pichi (Ecole Polytechnique Fédérale de Lausanne, Switzerland), S. Fresca (Politecnico di Milano, Italy)

2024 SIAM Conference on Uncertainty Quantification (UQ24), 27 Feb.-1 March 2024, Trieste, Italy
Minisymposium: Reduced order modeling, Learning, UQ, and their interaction
Organizers: N. R. Franco (Politecnico di Milano, Italy), S. Fresca (Politecnico di Milano, Italy), M. Guo (University of Twente, The Netherlands), A. Manzoni (Politecnico di Milano, Italy)

2023 SIAM Conference on Computational Science and Engineering, 26 Feb.-3 March 2023, Amsterdam, The Netherlands
Minisymposium: Reduced Order Modeling of Differential Equations through Deep Learning Algorithms
Organizers: N. R. Franco, S. Fresca (Politecnico di Milano, Italy)

Visiting Research Periods

June 2025 **Laboratoire de Mécanique de Paris Saclay (équipe OMEIR) - CentraleSupélec**, Paris, France
hosted by Prof. (Emeritus) Pierre-Etienne Gautier and Dr. Filippo Gatti

Sep. 2024 - March 2025 **Department of Computer Science and Technology, Cambridge University**, Cambridge, U.K.
hosted by Prof. Carola-Bibiane Schönlieb and Prof. Pietro Liò

Sep. 2024 Invited **Mechanical Engineering Department, University of Washington**, Seattle, U.S.
hosted by Prof. Steven Brunton

Nov. 2023 Invited **Computational Cardiology Laboratory, Medical University of Graz**, Graz, Austria

March 2023 Invited **Isaac Newton Institute for Mathematical Sciences**, *The mathematical and statistical foundation of future data-driven engineering*, University of Cambridge, Cambridge, U.K.

Competitive Research Projects

Oct. 2025 - ongoing **Co-PI,** *NeuroElastoSim: Neural operators and diffusion models for super-resolved 3D elastodynamics and broadband earthquake simulation*, Université Paris-Saclay - ETH Zurich - University of Washington
funded by NVIDIA Academic Grant Program (continuous use of 8 x A100 80GB GPUs), PI: Dr. Filippo Gatti

Feb. 2024 - ongoing **PI,** *Sviluppo e analisi di modelli di ordine ridotto basati su tecniche di deep learning - Development and analysis of reduced order models based on deep learning techniques*, Politecnico di Milano - SISSA - University of Pavia, Italy
funded by Istituto Nazionale di Alta Matematica - Gruppo Nazionale per il Calcolo Scientifico (INdAM - GNCS Project), code CUP_E53C24001950001 (2400€)

Feb. 2023 - Aug. 2025 **Participant (RTD-A),** *Future Artificial Intelligence Research (FAIR) Project*, Politecnico di Milano, Italy
funded by the NextGenerationEU program within the PNRR-PE-AI scheme (M4C2, Investment 1.3, Line on Artificial Intelligence), PI: Prof. Nicola Gatti.

Nov. 2022 - Feb. 2023 **Participant (Post-doc),** *AI4MEMS Project*, Politecnico di Milano, Italy
funded by STEAM Joint Research Center ST Microelectronics-PoliMI, PI: Prof. A. Manzoni.

Nov. 2020 - Oct. 2022 **Participant (Post-doc),** *Toward UQoRE (T-UQoRE) Project*, Politecnico di Milano, Italy
funded by Fondazione Cariplo (grant agreement no. 2019-4608), PI: Prof. A. Manzoni.

Nov. 2017 - Oct. 2020 **Participant (Ph.D.),** *An Integrated Heart Model for the simulation of the cardiac function (iHEART) Project*, Politecnico di Milano, Italy
funded by European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 740132), PI: Prof. Alfio Quarteroni.

Grants

2024 **Istituto Nazionale di Alta Matematica**, two-months funding for the visiting research period at University of Cambridge (3000€/month)

2022 **Istituto Nazionale di Alta Matematica - Gruppo Nazionale per il Calcolo Scientifico**, Finanziamento Progetto Giovani Ricercatori 2021, funding for conferences/travels (1500€)

2019 **IHU Liryc - L'Institut de Rythmologie et de Modélisation Cardiaque**, funding covering lodging and boarding costs for the 2019 Cardiac Electrophysiology Summer School organized by IHU Liryc in Bordeaux, France

2015 - 2016 **Politecnico di Milano**, full funding for the duration of the exchange program at Université Pierre et Marie Curie (Sorbonne Universités) in Paris, France

Awards and Recognitions

2023 **Certificate in recognition of commitments and merits in scientific research granted by L'Oréal-UNESCO**, For Women in Science Program, Italy

2022 **Runner-up best Ph.D. award in biomedical engineering granted at the 7th International Conference on Computational & Mathematical Biomedical Engineering (CMBE22)**, International Journal for Numerical Methods in Biomedical Engineering (IJNMBE), Milano, Italy

2021 **Best poster award granted by International CAE Conference and Exhibition**, Vicenza, Italy (1000€)
Multi-step Deep Learning-based Reduced Order Models for Geometric Nonlinearities in MEMS, G. Gobat, S. Fresca, A. Manzoni, A. Frangi.

Teaching Activity

Jan. 2027 - March 2027 **Lecturer**, *ME565: Mechanical Engineering Analysis II*, M.Sc. in Mechanical Engineering, University of Washington, 30h, 3 credits

Sep. 2026 - Dec. 2026 **Lecturer**, *ME564: Mechanical Engineering Analysis I*, M.Sc. in Mechanical Engineering, University of Washington, 30h, 3 credits

March 2026 - June 2026 **Lecturer**, *ENGR 520: Physics-informed Machine Learning*, M.Sc. in Artificial Intelligence and Machine Learning for Engineering, University of Washington, 30h, 3 credits

Jan. 2026 - March 2026 **Lecturer**, *ENGR 515: Data-driven Optimization*, M.Sc. in Artificial Intelligence and Machine Learning for Engineering, University of Washington, 40h, 4 credits

Feb. 2024 - June 2024 **Lecturer**, *Calcolo Numerico (Numerical Methods)*, B.Sc. in Biomedical Engineering, Politecnico di Milano, 30h, 5 CFU

Jan. 2024 **Lecturer**, *Advanced Numerical Methods for Predictive Digital Twins*, Ph.D. Program in Mathematical Models and Methods in Engineering, Politecnico di Milano, 25h, 10 CFU

Sep. 2023 - Dec 2023 **Teaching Assistant**, *Numerical Analysis for Machine Learning*, M.Sc. in Mathematical Engineering, Politecnico di Milano, 30h, 10 CFU

Feb. 2023 - June 2023 **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in Aerospace Engineering, Politecnico di Milano, 40h, 10 CFU

Sep. 2022 - Dec. 2022 **Teaching Assistant**, *Computational Statistics*, M.Sc. in Mathematical Engineering, Politecnico di Milano, 12h, 8 CFU

Feb. 2022 - June 2022 **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in Aerospace Engineering, Politecnico di Milano, 40h, 10 CFU

Sep. 2021 - Dec. 2021 **Teaching Assistant**, *Computational Statistics*, M.Sc. in Mathematical Engineering, Politecnico di Milano, 12h, 8 CFU

Oct. 2020 - Dec. 2020 **Teaching Assistant**, *Matlab Course - Analisi I*, B.Sc. in Mathematical Engineering, Politecnico di Milano, 9h, 10 CFU

Oct. 2019 - Dec. 2019 **Teaching Assistant**, *Matlab Course - Analisi I*, B.Sc. in Mathematical Engineering, Politecnico di Milano, 10h, 10 CFU

Feb. 2019 - June 2019 **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in Aerospace Engineering, Politecnico di Milano, 48h, 10 CFU

Feb. 2018 - June 2018 **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in Aerospace Engineering, Politecnico di Milano, 48h, 10 CFU

Nov. 2017 - Jan. 2018 **Teaching Assistant**, *Metodi Analitici e Numerici per l'Ingegneria (Numerical Methods)*, B.Sc. in Mechanical Engineering, Politecnico di Milano, 5 CFU

Post-doc Advising

May 2025 - ongoing **Sheida Nozari**, Multi-level control and modeling of multi-agent systems via deep learning algorithms, L2S - CentraleSupélec
Advisor: A. Iovine (L2S - CentraleSupélec), Co-advisors: S. Fresca, F. Gatti (Laboratoire de Mécanique Paris Saclay - CentraleSupélec)

Ph.D. Advising

Sep. 2025 - ongoing **Alice Ragonesi**, Department of Mechanical Engineering, University of Washington
Advisor: S. Fresca

Sep. 2025 - ongoing **Ruige Kong**, Department of Mechanical Engineering, University of Washington
Advisor: S. Fresca

Ph.D. Committes

Dec. 2025 **Jan M. Williams**, Department of Mechanical Engineering, University of Washington
Advisor: K. Manohar

Nov. 2025 **Arvindh Sharma**, Aeronautics and Astronautics - SPACE Lab, University of Washington
Advisor: J. Little

Oct. 2025 **Nicholas Zolman**, Department of Mechanical Engineering, University of Washington
Advisor: S. Brunton

Theses Advising

M.Phil. thesis **Pramoth Ragavan**, Master Program in Computer Science, University of Cambridge, Ongoing
Advisor: P. Liò (University of Cambridgey), Co-advisors: J. Rowbottom (University of Cambridge), S. Fresca

M.Sc. thesis **Niccolò Perrone**, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, Ongoing
Advisor: S. Fresca, Co-advisor: F. Gatti (Laboratoire de Mécanique Paris Saclay - CentraleSupélec)

M.Sc. thesis **Niccolò Grillo**, *"HypeR adaptivity: Joint hr-adaptive meshing via hypergraph multi-agent deep reinforcement learning"*, Master Program in Mathematical Engineering - Statistical Learning, Politecnico di Milano, 2025
Advisor: S. Fresca, Co-advisors: J. Rowbottom, P. Liò, C. B. Schönlieb (University of Cambridge)

M.Phil. thesis **Adam Dray**, *"Physics-informed graph neural networks with divergence-free constraints for incompressible flow simulations"*, Master Program in Scientific Computing, University of Cambridge, 2025
Advisor: P. Liò (University of Cambridge), Co-advisors: J. Rowbottom (University of Cambridge), S. Fresca

M.Sc. thesis **Filippo Baldini**, *"Active flow control of unsteady flows using deep reinforcement learning"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2025
Advisor: S. Fresca

M.Sc. thesis **Alice Ragonesi**, *"Deep learning-based classification of pathological electrocardiographic signals"*, Master Program in Mathematical Engineering - Statistical Learning, Politecnico di Milano, 2025
Advisor: S. Fresca, Co-advisor: E. Zappon (Medical University of Graz)

M.Sc. thesis **Pietro Devecchi**, *"Graph neural networks based autoencoder in reduced order modeling of dynamical systems"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2024
Advisor: A. Manzoni, Co-advisors: S. Fresca, N. R. Franco

M.Sc. thesis **Nicola Farenga**, *"On latent dynamics learning in nonlinear reduced order modeling"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2024
Advisor: A. Manzoni, Co-advisor: S. Fresca

M.Sc. thesis **Edoardo Zuanon**, *"Efficient approximation of PDEs defined on domains with variable shape through POD-enhanced deep learning-based reduced order models"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2023
Advisor: A. Manzoni, Co-advisor: S. Fresca

M.Sc. thesis **Filippo Tombari**, *"Deep Learning-based surrogate models for parametrized PDEs: including geometrical features through graph neural networks"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2023
Advisor: A. Manzoni, Co-advisors: S. Fresca, N. R. Franco

M.Sc. thesis **Simone Brivio**, *"Physics-informed deep learning-based reduced order modeling for parametric operators"*, Master Program in Mathematical Engineering - Computational Science and Computational Learning, Politecnico di Milano, 2022
Advisor: A. Manzoni, Co-advisor: S. Fresca

M.Sc. thesis **Federico Capello**, *"Approximate bayesian ensembling for physics-Informed deep learning architectures"*, Master Program in Mathematical Engineering - Statistical Learning, Politecnico di Milano, 2021
Advisor: A. Manzoni, Co-advisor: S. Fresca

M.Sc. thesis **Federico Fatone**, *"Long-time prediction of nonlinear parametrized dynamical systems through deep learning-based reduced order models"*, Master Program in Mathematical Engineering - Statistical Learning, Politecnico di Milano, 2021
Advisor: A. Manzoni, Co-advisor: S. Fresca

B.Sc. thesis **Marco Morrone**, *"Physics-informed neural networks for the solution of PDEs"*, Bachelor Program in Mathematical Engineering, Politecnico di Milano, 2019
Advisor: A. Manzoni, Co-advisors: S. Pagani, S. Fresca

Projects co-Advising

Master project **Zhenghao Jing**, Master Program in Mechanical Engineering, University of Washington, Ongoing

Master project **Hunter Jackson Goleman**, Master Program in Applied Mathematics, University of Washington, Ongoing

Undergrad project **Jonathan Zhang**, Undergraduate Program in Applied Mathematics, University of Washington, Ongoing

M.Phil. project **Shuoyu Yue**, *"Multi-scale machine learning for turbulence simulation"*, Master Program in Scientific computing, Cambridge University, 2025

M.Sc. project **Francesca Zambetti, Andrea Rella**, *"Accelerated early warning systems for natural catastrophes by deep learning-driven simulations"*, Numerical Analysis for PDEs, Master Program in Mathematical Engineering, Politecnico di Milano, 2025

M.Sc. project **Niccolò Perrone**, *"Integrating Fourier neural operators with diffusion models to improve spectral representation of synthetic earthquake ground motion response"*, Numerical Analysis for PDEs, Master Program in Mathematical Engineering, Politecnico di Milano, 2025

M.Sc. project **Andrea Toccaceli, Niccolò Grillo**, *"Puzzle solving with graph neural networks and deep reinforcement learning"*, Advanced Programming for Scientific Computing, Master Program in Mathematical Engineering, Politecnico di Milano, 2024

M.Sc. project **Marcello Svagna, Pietro Devecchi, Filippo Baldini**, *"Backward step flow control with deep reinforcement learning"*, Advanced Programming for Scientific Computing, Master Program in Mathematical Engineering, Politecnico di Milano, 2024

M.Sc. project **Filippo Tombari**, *"Deep learning-based reduced order models for parametrized PDEs: including geometrical features through Graph Neural Networks"*, Advanced Programming for Scientific Computing, Master Program in Mathematical Engineering, Politecnico di Milano, 2023

M.Sc. project **Arash Andrea Roknian**, *"Forward UQ with deep learning-based ROMs"*, Computational Statistics, Master Program in Mathematical Engineering, Politecnico di Milano, 2022

M.Sc. project **Luca Caivano, Paulina Moskwa, Manfred Nesti**, *"Neural differential equations"*, Computational Statistics, Master Program in Mathematical Engineering, Politecnico di Milano, 2022

M.Sc. project **Roberto Valendino, Ilaria De vittori, Elisabetta Garbin**, *"Neural ODE processes"*, Computational Statistics, Master Program in Mathematical Engineering, Politecnico di Milano, 2022

M.Sc. project **Simone Brivio**, *"DeepONet neural networks"*, Computational Statistics, Master Program in Mathematical Engineering, Politecnico di Milano, 2022

M.Sc. project **Nicola Farenga**, *"Neural ODEs"*, Computational Statistics, Master Program in Mathematical Engineering, Politecnico di Milano, 2022

M.Sc. project **Federico Capello**, *"GRAPH-DL-ROMs: Non intrusive reduced order models by graph neural networks"*, Advanced Programming for Scientific Computing, Master Program in Mathematical Engineering, Politecnico di Milano, 2021

Editorial Activity

- **Area Editor:** Scientific Machine Learning Area, Advances in Continuous and Discrete Models (ACDM), Springer Nature.
- **Associate Editor:** Advanced Modelling and Simulation in Engineering Sciences (AMSES), Springer Nature.
- **Review Editor:** Computational Physiology and Medicine, Frontiers in Physiology.

Journal Reviewing

- Journal of Machine Learning Research
- Communications Physics
- Neurocomputing
- Expert Systems With Applications
- Mechanical Systems and Signal Processing

- Computer Methods in Applied Mechanics and Engineering
- Data-Centric Engineering
- Calcolo
- Artificial Intelligence Journal
- Nonlinear Dynamics
- Proceedings of the Royal Society A
- International Journal for Numerical Methods in Engineering
- Engineering with Computers
- Journal of Computational Physics
- Mathematics in Engineering
- Frontiers in Physiology
- Journal of Computational Science
- Computers and Fluids
- AIAA Journal
- EP Europace

Proceedings Reviewing

- 1^{st} Workshop on Neural Reasoning and Mathematical Discovery – An Interdisciplinary Two-Way Street, NEURMAD@AAAI'25
- The Symbiosis of Deep Learning and Differential Equations, 36^{th} Conference on Neural Information Processing Systems
- The Symbiosis of Deep Learning and Differential Equations, 35^{th} Conference on Neural Information Processing Systems

Project Reviewing

- National Research and Development Agency of the Ministry of Science, Technology, Knowledge and Innovation of Chile

Membership in Scientific Societies

Ongoing *University of Cambridge ELLIS Unit*

Ongoing *European Laboratory for Learning and Intelligent Systems (ELLIS) Society*

Ongoing *Gruppo Nazionale per il Calcolo Scientifico (GNCS)*, Italy

Society for Industrial and Applied Mathematics (SIAM), U.S.

Società Italiana di Matematica Applicata e Industriale (SIMAI), Italy

Unione Matematica Italiana (UMI), Italy

Additional Courses/Workshops/Schools

July 2021 **Computer Vision Crash Course**, *MaLGa - Machine Learning Genoa Center*, Genova, (admission upon selection)

Oct. 2019 **Mathematical and Computational Aspects of Machine Learning School**, *Ennio De Giorgi Mathematical Research Center of Scuola Normale Superiore*, Pisa, (admission upon selection)

July 2019 **2019 Cardiac Electrophysiology Summer School**, *IHU Liryc - L'Institut de Rythmologie et de Modélisation Cardiaque*, Bordeaux, (admission upon selection)

Feb. 2019 **Advances in Deep Learning with Applications in Text and Image Processing**, *Politecnico di Milano*

Sep. 2018 **Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization**, *deeplearning.ai, Coursera*

Sep. 2018 **Natural Language Processing: an Overview with Python**, *Politecnico di Milano*

Apr. 2018 **Mathematical and Numerical Modeling of the Cardiovascular System** (INdAM Workshop), *Sapienza - Universitá di Roma*

Media

Interview "Conosci chi fa ricerca" section on the Mathematics Department's website at Politecnico di Milano, 2024. [link]

Post Coventor MEMS+ Blog, "Using Machine Learning to Develop a Real-Time Model of a MEMS Disk Resonating Gyroscope", 2023.

Article Enginsoft Newsletter - RESEARCH & INNOVATION, "Deep learning-based reduced order models: the new frontier in numerical simulation for microsystems", 2022. [link]

Talk MCF2021 Congress, "Deep learning-based reduced order models for the real-time approximation of nonlinear time-dependent parametrized PDEs", 2021. [link]

Talk 36^{th} international CAE conference and exhibition, "How medicine and engineering interrelate - a female bioengineering perspective", 2020. [link]

Interview iODONNA, "Politecnico di Milano: una dottoranda studia come curare il cuore con la matematica", 2020. [link]

Interview youtube channel iHEART Project, "How will artificial intelligence contribute to computational cardiac medicine of the future?", 2020. [link]

Talk RISM Congress, "Deep learning-based model order reduction for cardiac electrophysiology", 2019. [link]

Languages

Italian: **Native**. English: **Fluent** [TOEIC score: 955/990 (22 January 2014)]. Spanish: **Intermediate** [DELE score: 88.08/100 (May 2009)]. French: **Basic**.

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