

MOX - Modeling and Scientific Computing  
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# STEFANIA FRESCA, Ph.D.

## Junior Assistant Professor

### Scientific Interests

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

### Academic Positions

- Sep. 2025 **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 - **Junior Assistant Professor (RTD-A) in Numerical Analysis**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*  
Aug. 2025 - 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 - **Post-doc Research Fellow**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*  
Feb. 2023
- Nov. 2017 - **Ph.D. Student**, *MOX (Laboratory for Modeling and Scientific Computing) - Department of Mathematics, Politecnico di Milano*  
Nov. 2020 - 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 - **Scientific Advisor**, *Corintis SA, EPFL Innovation Park, Lausanne, Switzerland*
- Jul. 2025 - Provided input, advice, guidance, and actionable feedback on scientific machine learning topics relevant to the company's work.
- June 2017 - **Risk Advisory Intern**, *Ernst & Young, Milano*
- Oct. 2017 - 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.

### Education

- Nov. 2017 - **Ph.D. in Mathematical Models and Methods in Engineering**, *Politecnico di Milano, Italy*  
Feb. 2021 - 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 - **Exchange Program**, *Université Pierre et Marie Curie (Sorbonne Universités), Paris, France*  
Mar. 2016
- Mar. 2014 - **M.Sc. in Mathematical Engineering - Computational Science and Engineering**, *Politecnico di Milano, Italy*  
Apr. 2017 - Master Thesis: *Goal-Oriented mesh adaptivity for topology optimization*.  
Advisors: Simona Perotto, Stefano Micheletti (Politecnico di Milano).
- Sep. 2010 - **B.Sc. in Mathematical Engineering**, *Politecnico di Milano, Italy*  
Dec. 2013 - 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. *28<sup>th</sup> 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. *1<sup>st</sup> 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, 36<sup>th</sup> Conference on Neural Information Processing Systems (NeurIPS)*, 2022.  
[https://openreview.net/pdf?id=Yk\\_I37Ca8Q](https://openreview.net/pdf?id=Yk_I37Ca8Q)
- S. Fresca, A. Manzoni, L. Dede', A. Quarteroni. Deep learning-based reduced order models in cardiac electrophysiology. *7<sup>th</sup> International Conference on Computational and Mathematical Biomedical Engineering*, 2022.  
<https://www.compbioed.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, 35<sup>th</sup> Conference on Neural Information Processing Systems (NeurIPS)*, 2021.  
[https://openreview.net/pdf?id=kQ\\_P1YH3NsF](https://openreview.net/pdf?id=kQ_P1YH3NsF)

### 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. Zappone, 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

- 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](https://github.com/stefaniafresca/DL-ROM-Meth), Python/Tensorflow.
- DL-ROM: [github.com/stefaniafresca/DL-ROM](https://github.com/stefaniafresca/DL-ROM), Python/Tensorflow.
- POD-DL-ROM: [github.com/stefaniafresca/POD-DL-ROM](https://github.com/stefaniafresca/POD-DL-ROM), Python/Tensorflow.
- DLROM-hub: [github.com/DLROM-hub](https://github.com/DLROM-hub), Python/Tensorflow/PyTorch.

## Talks and Seminars

### Invited Seminars

- 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

- 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.
- 3<sup>rd</sup> 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

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

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

**9<sup>th</sup> 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

**7<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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.

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## Memberships of Scientific Committees

**7<sup>th</sup> International Workshop on Model Order Reduction Techniques (MORTech 2025)**, 26-28 Nov. 2025, Zaragoza, Spain

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## Workshop/Minisymposia Organization

**3<sup>rd</sup> IACM Digital Twins in Engineering Conference (DTE 2025) & 1<sup>st</sup> 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<sup>th</sup> 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<sup>th</sup> 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)

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

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

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

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

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## Competitive Research Projects

Feb. 2024 - **Principal Investigator**, *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

Feb. 2023 - **Participant (RTD-A)**, *Future Artificial Intelligence Research (FAIR) Project*, Politecnico di Milano, Italy  
ongoing 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 - **Participant (Post-doc)**, *AI4MEMS Project*, Politecnico di Milano, Italy  
 Feb. 2023 funded by STEAM Joint Research Center ST Microelectronics-PoliMI, PI: Prof. A. Manzoni.
- Nov. 2020 - **Participant (Post-doc)**, *Toward UQoRE (T-UQoRE) Project*, Politecnico di Milano, Italy  
 Oct. 2022 funded by Fondazione Cariplo (grant agreement no. 2019-4608), PI: Prof. A. Manzoni.
- Nov. 2017 - **Participant (Ph.D.)**, *An Integrated Heart Model for the simulation of the cardiac function (iHEART) Project*,  
 Oct. 2020 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 7<sup>th</sup> 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

- Feb. 2024 - **Lecturer**, *Calcolo Numerico (Numerical Methods)*, B.Sc. in Biomedical Engineering, Politecnico di Milano,  
 June 2024 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 - **Teaching Assistant**, *Numerical Analysis for Machine Learning*, M.Sc. in Mathematical Engineering, Politecnico di Milano, 30h, 10 CFU  
 Dec 2023
- Feb. 2023 - **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in  
 June 2023 Aerospace Engineering, Politecnico di Milano, 40h, 10 CFU
- Sep. 2022 - **Teaching Assistant**, *Computational Statistics*, M.Sc. in Mathematical Engineering, Politecnico di Milano,  
 Dec. 2022 12h, 8 CFU
- Feb. 2022 - **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in  
 June 2022 Aerospace Engineering, Politecnico di Milano, 40h, 10 CFU
- Sep. 2021 - **Teaching Assistant**, *Computational Statistics*, M.Sc. in Mathematical Engineering, Politecnico di Milano,  
 Dec. 2021 12h, 8 CFU
- Oct. 2020 - **Teaching Assistant**, *Matlab Course - Analisi I*, B.Sc. in Mathematical Engineering, Politecnico di Milano,  
 Dec. 2020 9h, 10 CFU
- Oct. 2019 - **Teaching Assistant**, *Matlab Course - Analisi I*, B.Sc. in Mathematical Engineering, Politecnico di Milano,  
 Dec. 2019 10h, 10 CFU
- Feb. 2019 - **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in  
 June 2019 Aerospace Engineering, Politecnico di Milano, 48h, 10 CFU
- Feb. 2018 - **Teaching Assistant**, *Calcolo Numerico ed Elementi di Analisi (Applied Numerical Analysis)*, B.Sc. in  
 June 2018 Aerospace Engineering, Politecnico di Milano, 48h, 10 CFU

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

## Post-doc Advising

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

## Ph.D. Advising

Sep. 2025 - **Alice Ragonesi**, Department of Mechanical Engineering, University of Washington  
ongoing  
Advisor: S. Fresca, Co-Advisor: E. Zappa (Medical University of Graz)  
Sep. 2025 - **Ruige Kong**, Department of Mechanical Engineering, University of Washington  
ongoing  
Advisor: S. Fresca

## Theses Advising

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**, Master Program in Mathematical Engineering - Statistical Learning, Politecnico di Milano, Ongoing  
Advisor: S. Fresca, Co-advisors: J. Rowbottom, P. Liò, C. B. Schönlieb (Cambridge University)

M.Phil. thesis **Adam Dray**, Master Program in Scientific computing, Cambridge University, Ongoing  
Advisor: P. Liò (Cambridge University), Co-advisors: J. Rowbottom (Cambridge University), 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. Zappa (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

- Undergrad. project **Ishan Nath**, Undergraduate Program in Mathematical Tripos, Cambridge University, Ongoing
- M.Phil. project **Shuoyu Yue**, Master Program in Scientific computing, Cambridge University, Ongoing
- 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

- **Associate Editor:** Advanced Modelling and Simulation in Engineering Sciences (AMSES), Springer Nature.
- **Review Editor:** Computational Physiology and Medicine, Frontiers in Physiology.

## Journal Reviewing

- 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 Europe

## Proceedings Reviewing

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