FEDERICO PICHI

PERSONAL INFORMATION

Born in Rome, Italy 23 February 1992
Ph.D. in Mathematical Analysis, Modelling and Applications

email fpichi@sissa.it
website https://fpichi.github.io

POSITION

Current Position 2024

Assistant Professor (RtdA) at SISSA (International School for Advanced Studies) in the mathLab group within the PNRR iNEST project.

Research Interests

Projection-based and data-driven reduced order models in computational science and engineering. Scientific machine learning and optimal transport based approaches with feedforward and graph neural network for complexity reduction. Numerical analysis of bifurcating phenomena held by parametrised non-linear equations, with applications from Continuum Mechanics to Fluid Dynamics.

PUBLICATIONS

Preprints

[6] F. Pichi, M. Strazzullo. "Deflation-based certified greedy algorithm and adaptivity for bifurcating nonlinear PDEs". arXiv:2501.12361. Accepted for publication in *Communications in Nonlinear Science and Numerical Simulation*.

[5] L. Tomada, M. Khamlich, F. Pichi, G. Rozza. "Sparse Identification for bifurcating phenomena in Computational Fluid Dynamics". 2502.11194.

[4] I. C. Gonnella, F. Pichi, G. Rozza. "Nonlinear reduction strategies for data compression: a comprehensive comparison from diffusion to advection problems". arXiv:2501.12816.

[3] M. Hirsch, F. Pichi, J S. Hesthaven. "Neural Empirical Interpolation Method for Nonlinear Model Reduction". arXiv:2406.03562.

[2] I. C. Gonnella, M. Khamlich, F. Pichi, G. Rozza. "A stochastic perturbation approach to nonlinear bifurcating problems". arXiv:2402.16803.

[1] S. Rathore, P C. Africa, F. Ballarin, F. Pichi, M. Girfoglio, G. Rozza. "Projection-based Reduced Order Modelling for Unsteady Parametrized Optimal Control Problems in 3D Cardiovascular Flows". arXiv:2410.20828. Accepted for publication in *Computer Methods and Programs in Biomedicine*.

Papers

[12] M. Khamlich, F. Pichi, M. Girfoglio, A. Quaini, G. Rozza. "Optimal Transport-Based Displacement Interpolation with Data Augmentation for Reduced Order Modeling of Nonlinear Dynamical Systems". Journal of Computational Physics, 2025.

[11] O. Morrison, F. Pichi, J S. Hesthaven. "GFN: A Graph Feedforward Network for resolution-invariant reduced operator learning in multi-fidelity applications". Computer Methods in Applied Mechanics and Engineering, 2024.

[10] M. Khamlich, F. Pichi, G. Rozza. "Optimal Transport-inspired Deep Learning Framework for Slow-Decaying Problems: Exploiting Sinkhorn Loss and Wasserstein Kernel". SIAM Journal on Scientific Computing, 2025.

[9] G. Rozza, F. Ballarin, L. Scandurra, F. Pichi. "Real time reduced order computational

mechanics: parametric PDEs worked out problems". Springer Nature Switzerland, SISSA Springer Series, 2024.

[8] F. Pichi, B. Moya, J. S. Hesthaven. "A convolutional graph neural network approach to model order reduction to non-linear parametrized PDEs". Journal of Computational Physics, 2024.

[7] F. Pichi, F. Ballarin, G. Rozza, J. S. Hesthaven. "An artificial neural network approach to bifurcating phenomena in computational fluid dynamics". Computers & Fluids, 2023.

[6] M. Khamlich, F. Pichi, G. Rozza. "Model order reduction for bifurcating phenomena in fluid-structure interaction problems". International Journal for Numerical Methods in Fluids, 2022.

[5] F. Pichi. "Reduced order models for parametric bifurcation problems in nonlinear PDEs". Ph.D. Thesis, Scuola Internazionale Superiore di Studi Avanzati, 2020.

[4] F. Pichi, M. Strazzullo, F. Ballarin, G. Rozza. "Driving bifurcating parametrized nonlinear PDEs by optimal control strategies: application to Navier-Stokes equations and model reduction". ESAIM: Mathematical Modelling and Numerical Analysis, 2022.

[3] M. Pintore, F. Pichi, M. Hess, G. Rozza, C. Canuto. "Efficient computation of bifurcation diagrams with a deflated approach to reduced basis spectral element method" Advances in Computational Mathematics, 47:1, 2021.

[2] F. Pichi, A. Quaini, G. Rozza. "A Reduced Order technique to study bifurcating phenomena: application to the Gross-Pitaevskii equation" SIAM Journal on Scientific Computing, 42:5, B1115-B1135, 2020.

[1] F. Pichi, G. Rozza. "Reduced basis approaches for parametrized bifurcation problems held by non-linear von Kármán equations" Journal of Scientific Computing, 10.1007/s10915-019-01003-3, 2019.

Proceedings & Chapters

[6] F. Pichi, G. Rozza. "Reduced Order Models for the Buckling of Hyperelastic Beams". *Reduction, Approximation, Machine Learning, Surrogates, Emulators and Simulators: RAMSES*, 2024

[5] M. Khamlich, F. Pichi, G. Rozza. "Chapter 15: Reduced Order Models for Bifurcating Phenomena in Fluid-Structure Interaction Problems". Proceedings of Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics, 2023.

[4] F. Pichi, F. Ballarin, G. Rozza. "Chapter 5: Reduced Basis Approaches to Bifurcating Nonlinear Parametrized Partial Differential Equations". Proceedings of Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics, 2023.

[3] F. Pichi, M. Strazzullo, F. Ballarin, G. Rozza. "Chapter 2: Finite Element-Based Reduced Basis Method in Computational Fluid Dynamics". Proceedings of Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics, 2023.

[2] F. Pichi, F. Ballarin, G. Rozza, J. S. Hesthaven. "Artificial neural network for bifurcating phenomena modelled by nonlinear parametrized PDEs". PAMM, 20(S1):e202000350, 2021.

[1] D.B.P. Huynh, F. Pichi and G. Rozza. "Reduced Basis Approximation and A Posteriori Error Estimation: Applications to Elasticity Problems in Several Parametric Settings" Numerical Methods for PDEs: State of the Art Techniques, Springer International Publishing, Ch. 8, 203–247, 2018.

EDUCATION

2022-2024 EPFL, Lausanne (Switzerland)

Research Scientist MCSS group

Project: *Data-driven and projection-based reduced order models*
PI: Prof. Jan S. Hesthaven

2020-2021 SISSA-EPFL, Lausanne (Switzerland)

Postdoc

CRUI GO for IT grant · mathLab-MCSS
Project: *Reduced order methods for nonlinear PDEs enhanced by machine learning*
PIs: Prof. Gianluigi Rozza & Prof. Jan S. Hesthaven

2018-2019 MIT, Cambridge (USA)

Visiting Student

Massachusetts Institute of Technology · Computational Engineering
Advisor: Prof. Anthony Patera
Project: ROM2S Reduced Order Methods at MIT and SISSA

2016-2020 SISSA, Trieste (Italy)

Ph.D. degree

Mathematical Analysis, Modelling and Applications · Mathematics Area
Thesis: *Reduced order models for parametric bifurcation problems in nonlinear PDEs*
Advisors: Prof. Gianluigi Rozza & Dr. Francesco Ballarin
Final Grading *cum laude*

2014-2016 'La Sapienza' University, Rome (Italy)

Master degree

Applied Mathematics · Department of Mathematics
Thesis: *Reduced order methods for parametric Von Kármán equations*
Advisors: Prof. Maurizio Falcone & Prof. Gianluigi Rozza
Final Grading *110/110 cum laude*

2011-2014 'La Sapienza' University, Rome (Italy)

Bachelor degree

Mathematics · Department of Mathematics
Thesis: *Discontinuous differential equations in control theory*
Advisor: Prof. Corrado Mascia
Final Grading *110/110 cum laude*

OTHER INFORMATION

Teaching and Tasks

Courses

- *Advanced reduced order models in scientific machine learning*, SISSA, 2025.
- *Applied mathematics: introduction to scientific computing by numerical analysis*, SISSA, 2025.
- *Fundamentals of machine learning*, University of Twente, Earthsafe Doctoral Network 2024.
- *Reduced Order Methods for Computational Mechanics* [tutor], SISSA, 2022, 2024, and 2025.
- *Topics in Computational Fluid Dynamics* [tutor], SISSA, 2024.
- *Dynamics and bifurcation* [tutor], EPFL, 2022.
- *Analyse III* [tutor], EPFL, 2022 and 2023.
- *Summer School on Reduced Order Methods in Computational Fluid Dynamics*. SISSA, 2022.
- *MATLAB*, University of Trieste, 2019.
- *ROM in bifurcating parametrised non-linear equations*, SISSA, 2019.

Tutoring

- Ph.D. [6] · *M. Khamlich* (SISSA), *A. Orunnukaran* (SISSA), *I.C. Gonnella* (SISSA), *L. Tomada* (SISSA), *L. Mosconi* (SISSA), *M. Ramadan* (SISSA).
- Tutoring [9] · *Y. Chen* (Ocean University of China), *M. Hirsch* (UC Berkeley), *O. Morrison* (ECMWF), *S. Rathore* (SISSA), *A. Dahdah* (SISSA), *D. Oberto* (SISSA), *N. Kumar* (SISSA), *A. Kabalan* (SISSA), *C. Valentino* (UniSa), *B. Moya* (Univ. of Zaragoza).
- Master [9] · *G. Venier* (Univ. of Trieste), *L. Tomada* (Univ. of Trieste), *C. Filippin* (PoliTo), *A. Tataranni* (PoliTo), *I.C. Gonnella* (Univ. of Trieste), *O. Morrison* (EPFL, **IBM Prize**), *M. Khamlich* (PoliMi), *M. Pintore* (PoliTo).
- Internship [8] · L. *Tomada* (Univ. of Trieste), *F. Sala* (EPFL), *L. Trentini* (EPFL), *O. Morrison* (EPFL), *A. Radakovic* (SISSA), *J. Manson* (EPFL), *F. Pettenon* (EPFL), *M. Hirsch* (Carnegie Mellon University).

Scientific duties

- Research/talk invitations [6]: Università di Roma La Sapienza (D. Torlo), ETH Zurich (C. Schwab), Bordeaux INP (M. Azaiez), TU/e Eindhoven (K. Lux-Gottschalk), Inria Sophia Antipolis (S. Lanteri), Politecnico di Torino (M. Strazzullo).
- Organizer conferences/workshops [5]: EFEF - European Finite Element Fair 2025, SIMAI 2025, LOG Meetup 2024, SMLET - Scientific Machine Learning: emerging topics 2024, SISSA SIAM Student Chapter Colloquia 2020.
- Organizer mini-symposia [9]: WCCM 2024, ECCOMAS 2024, AICOMAS 2025, COUPLED 2025, M2P 2025, ADMOS 2025, ICOSAHOM 2025, SIMAI 2025, YIC 2025.
- Scientific committee [1]: COUPLED 2025.
- Developer scientific computing packages [4]: RBniCS, GCA-ROM, MLniCS, GFN.
- Reviewer [23]: International Journal for Numerical Methods in Engineering, Results in Engineering, Journal of Aerospace Engineering, SIAM Journal on Scientific Computing, Advances in Computational Mathematics, Journal of Scientific Computing, Finite Elements in Analysis and Design, International Journal of Bifurcation and Chaos, AMS Math. Reviews, Advances in Continuous and Discrete Models, Applied Mathematics and Computation, Computers & Mathematics with Applications, Journal of Computational Physics, Communications in Nonlinear Science and Numerical Simulation, Applied Mathematical Modelling, Computer Methods in Applied Mechanics and Engineering, Chaos, Advanced Modeling and Simulation in Engineering Sciences, Physica D: Nonlinear Phenomena, SIAM Review, Journal of Computational Science, Computational and Applied Mathematics, Engineering Applications of Artificial Intelligence.
- Member of GNCS, SIAM, SIMAI.
- President of SISSA Siam Student Chapter (2019-2020).
- Webmaster of SISSA Mathematics Area (2018-2020).

Awards and Funding

2025 INDAM GNCS · Sviluppo e analisi di modelli di ordine ridotto basati su tecniche di deep learning.

2024 iNEST Young Researcher · PI of the project "Surrogate Models for Scientific Machine Learning", iNEST-Interconnected Nord-Est Innovation Ecosystem (50K).

2024 INDAM GNCS · Grant for "Joint GNCS-SIAM Meeting for Young Researchers in Numerical Analysis and Applied Mathematics, Università degli Studi di Pavia.

2024 DeNSiProAM · PI Peregrina Quintela (USC) "Development of numerical simulation tools for process improvement in additive manufacturing" (120k).

2024 H2SmartLab · Lead institution Area Science Park - Infrastruttura di ricerca per idrogeno rinnovabile e tecnologie intelligenti e resilienti (2.1M).

2021 CRUI project GO for IT · Research grant between EPFL and SISSA: "Reduced order methods for nonlinear PDEs enhanced by machine learning".

2021 INDAM GNCS · Grant for Coupled Problems 2021.

2021 Fondazione CIME · Grant for CIME Summer School: Model Order Reduction and Applications.

2020 ECCOMAS Scholarship · Grant for WCCM-ECCOMAS Virtual Congress.

2019 Banco Santander Financial Support Program · Grant for 9th International Congress on Industrial and Applied Mathematics ICIAM2019.

2019 SIAM · Student Chapter certificate of recognition.

2018 MIT-Italy - FVG · "ROM2S - Reduced Models at MIT and SISSA" (10K).

2018 INDAM GNCS · Tecniche di riduzione di modello per le applicazioni mediche.

2016 INDAM GNCS · Tecniche di riduzione computazionale per le scienze applicate.

SISSA · Master thesis fellowship for pre-graduate students.

Università di Roma La Sapienza · Excellence course for Bachelor (2011-2014) and Master degrees in Mathematics (2014-2016).

Conferences and Workshops

Talks [38]: EMS-TAG-SCIML 2025 (keynote), GNCS-SIAM Chapters Meeting 2025 (keynote), AICOMAS 2025 (keynote), ZHACM Colloquia @ETH 2024 (colloquium), ARIA Workshop 2024 (talk), AI Day Bordeaux 2024 (invited talk), YAMC 2024 (talk), ECM 2024 (talk), SciML 2024 (talk), SMLET 2024 (talk), @TU/e 2024 (invited talk), ECCOMAS 2024 (talk), SIAM UQ 2024 (talk), @INRIA 2024 (invited talk), @DISMA 2023 (invited talk), @Sapienza 2023 (talk), YIC 2023 (talk), IWROMS 2023 (talk), CFC 2023 (talk), NA G-ROM (talk), SIAM CSE 2023 (talk), CODES@Emory 2022 (invited talk), MORE 2022 (talk), ROM in CFD 2022 (talk), ECCOMAS 2022 (talk), RAMSES 2021 (talk), MMLDT-CSET 2021 (keynote), CIME Summer School 2021 (talk), Coupled 2021 (talk), FEniCS 2021 (talk), SIAM CSE 2021 (talk), WCCM-ECCOMAS 2020 (talk), MORSS 2020 (talk), SAMM 2020 (poster), UMI 2019 (talk), ICIAM 2019 (talk), ROM in CFD (poster), CIME-EMS Summer School, ICOSAHOM 2018 (talk), MoRePaS 2018 (poster), QUIET 2017, FEF 2017, EU-MORNET.

May 9, 2025