FEDERICO PICHI

PERSONAL INFORMATION

Born in Rome, Italy 23 February 1992

Ph.D. in Mathematical Analysis, Modelling and Applications

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website https://fpichi.github.io

POSITION

Current Position 2021-2023

Postdoctoral researcher at EPFL (École Polytechnique Fédérale de Lausanne) in the MCSS group of Prof. Jan S. Hesthaven.

Research Interests

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

PUBLICATIONS

In preparation

[18] G. Rozza, F. Ballarin, L. Scandurra, F. Pichi. "Real time reduced order computational mechanics: parametric PDEs worked out problems".

[17] F. Pichi, M. Strazzullo. "A deflation-based certified greedy algorithm for bifurcating nonlinear PDEs".

[16] F. Ballarin, F. Pichi, G. Rozza. "A successive partition method for the efficient evaluation of parametrized stability factors".

Preprint

[15] M. Khamlich, F. Pichi, G. Rozza. "Optimal Transport-inspired Deep Learning Framework for Slow-Decaying Problems: Exploiting Sinkhorn Loss and Wasserstein Kernel". arXiv:2308.13840.

[14] F. Pichi, G. Rozza. "Reduced Order Models for the Buckling of Hyperelastic Beams". arXiv:2305.19764. Accepted in *Lecture notes in CSE, Springer*.

[13] F. Pichi, B. Moya, J. S. Hesthaven. "A convolutional graph neural network approach to model order reduction to non-linear parametrized PDEs". arXiv:2305.08573.

Published

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

[11] 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.

[10] 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.

[9] 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.

[8] 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.

[7] 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.

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

[5] 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.

[4] 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.

[3] 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.

[2] 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.

[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

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

- *Analyse III* [TA], EPFL, 2022.
- *Summer School on Reduced Order Methods in Computational Fluid Dynamics*. Invited lecturer, SISSA, 2022.
- *Dynamics and bifurcation* [TA], EPFL, 2022.
- *Computational Mechanics by Reduced Order Methods* [TA], SISSA, 2022.
- *MATLAB*, University of Trieste, 2019.
- *ROM in bifurcating parametrised non-linear equations*, SISSA, 2019.

Tutoring

- Semester and Master · O. Morrison, Mathematics, EPFL, 2023.
- Master · I. Gonnella, Data Science and Sci. Comp., University of Trieste, 2023.
- Semester · F. Pettenon, Mathematics, EPFL, 2023.
- Semester · HaPINNess project, Machine Learning course CS433, EPFL, 2023.
- Internship · M. Hirsch, Math. Sciences, Carnegie Mellon University, 2022.
- Master and Ph.D. · M. Khamlich, Math. Eng., Politecnico di Milano, 2021.
- Master · M. Pintore, Math. Eng., Politecnico di Torino, 2019.

Miscellanea

- Member of GNCS, SIMAI, SIAM.
- President of SISSA Siam Student Chapter (2019-2020).
- Organizer of SISSA SIAM Student Chapter Colloquia 2020, Virtual Event.
- Webmaster of SISSA Mathematics Area (2018-2020).
- Reviewer: 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.

Awards and Funding

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 Order Methods at MIT and SISSA

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

Sapienza University · Excellence course for Bachelor (2011-2014) and Master degrees in Mathematics (2014-2016)

Conferences and Workshops

YIC 2023 (talk) IWROMS 2023 (talk) CFC 2023 (talk) NA G-ROM (talk), SIAM CSE 2023 (talk), CODES@Emory 2022 (talk), MORE 2022 (talk), ROM in CFD 2022 (talk), ECCOMAS 2022 (talk), RAMSES 2021 (talk), MMLDT-CSET 2021 (talk), 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.

August 30, 2023