Mattia Cenedese

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WORK EXPERIENCE

Model Validation Quantitative Analyst at UBS (Switzerland) December 2022 - Present

APPOINTMENT HISTORY

Postdoctoral researcher at ETH Zürich (Switzerland) October 2021 - November 2022

Scientific assistant I at ETH Zürich (Switzerland) September 2017 - September 2021

Research scientist at Politenico di Milano (Italy) May - August 2017

EDUCATION

Ph.D. in Mechanical Engineering at ETH Zürich (Switzerland) June 2021
- Thesis title: *A geometric approach to nonlinear mechanical vibrations: from analytic to data-driven methods* [link]
- Supervisor: Prof. Dr. George Haller
- Co-supervisor: Prof. Dr. Melih Eriten

M.Sc. in Mechanical Engineering at Politecnico di Torino (Italy) December 2017
- Final score: 110 *cum laude* / 110

M.Sc. in Mechanical Engineering at Politecnico di Milano (Italy) December 2016
- Final score: 110 *cum laude* / 110
- Thesis title: *Smart periodic structures: from wave propagation to electromechanical design* [link]
- Supervisor: Prof. Dr. Francesco Braghin
- Co-supervisor: Prof. Dr. Laura Gastaldi

Enrolled in *Alta Scuola Politecnica*, XI Cycle November 2014 - June 2016
- Final project: *IntegraGreen: integration of additive manufacturing and conventional processes in view of green and sustainable development* [link]
- Supervisors: Prof. Dr. Luca Settineri, Prof. Dr. Bianca Maria Colosimo, Prof. Luca Iuliano, Dr. Paolo Priarone, Leonardo Napoli

Laurea in Mechanical Engineering at Politecnico di Milano (Italy) September 2014
- Final score: 110 *cum laude* / 110
- Equivalent to a B.Sc.

PROFESSIONAL TRAINING & SKILLS

Workshops & summer schools

- ▷ *Effective High-Performance Computing & Data Analytics with GPUs*, July 19-30, 2021, organized by the Swiss National Supercomputing Centre and Università della Svizzera italiana (Switzerland).
- ▷ *Tribomechadynamics Research Camp* held at Rice University in Houston, July 2019, organized by Matthew Brake (Rice University, USA).
- ▷ *Advanced Summer School on Continuation Methods for Nonlinear Problems* held at University of Illinois at Urbana-Champaign (UIUC), August 2018, co-organized by Harry Dankowicz (UIUC, USA) and Jan Sieber (University of Exeter, UK).
- ▷ Course in *Substructuring in Engineering Dynamics* held at the International Center for Mechanical Science (CISM) in Udine (Italy), July 2018, organized by Matthew Allen (University of Wisconsin-Madison, USA) and Daniel Rixen (Technische Universität München, Germany).

Selected courses from M.Sc. & Ph.D. studies

- ▷ Nonlinear Dynamics and Chaos I, II
- ▷ Differential Geometry
- ▷ Introduction to Machine Learning
- ▷ Uncertainty Quantification and Data Analysis in Applied Sciences
- ▷ Numerical Analysis of Stochastic Ordinary Differential Equations
- ▷ Noise and Vibration Engineering
- ▷ Mechatronic Systems and Laboratory

Computer skills

- ▷ Advanced knowledge of MATLAB®.
- ▷ Expert with *Python* in numerical and machine learning packages, e.g. *NumPy*, *SciPy*, *Pandas*, *Matplotlib*, *Plotly*, *FENICS*, *TensorFlow*, *PyTorch*, *Scikit-Learn*.
- ▷ Competent in HTML and LaTeX programming languages, engineering commerical softwares (*Abaqus FEA®*, *Comsol Multiphysics®*, *Inventor®*, *Solidworks®*), *Microsoft Office®* suite.

Coursera accomplishments

- ▷ *Data Science*: Data Analysis with Python (IBM), Data Visualization with Python (IBM), Exploratory Dana Analysis for Machine Learning (IBM), Data Science Ethics (University of Michigan)
- ▷ *Machine Learning*: Supervised Machine Learning: Regression (IBM), Supervised Machine Learning: Classification (IBM), Unsupervised Machine Learning (IBM), Deep Learning and Reinforcement Learning (IBM), Specialized Models: Time Series and Survival Analysis (IBM)
- ▷ *Generative AI*: Generative AI with Large Language Models (DeepLearning.AI), ChatGPT Prompt Engineering for Developers (DeepLearning.AI)

RESEARCH TOPICS

- ▷ Construction of data-driven methods for reduced-order modeling of nonlinear dynamical systems capitalizing on machine learning algorithms.
- ▷ Development analytical techniques for the analysis of multi-degree-of-freedom, forced-damped, nonlinear mechanical systems.
- ▷ Vibration reduction exploiting synergies between periodic structural design and smart elements.

TEACHING & SUPERVISION ACTIVITIES

- Teaching assistant for the course *Dynamics*, undergraduate level, ETH Zürich, 2017.
- Teaching assistant and substitute lecturer for the course *Nonlinear Dynamics and Chaos II*, graduate level, ETH Zürich, 2020, 2022.
- Supervision of master theses:
  - A. Massocco, *Model order reduction of wakes behind bluff bodies*, June - December 2020.
  - R. Uslenghi, *Exploring frequency aware machine learning techniques for discontinuous fluids data*, May - October 2021.
  - Z. Xu, *Experimental identification and control of fluttering instabilities*, February - July 2022.

PROFESSIONAL ACADEMIC SERVICE

- Reviewer of research articles for the following journals: *Arch. Appl. Mech.*, *Appl. Phys. Lett.*, *Comput. Methods Appl. Mech. Eng.*, *Int. J. Non-Linear Mech.*, *Int. J. Robot. Res.*, *J. Appl. Mech.*, *J. Appl. Phys.*, *J. Nonlinear Sci.*, *J. Vib. Acoust.*, *Mech. Syst. Signal Process.*, *Nonlinear Dyn.*, *Phys. Rev. Fluids*
- Chairman for the session *Data analysis and data-driven modelling* of the conference DynamicsDays XL, August 23-27, 2021, Nice, France.
- Chairman for the special session *Global problems in nonlinear dynamics* of the 16th International Conference Dynamical Systems – Theory and Applications (DSTA 2021).
- Organizer of the minisymposia:
  - *Data-driven reduced-order modeling of nonlinear dynamical systems* for the 9th GACM Colloquium on Computational Mechanics 2022, September 21-23, Essen, Germany.
  - *Equation- and data-driven reduced-order modeling for fluid flows* for the 22nd Computational Fluids Conference 2023, April 25-28, Cannes, France.

SOFTWARE DEVELOPMENT

- `SSMLearn`: data-driven reduced order modeling package for nonlinear dynamical systems. Available for MATLAB® at github.com/haller-group/SSMLearn and for Python at github.com/haller-group/SSMLearnPy

AWARDS & RECOGNITIONS

- *Silver Medal of ETH Zürich* for outstanding doctoral thesis in 2022. [link]
- *2022 SWICCOMAS Best Thesis Award*, selected among national doctoral thesis for computational methods in applied sciences. [link]
- 1st prize among presentations by junior scientists at the 8th International Conference on Nonlinear Vibrations, Localization and Energy Transfer, July 6-9, 2021, Ascona, Switzerland.
- Paper selected for the cover page: M. Cenedese, E. Belloni & F. Braghin, *Interaction of Bragg scattering bandgaps and local resonators in mono-coupled periodic structures*, *Journal of Applied Physics* 129 (2021) 124501. [link]
- Scholarship *Atlantia per la conoscenza 2015-2016* sponsored by Atlantia S.p.A. (holding company of "Autostrade per l'Italia" and "Aeroporti di Roma") after selection among the best engineering students of Politecnico di Milano.
- Full tuition waiver obtained for both the master's degrees and half tuition waiver obtained for the bachelor's degree in 2013, 2014.

IN THE PRESS

▷ *Predicting complex dynamics from data*, by O. Morsch, ETH Zürich News. [link]

TALKS & PRESENTATIONS

Invited talks

[1] *Dynamics-based learning of reduced-order models for nonlinear systems from numerical and experimental data*. Internal seminar at Kurt Lab, May 19, 2023, University of Washington, Seattle, USA.

[2] *Modeling and prediction of non-linearizable phenomena via dynamics-based machine learning*. Applied Machine Learning Days EPFL 2022, March 26-30, Lausanne, Switzerland. [video]

[3] *Data-driven explicit models and predictions of non-linearizable dynamical systems*. IMES Seminar series, October 8, 2021, ETH Zürich, Switzerland.

[4] *Reduction of large nonliner models and data sets to spectral submanifolds* (tutorial). 8th International Conference on Nonlinear Vibrations, Localization and Energy Transfer, July 6-9, 2021, Ascona, Switzerland.

[5] *Bifurcation and stability of nonlinear oscillations from their conservative limit*. IMES Seminar series, March 27, 2020, ETH Zürich, Switzerland.

Conference presentations

[1] *Spectral submanifold reduction for non-smooth dynamical systems*. Conference on Applications of Dynamical Systems (SIAM DS 2023), May 14-18, 2023, Portland, OR, USA.

[2] *Data-driven spectral submanifold reduction for the dynamics of fluids, solids and their interaction*. 22nd Computational Fluids Conference (CFC 2023), April 25-28, 2023, Cannes, France.

[3] *Model reduction via dynamics-based machine learning for mechanical systems* . International Modal Analysis Conference (IMAC) Ed. 41, February 13-16, 2023, Austin, TX, USA.

[4] *Using spectral submanifolds for forced response prediction in nonlinear finite element models: direct and nonintrusive methods*. 10th European Nonlinear Dynamics Conference (ENOC 2022), July 17-22, 2022, Lyon, France.

[5] *Reduced-order modeling from experimental data via spectral submanifolds*. 10th European Nonlinear Dynamics Conference (ENOC 2022), July 17-22, 2022, Lyon, France.

[6] *Reducing nonlinear mechanical systems from numerical and experimental data via spectral submanifolds*. 11th European Solid Mechanics Conference (ESMC 2022), July 4-8, 2022, Galway, Ireland.

[7] *Non-intrusive model reduction via spectral submanifolds in structural and fluid dynamics*. 8th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS Congress 2022), June 5-9, 2022, Oslo, Norway.

[8] *Data-driven model reduction for nonlinear systems using spectral submanifolds*. International Modal Analysis Conference (IMAC) Ed. 40, February 6-10, 2022, Orlando, FL, USA.

[9] *Data-driven reduced-order nonlinear nodels from spectral submanifolds*. 16th International Conference Dynamical Systems – Theory and Applications (DSTA), December 6-9, 2021, Online.

[10] *Data-driven low-dimensional nonlinear models based on spectral submanifolds*. Dynamics-Days XL, August 23-27, 2021, Nice, France.

[11] *Learning spectral submanifolds of mechanical systems from vibrations data*. 8th International Conference on Nonlinear Vibrations, Localization and Energy Transfer, July 6-9, 2021, Ascona, Switzerland.

[12] *Reduced-order modeling for wakes around bluff bodies using spectral submanifolds*. 2nd International Nonlinear Dynamics Conference (NODYCON), February 16-19, 2021, Rome, Italy.

[13] *Establishing the exact relation between conservative backbone curves and frequency responses via energy balance*. International Modal Analysis Conference (IMAC) Ed. 39 - Virtual, February 8-11, 2021.

[14] *Experimental spectral submanifold reduced order models from machine learning*. International Modal Analysis Conference (IMAC) Ed. 38, February 10-13, 2020, Houston, TX, USA.

[15] *Nonlinear system identification of a jointed structure using full field data - part 2: analysis*. Tribomechadynamics Conference 2019, July 29-August 2, 2019, Rice University, Houston, TX, USA.

[16] *Predicting frequency response as perturbation from the conservative limit* (poster). 7th International Conference on Nonlinear Vibrations, Localization and Energy Transfer, July 1-4, 2019, Marseille, France.

[17] *A geometric approach for time-periodic resonant perturbations of energy-parametrized families of periodic orbits*. 1st International Nonlinear Dynamics Conference (NODYCON), February 17-20, 2019, Rome, Italy.

[18] *Constructing backbone curves from free-decay vibrations data in multi-degrees of freedom oscillatory systems*. International Modal Analysis Conference (IMAC) Ed. 37, January 28-31, 2019, Orlando, FL, USA.

[19] *Design of a smart periodic beam with coupling between local resonances and Bragg band gaps*. 8th ECCOMAS Thematic Conference on Smart Structures and Materials, June 5-8, 2017, Madrid, Spain.

PUBLICATIONS

Refereed journal articles

[1] J.I. Alora, M. Cenedese, G. Haller & M. Pavone, *Discovering dominant dynamics for nonlinear continuum robot control*, *npj Robotics* 3 (2025) 5. DOI: 10.1038/s44182-025-00021-8 [PDF]

[2] M. Cenedese, J. Marconi, G. Haller & S. Jain, *Data-assisted non-intrusive model reduction for forced nonlinear finite elements models*, *Nonlinear Dynamics* 113 (2024) 6465-6489. DOI: 10.1007/s11071-024-10507-z [PDF]

[3] L. Bettini, M. Cenedese & G. Haller, *Fast data-driven model reduction for nonlinear dynamical systems*, *International Journal of Non-Linear Mechanics* 163 (2024) 104753. DOI: 10.1016/j.ijnonlinmec.2024.104753 [PDF]

[4] Z. Xu, B. Kaszás, M. Cenedese, G. Berti, F. Coletti & G. Haller, *Data-driven modelling of the regular and chaotic dynamics of an inverted flag from experiments*, *Journal of Fluid Mechanics* 987 (2024) R7. DOI: 10.1017/jfm.2024.411 [PDF]

[5] J. Axås, M. Cenedese & G. Haller, *Fast data-driven model reduction for nonlinear dynamical systems*, *Nonlinear Dynamics* 111 (2023) 7941-7957. DOI: 10.1007/s11071-022-08014-0 [PDF] [Supplementary information]

[6] B. Kaszás, M. Cenedese & G. Haller, *Dynamics-based machine learning of transitions in Couette flow*, *Physical Review Fluids* 7 (2022) L082402. DOI: 10.1103/PhysRevFluids.7.L082402 [PDF] [Supplemental material]

[7] M. Cenedese, J. Axås, H. Yang, M. Eriten & G. Haller, *Data-driven nonlinear model reduction to spectral submanifolds in mechanical systems*, *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 380 (2022) 20210194. DOI: 10.1098/rsta.2021.0194 [PDF]

[8] M. Cenedese, J. Axås, B. Bäuerlein, K. Avila & G. Haller, *Data-driven modeling and prediction of non-linearizable dynamics via spectral submanifolds*, *Nature Communications*, 13 (2022) 872. DOI: 10.1038/s41467-022-28518-y. Article featured on the Editors' Highlights of recent research in *Applied physics and mathematics* [PDF] [Supplementary information]

[9] M. Jin, G. Kosova, M. Cenedese, W. Chen, D. Jana, A. Singh, M. R. W. Brake, C. W. Schwingshackl, S. Nagarajaiah, K. J. Moore & J. Noël, *Measurement and identification of the nonlinear dynamics of a jointed structure using full-field data; Part II - Nonlinear system identification*, *Mechanical Systems and Signal Processing* 166 (2022) 108402. DOI: 10.1016/j.ymssp.2021.108402 [PDF]

[10] W. Chen, D. Jana, A. Singh, M. Jin, M. Cenedese, G. Kosova, M. R. W. Brake, C. W. Schwingshackl, S. Nagarajaiah, K. J. Moore & J. Noël, *Measurement and identification of the nonlinear dynamics of a jointed structure using full-field data; Part I – Measurement of nonlinear dynamics*, *Mechanical Systems and Signal Processing* 166 (2022) 108401. DOI: 10.1016/j.ymssp.2021.108401 [PDF]

[11] M. Cenedese, E. Belloni & F. Braghin, *Interaction of Bragg scattering bandgaps and local resonators in mono-coupled periodic structures*, *Journal of Applied Physics* 129 (2021) 124501. DOI: 10.1063/5.0038438. Article featured on the journal cover page [PDF]

[12] M. Cenedese & G. Haller, *Stability of forced-damped response in mechanical systems from a Melnikov analysis*, *Chaos: an Interdisciplinary Journal of Nonlinear Science* 30 (2020) 083103. DOI: 10.1063/5.0012480 [PDF]

[13] M. Cenedese & G. Haller, *How do conservative backbone curves perturb into forced responses? A Melnikov function analysis*, *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences* 476 (2020) 20190494. DOI: 10.1098/rspa.2019.0494 [PDF]

[14] E.A. Flores Parra, A. Bergamini, B. Lossouarn, B. Van Damme, M. Cenedese & P. Ermanni, *Bandgap control with local and interconnected LC piezoelectric shunts*, *Applied Physics Letters* 111 (2017) 111902. DOI: 10.1063/1.4994779 [PDF]

Peer-reviewed conference proceedings

[1] J.I. Alora, L.A. Pablon, J. Köhler, M. Cenedese, E. Schmerling, M.E. Zeilinger, G. Haller & M. Pavone, *Robust nonlinear reduced-order model predictive control*, *62nd IEEE Conference on Decision and Control (CDC) Singapore* (2023) 4798-4805. DOI: 10.1109/CDC49753.2023.10383243 [PDF]

[2] J.I. Alora, M. Cenedese, E. Schmerling, G. Haller & M. Pavone, *Practical Deployment of Spectral Submanifold Reduction for Optimal Control of High-Dimensional Systems*, *IFAC-PapersOnLine* 56, 2 (2023) 4074-4081. DOI: 10.1016/j.ifacol.2023.10.1734 [PDF]

[3] J.I. Alora, M. Cenedese, E. Schmerling, G. Haller & M. Pavone, *Data-driven spectral submanifold reduction for nonlinear optimal control of high-dimensional robots*, *2023 IEEE International*

Conference on Robotics and Automation (ICRA), London, United Kingdom (2023) 2627-2633. DOI: 10.1109/ICRA48891.2023.10160418 [PDF]

Conference papers

[1] M. Cenedese & G. Haller, *Establishing the exact relation between conservative backbone curves and frequency responses via energy balance*, in *Nonlinear Structures & Systems*, Vol. 1 (2022), pp 189-192, edited by G. Kerschen, M.R.W. Brake & L. Renson. Conference Proceedings of the Society for Experimental Mechanics Series. IMAC XXXIX. Springer, Cham. DOI:10.1007/978-3-030-77135-5_21

[2] M. Cenedese, J. Axås, & G. Haller, *Data-driven reduced-order nonlinear models from spectral submanifolds*, in abstracts of the *16th Conference on DYNAMICAL SYSTEMS Theory and Applications DSTA 2021*, pp 159-160, edited by J. Awrejcewicz, M. Kaźmierczak, J. Mrozowski & P. Olejnik. Łódź, December 6-9, 2021, Poland. DOI:10.34658/9788366741201

[3] M. Cenedese & G. Haller, *Experimental spectral submanifold reduced order models from machine learning*, in *Nonlinear Structures & Systems*, Vol. 1 (2021), pp 249-251, edited by G. Kerschen, M.R.W. Brake & L. Renson. Conference Proceedings of the Society for Experimental Mechanics Series. IMAC XXXVIII. Springer, Cham. DOI:10.1007/978-3-030-47626-7_36

[4] G. Kosova, M. Jin, M. Cenedese, W. Chen, A. Singh, D. Jana, M.R.W. Brake, C.W. Schwingshackl, S. Nagarajaiah, K.J. Moore & J.P. Noël, *Nonlinear system identification of a jointed structure using full-field data: part II analysis*, in *Nonlinear Structures & Systems*, Vol. 1 (2021), pp 185-188, edited by G. Kerschen, M.R.W. Brake & L. Renson. Conference Proceedings of the Society for Experimental Mechanics Series. IMAC XXXVIII. Springer, Cham. DOI:10.1007/978-3-030-47626-7_27

[5] M. Cenedese & G. Haller, *Constructing backbone curves from free-decay vibrations data in multi-degrees of freedom oscillatory systems*, in *Nonlinear Structures & Systems*, Vol. 1 (2020), pp 221-223, edited by G. Kerschen, M.R. Brake & L. Renson. Conference Proceedings of the Society for Experimental Mechanics Series. IMAC XXXVII. Springer, Cham. DOI:10.1007/978-3-030-12391-8_30

[6] M. Cenedese & G. Haller, *Predicting frequency response as perturbation from the conservative limit*, in *7th International Conference on Nonlinear Vibrations, Localization and Energy Transfer: Extended Abstracts* (2019), edited by B. Cochelin, 7th International Conference on Nonlinear Vibrations, Localization and Energy Transfer, Jul 2019, Marseille, France. Publications du LMA, 160. HAL ID:hal-02319600

[7] E. Belloni, M. Cenedese & F. Braghin, *Dynamics of periodic spring-mass chain coupled with an electric transmission line*, in *Proceedings of SPIE 10164, Active and Passive Smart Structures and Integrated Systems* (2017) 101642Y (11 April 2017). DOI:10.1117/12.2259896

[8] E. Belloni, G. Cazzulani, M. Cenedese & F. Braghin, *Design of a smart periodic beam with coupling between local resonances and Bragg band-gaps*, in *Proceedings of the 8th Conference on Smart Structures and Materials SMART 2017* (2017), edited by A. Güeme, A. Benjeddou, J. Rodellar & J. Leng. Publication of the International Center for Numerical Methods in Engineering (CIMNE) Barcelona, Spain. [PDF]

[9] E. Belloni, F. Braghin, G. Cazzulani & M. Cenedese, *Invariant representation of wave propagation properties for a mono-coupled electro-mechanical periodic structure*, in *Proceedings of the ASME 2016 Conference on Smart Materials, Adaptive Structures and Intelligent Systems*, Vol. 1 (2016). Stowe, Vermont, USA. September 28–30. V001T02A004. ASME. DOI:10.1115/SMASIS2016-9117

Popular science articles

[1] G. Haller, S. Jain & M. Cenedese, *Dynamics-based machine learning for nonlinearizable phenomena*, *SIAM News*, Volume 55, Number 5, June 2022. [link]

ACADEMIC REFERENCES

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