

# Francesco Regazzoni

## *curriculum vitæ*

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### Academic position

- May 2024 - to date **Tenure-track Assistant Professor (RTT) in Numerical Analysis, MOX**  
- *Department of Mathematics, Politecnico di Milano*
- May 2021 - May 2024 **Junior Assistant Professor (RTDa) in Numerical Analysis, MOX** -  
*Department of Mathematics, Politecnico di Milano*
- Nov 2019 - Apr 2021 **Post-doctoral Research Fellow, MOX** - *Department of Mathematics,*  
*Politecnico di Milano, responsible for the research: Prof. Pasquale Ciarletta*
- Nov 2016 - Oct 2019 **PhD Student, MOX** - *Department of Mathematics, Politecnico di Milano,*  
*supervised by Prof. Alfio Quarteroni*

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### Scientific qualification

- Dec 11, 2023 **Italian National Scientific Qualification as Associate Professor, S.C.**  
*01/A5 Analisi Numerica (Numerical Analysis)*

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### Invited research visits

- Mar 2024 **Università degli Studi di Firenze, Dipartimento di Fisiologia e Dipar-**  
*timento di Farmacologia, with Prof. Cecilia Ferrantini and Prof. Corrado*  
*Poggesi*
- Feb 2024 **Università degli Studi di Trento, Dipartimento di Matematica, with Dr.**  
*Simone Pezzuto*
- Apr 2022 **University of Graz, Institute of Mathematics and Scientific Computing,**  
*with Dr. Federica Caforio*
- Jul 2022 **Università degli Studi di Firenze, Dipartimento di Fisiologia e Dipar-**  
*timento di Farmacologia, with Prof. Cecilia Ferrantini and Prof. Corrado*  
*Poggesi*
- Dec 2019 - Feb 2020 **Inria Saclay Île-de-France and École Polytechnique, M3DISIM and**  
*LMS (Laboratoire de Mécanique des Solides), with Prof. Dominique Chapelle*  
*and Prof. Philippe Moireau*
- Aug 2019 - Sep 2019 **Pennsylvania State University, Department of Mathematics, State College,**  
*Pennsylvania (USA), with Prof. Jinchao Xu*
- Sep 2018 - Feb 2019 **Inria Saclay Île-de-France and École Polytechnique, M3DISIM and**  
*LMS (Laboratoire de Mécanique des Solides), with Prof. Dominique Chapelle*  
*and Prof. Philippe Moireau*

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## International scientific boards

### 2023 to date **EMS Young Academy (EMYA)**

Nominated member of the EMS Young Academy (EMYA), established by the European Mathematical Society (EMS) with the aim of strengthening the role in the mathematical community and the perspective of the generation of young mathematicians in Europe.

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## Honors and awards

### 2024 **Oden-Hughes Award**

Best paper published in CMAME (Computer Methods in Applied Mechanics and Engineering) in the years 2022-2023, for the paper “A comprehensive and biophysically detailed computational model of the whole human heart electromechanics” by M. Fedele, R. Piersanti, F. Regazzoni, M. Salvador, P. C. Africa, M. Bucelli, A. Zingaro, L. Dede’, A. Quarteroni.

### 2022 **IJNMBE Best PhD Award in Biomedical Engineering**

Prize awarded for the best PhD Thesis related to Biomedical Engineering defended in 2020, 2021 or 2022. The award consists of a registration fee waiver, a travel grant and a money prize, sponsored by the International Journal for Numerical Methods in Biomedical Engineering (IJNMBE).

### 2021 **ECCOMAS Best PhD Thesis Award**

Prize awarded by ECCOMAS, the European Community on Computational Methods in Applied Sciences, for the best PhD Thesis in the field of Computational Methods in Applied Sciences and Engineering. The award is accompanied with a money prize and the winner awarded during the 8th ECCOMAS Congress (Oslo, Norway).

### 2021 **Best VPHi Thesis Award in *In Silico* Medicine**

Prize awarded by VPH Institute to reward individuals for outstanding achievements during their PhD thesis. The award is accompanied with a money prize and the winner is invited to give a plenary lecture at the 5th VPH Barcelona Summer School.

### 2021 **SIMAI best PhD Thesis**

Best Thesis on Computational Methods in Applied Sciences and Engineering (SIMAI nomination to the ECCOMAS PhD award).

### 2020 **VPH2020 Young Investigator Award**

Best talk in the conference VPH2020 among young researchers (PhD defended in 2016 and later). Voted by the Scientific Committee members.

### 2020 **GBMA PhD Award 2020**

Prize awarded by AIMETA (Italian Association of Theoretical and Applied Mechanics, Biomechanics Group – GBMA) for the best Doctoral Thesis on Theoretical and Applied Biomechanics, defended in the period May 1<sup>st</sup>, 2019 – April 30<sup>th</sup>, 2020 in an Italian University or Research Centre.

### 2017 **Carlo Cercignani Prize**

Best thesis of the year 2016 in *Mathematical Engineering - Computational Science and Engineering* (Politecnico di Milano).

### 2012 **Best 1st-year students of Academic Year 2011/2012**

Winner of the scholarship.

### 2012 **Best Politecnico di Milano admission test score**

Rewarded by Politecnico’s rector Prof. Giovanni Azzone for the score gained in the admission test (100/100), during the “Politest Top Schools” event.

2005–2010 **Kangourou della Matematica**

Qualified for six consecutive italian national finals. Best placings:

- 2007 Edition: 2<sup>nd</sup> position
- 2008 Edition: 4<sup>th</sup> position
- 2009 Edition: 5<sup>th</sup> position

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Education

- Nov 2016 - Oct 2019 **PhD in Mathematical Models and Methods in Engineering**, MOX, Department of Mathematics, Politecnico di Milano  
Thesis: Mathematical Modeling and Machine Learning for the Numerical Simulation of Cardiac Electromechanics (Advisor: Prof. A. Quarteroni, Coadvisor: Prof. L. Dede')  
Thesis defense: 18/02/2020 (Milan)  
Evaluation *cum laude*
- Dec 2017 **Master Degree in Mathematical Engineering**, Politecnico di Torino  
Evaluation: 110/110 *cum laude*  
Double Degree program in the context of Alta Scuola Politecnica.
- Oct 2014 - Sep 2016 **Master Degree in Mathematical Engineering**, Politecnico di Milano  
Track: *Computational Science and Engineering*  
Thesis: Topology optimization of self-assembling anisotropic materials (Advisor: Prof. M. Verani, Coadvisors: Prof. N. Parolini, Prof. S. Berrone)  
Evaluation: 110/110 *cum laude*  
Weighted average mark: 29.81/30 (10 exams *cum laude* out of 12)  
Language: English
- 2014 - 2016 **Alta Scuola Politecnica (ASP), XI cycle**  
School of excellence founded by the Politecnico di Milano and the Milan Polytechnic, whose mission is to train high-profile graduates capable of working in a multidisciplinary and multicultural environment. <https://www.asp-poli.it/>
- Sep 2011 - Sep 2014 **Bachelor Degree in Mathematical Engineering**, Politecnico di Milano  
Final dissertation on “Stationary random sequences and Birkhoff’s ergodic theorem” (Advisor: Prof. M. A. Fuhrman)  
Evaluation: 110/110 *cum laude*  
Weighted average mark: 30/30 (15 exams *cum laude* out of 20)
- Sep 2006 - Jul 2011 **Diploma of Liceo Classico**, Liceo Ginnasio Statale “A. Manzoni”, Lecco  
Evaluation 100/100

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Talks and seminars

**Invited seminars**

- March 27, 2024 “Mathematical and numerical modeling of the human heart: linking the sarcomere scale with the organ scale function”, *Università degli studi di Firenze*, Florence, Italy.
- February 5, 2024 “Augmenting physics-based models by means of Scientific Machine Learning methods in Computational Cardiology”, *Università di Trento*, Trento, Italy.
- October 4, 2023 “The regulation of cardiac active force generation: from micro-scale mechanisms to organ-scale simulations”, *SoftMech Seminars*, Glasgow, UK (online).
- September 11, 2023 “Machine Learning augmentation of physics-based models in medicine”, *AI Seminars 2023, Politecnico di Milano - Spoke 4, FAIR*, Milan.

- September 22, 2022 “A virtual heart: mathematical and numerical models of the cardiac electromechanical function”, *Center of Advanced Mathematical Sciences (CAMS), American University of Beirut, Beirut, Lebanon* (online).
- July 4, 2022 “A novel in silico model of sarcomeres with cooperative thin filament regulation: from microscale dynamics to macroscale simulations”, *Università degli studi di Firenze, Florence, Italy*.
- April 25, 2022 “Regulatory mechanisms in cardiac active mechanics: from microscale models to multiscale numerical methods”, *University of Graz, Graz, Austria*.
- January 8, 2021 “Biophysically detailed mathematical models of microscale active force generation in the cardiac tissue”, *Università di Bologna, Bologna, Italy*.
- August 27, 2019 “Machine learning for fast and reliable solutions of time dependent differential equations”, *Pennsylvania State University, Department of Mathematics, State College, USA*.
- February 21, 2019 “Blending Data Assimilation and Machine Learning for data-driven modeling of multiscale problems”, *Inria Saclay Île-de-France, Palaiseau, France*.

#### **Plenary lectures in conferences**

- September 29–30, 2022 “Automatic discovery of low-dimensional dynamics underpinning time-dependent PDEs by means of Neural Networks”, *Plenary lecture at GIMC SIMAI YOUNG Conference 2022, Pavia, Italy*.

#### **Invited lectures in workshop**

- April 15–19, 2024 “Accelerating cardiac simulations: numerical methods and scientific machine learning (*Keynote Lecture*)”, *INdAM Workshop on Mathematical and Numerical Modeling of the Cardiovascular System, Rome, Italy*.
- December 4–7, 2023 “Augmenting physics-based models by means of Scientific Machine Learning methods in Computational Cardiology”, *Special Semester on Mathematical Methods in Medicine – Workshop on ML and AI for medical applications, Linz, Austria*.
- October 25–26, 2022 “Regulatory mechanisms in cardiac active mechanics: from microscale models to multiscale numerical methods”, *Workshop on Mathematics for the Health Sciences, Beirut, Lebanon* (online).
- June 8, 2021 “Mathematical Modeling and Machine Learning for the Numerical Simulation of Cardiac Electromechanics”, *Lecture for the GBMA PhD Award, in the context of the GBMA, GIMC GMA Giovani alla ricerca Workshop, online*.

#### **Lectures in international schools**

- July 9, 2023 “AI-based and hybrid modelling”, *Lecture in the ESB23 (European Society of Biomechanics) pre-courses, Maastricht, the Netherlands*.
- June 7, 2021 “Mathematical Modeling and Machine Learning for the Numerical Simulation of Cardiac Electromechanics”, *Plenary lecture for the Best VPHi Thesis Award in In Silico Medicine (in the context of the 5th VPH Summer School), Barcelona, Spain* (online).

#### **Invited talks in conferences**

- February 27–March 1, 2024 “Non-Intrusive Mesh-Free Surrogate Models in Variable Shape Domains”, *SIAM Conference on Uncertainty Quantification, Trieste, Italy*.

- August 20–25, 2023 “Automatic discovery of low-dimensional dynamics underpinning time-dependent PDEs for inverse problems resolution”, *ICIAM Conference*, Tokyo, Japan (hybrid).
- July 31–August 4, 2023 “A Biophysically Detailed Computational Model of the Four Chamber Human Heart Electromechanics”, *Workshop “Mathematical mechanical biology: old school and new school, methods and applications” at Isaac Newton Institute for Mathematical Sciences*, Cambridge, UK.
- May 30–June 1, 2023 “A Biophysically Detailed Computational Model of the Four Chamber Human Heart Electromechanics”, *Math 2 Product (M2P), ECCOMAS Thematic Conference*, Taormina, Italy.
- July 31–August 05, 2022 “Stabilizing numerical oscillations in cardiac active mechanics: an oscillations-free and accurate fully partitioned scheme”, *15th World Congress of Computational Mechanics (WCCM)*, Yokohama, Japan (online).
- July 10–14, 2022 “Bayesian parameter calibration for multiscale cardiovascular models enabled by Artificial Neural Networks”, *9th World Congress of Biomechanics*, Taipei, Taiwan (online).
- June 27–29, 2022 “Machine learning based real-time simulation of the cardiac electromechanical function enabling global sensitivity analysis and Bayesian parameter estimation”, *7th International Conference on Computational and Mathematical Biomedical Engineering (CMBE22)*, Milano, Italy.
- June 4–11, 2022 “Efficient identification of biomechanical properties in cardiac models based on physics-informed neural networks”, *ECCOMAS 2022 Congress*, Oslo, Norway.
- November 9–12, 2021 “Machine Learning enhanced cardiac models for computationally efficient multiscale simulations, sensitivity analysis and parameter estimation”, *XLII Ibero-Latin-American Congress on Computational Methods in Engineering (CILAMCE-2021)*, Rio de Janeiro, Brazil (online).
- September 26–29, 2021 “Data-driven reduced order modeling for fast and reliable solution of differential equations, with application to multiscale cardiac modeling”, *IACM Conference on Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, San Diego, USA (online).
- June 27–30, 2021 “Data-driven model order reduction for fast and reliable solution of differential equations: application to multiscale cardiac modeling”, *4th International Conference on Uncertainty Quantification in Computational Sciences and Engineering (ECCOMAS Thematic Conference)*, Athens, Greece (online).
- September 2–7, 2019 “An Artificial Neural Network based approach to Model Order Reduction of time-dependent models”, *UMI Congress 2019*, Pavia, Italy.
- July 15–19, 2019 “Machine learning of active force generation models for the efficient multiscale simulation of the cardiac function”, *ICIAM Conference 2019*, Valencia, Spain.
- July 2–6, 2018 “A reduced model for active contraction in cardiac cells: towards computational efficiency in heart simulation”, *EUROMECH Conference ESMC 2018*, Bologna, Italy.
- May 10, 2018 “Towards computational efficiency in heart simulation: a reduced model of active contraction of the cardiac tissue”, *MediolaNUM, University of Milano Bicocca*, Milan, Italy.

### Contributed talks in conferences

- January 17–19, 2024 “Scientific Machine Learning augmentation of physics-based models in Computational Cardiology”, *Mathematics for Artificial Intelligence and Machine Learning*, Bocconi University, Milan, Italy.
- October 19–20, 2023 “Automatic discovery of low-dimensional dynamics underpinning time-dependent PDEs by means of Latent Dynamics Networks”, *BUILDing a Digital Twin: requirements, methods, and applications*, Rome, Italy.
- July 9–12, 2023 “Regulatory mechanisms in cardiac active mechanics: from microscale models to multiscale numerical methods”, *28th Congress of the ESB (European Society of Biomechanics)*, Maastricht, the Netherlands.
- September 30 – October 2, 2022 “Stabilization of staggered schemes for 3D cardiac mechanics coupled with 0D blood dynamics”, *Modeling the Cardiac Function – Theory, Numerical Methods, Clinical Applications*, Cetraro, Italy.
- July 27–29, 2022 “Neural networks based real-time simulations of cardiac electromechanics”, *10th Vienna International Conference on Mathematical Modelling*, Wien, Austria.
- February 14–15, 2022 “A Machine Learning Method for Real-time Numerical Simulations of Cardiac Electromechanics”, *COLIBRI Focus Workshop – Mathematical Modeling and Machine Learning in Computational Medicine*, Graz, Austria.
- August 22–17, 2021 “An oscillation-free fully staggered algorithm for the numerical simulation of cardiac active mechanics”, *25th International Congress of Theoretical and Applied Mechanics*, Milan, Italy (*online*).
- July 11–14, 2021 “Stabilization for segregated algorithms in cardiac active mechanics”, *26th Congress of the European Society of Biomechanics*, Milan, Italy (*online*).
- July 1–3, 2021 “An oscillation-free segregated algorithm for the numerical simulation of cardiac active mechanics”, *Modeling the Cardiac Function – Theory, Numerical Methods, Clinical Applications*, Milan, Italy (*online*).
- January 11–15, 2021 “Data-driven model order reduction for fast and reliable solution of differential equations: application to multiscale cardiac modeling”, *WCCM-ECCOMAS Congress 2020*, Paris, France (*online*).
- August 31 – September 2, 2020 “A Biophysically-detailed Human Cardiomyocytes Model: towards Computationally Efficient Simulations”, *Modeling the Cardiac Function – Theory, Numerical Methods, Clinical Applications*, Milan, Italy (*online*).
- August 24–28, 2020 “A biophysically-detailed model of cardiomyocytes: towards computationally efficient simulations”, *VPH2020: Virtual Physiological Human Conference 2020 Edition*, Paris, France (*online*).
- July 22–24, 2019 “Multiscale numerical simulation of the cardiac function: exploiting machine learning for modeling active force generation”, *RISM Congress 2019, Modelling the Cardiac Function*, Varese, Italy.
- June 11–15, 2018 “A reduced model of active contraction of the cardiac muscle tissue”, *ECCOMAS Conference ECCM-ECFD 2018*, Glasgow, UK.
- April 16–19, 2018 “Active contraction of cardiac cells: a reduced model of force generation”, *INdAM Workshop on Mathematical and Numerical Modeling of the Cardiovascular System*, Rome, Italy.

May 15–19, 2017 “Multiscale topology optimization for self-assembling anisotropic materials”, *INdAM Workshop on Innovative Mathematical Models and Methods for Industrial Applications*, Rome, Italy.

#### Posters

September 2–6, 2023 “A novel computational model of cardiac electromechanics: linking sarcomere-level mechanisms with organ-level function”, *EMC2023: European Muscle Conference*, Florence, Italy.

August 24–28, 2020 “Combining Data Assimilation and Machine Learning to build data-driven models for unknown long time dynamics”, *VPH2020: Virtual Physiological Human Conference 2020 Edition*, Paris, France (*online*).

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### Organization of conferences and scientific events

June 24–26, 2024 **Minisymposium at Computational and Mathematical Biomedical Engineering - CMBE24**, *Innovative computational models and methods for the cardiac function*, Arlington, USA, Organizers: L. Dede’ (Politecnico di Milano, Italy), S. Pagani (Politecnico di Milano, Italy), F. Regazzoni (Politecnico di Milano, Italy), C. Vergara (Politecnico di Milano, Italy)

June 3–7, 2024 **Minisymposium at European Community on Computational Methods in Applied Sciences Congress - ECCOMAS 2024**, *Computational Cardiology: Modeling and Simulating the Heart*, Lisbon, Portugal, Organizers: M. Bucelli (Politecnico di Milano, Italy), S. Pagani (Politecnico di Milano, Italy), R. Piersanti (Politecnico di Milano, Italy), F. Regazzoni (Politecnico di Milano, Italy), M. Schuster (RWTH Aachen, Germany), E. Zappon (Politecnico di Milano, Italy), A. Zingaro (ELEM Biotech, Spain)

February 27 – March 1, 2024 **Minisymposium at SIAM Conference on Uncertainty Quantification**, *Algorithms and methods for PDEs in parametric or uncertain domains*, Trieste, Italy, Organizers: F. Bonizzoni (Politecnico di Milano, Italy), S. Pagani (Politecnico di Milano, Italy), S. Pezzuto (Università di Trento, Italy), F. Regazzoni (Politecnico di Milano, Italy)

August 28 – September 1, 2023 **Minisymposium at the bi-annual congress of the Italian Society of Applied and Industrial Mathematics (SIMAI)**, *Scientific computing and data science in biomedicine*, Matera, Italy, Organizers: F. Caforio (University of Graz, Austria), E. Karabelas (University of Graz, Austria), F. Regazzoni (Politecnico di Milano, Italy), S. Pagani (Politecnico di Milano, Italy), E. Zappon (Politecnico di Milano, Italy)

August 20–25, 2023 **Minisymposium at International Congress on Industrial and Applied Mathematics (ICIAM)**, *Differential Equations meet Data: Scientific Machine Learning for Cardiovascular Applications*, Tokyo, Japan, Organizers: F. Regazzoni (Politecnico di Milano, Italy), S. Pagani (Politecnico di Milano, Italy), Francisco Sahli Costabal (Pontificia Universidad Católica de Chile), Simone Pezzuto (Università di Trento)

May 30 – June 1, 2023 **Minisymposium at Math 2 Product (M2P) Conference**, *Computational Medicine: Data-driven and physics-based tools for clinical applications*, Taormina, Italy, Organizers: F. Caforio (University of Graz, Austria), S. Pagani (Politecnico di Milano, Italy), F. Regazzoni (Politecnico di Milano, Italy), M. Strocchi (King’s College London, United Kingdom), E. Karabelas (University of Graz, Austria)

June 5–9, 2022 **Minisymposium at European Community on Computational Methods in Applied Sciences Congress - ECCOMAS 2022**, *Physics-based and data-driven methods for Computational Cardiology*, Oslo, Norway, Organizers: P. C. Africa, M. Fedele, I. Fumagalli, S. Pagani, F. Regazzoni (Politecnico di Milano, Italy)

May 27, 2022 **MOX20**, *Celebrations for the 20th anniversary of MOX*, Milano, Italy, Organizing Committee: I. Mazzieri, A. Menafoglio, F. Regazzoni, D. Riccobelli, M. Verani

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## Publications

Google Scholar <https://scholar.google.it/citations?user=9xq4ulgAAAAJ>  
ORCID <https://orcid.org/0000-0002-4207-1400>  
ResearchGate [https://www.researchgate.net/profile/Francesco\\_Regazzoni](https://www.researchgate.net/profile/Francesco_Regazzoni)  
Scopus <https://www.scopus.com/authid/detail.uri?authorId=57202447315>  
Web of Science <https://www.researcherid.com/rid/V-4074-2017>

### Published / in press

- **F. Regazzoni**, S. Pagani, M. Salvador, L. Dede', A. Quarteroni. Learning the intrinsic dynamics of spatio-temporal processes through Latent Dynamics Networks. *Nature Communications* (2024) 15: 1834  
<https://doi.org/10.1038/s41467-024-45323-x>
- N. A. Barnafi, **F. Regazzoni**, D. Riccobelli. Reconstructing relaxed configurations in elastic bodies: mathematical formulation and numerical methods for cardiac modeling. *Computer Methods in Applied Mechanics and Engineering* (2024) 423, 116845  
<https://doi.org/10.1016/j.cma.2024.116845>
- A. Zingaro, M. Bucelli, R. Piersanti, **F. Regazzoni**, L. Dede', A. Quarteroni. An electromechanics-driven fluid dynamics model for the simulation of the whole human heart. *Journal of Computational Physics* (2024) 504: 112885  
<https://doi.org/10.1016/j.jcp.2024.112885>
- M. Salvador, M. Strocchi, **F. Regazzoni**, L. Dede', S. Niederer, A. Quarteroni. Whole-heart electromechanical simulations using Latent Neural Ordinary Differential Equations. *npj Digital Medicine* (2024) 7: 90  
<https://doi.org/10.1038/s41746-024-01084-x>
- G. M. Pelagi, A. Baggiano, **F. Regazzoni**, L. Fusini, M. Alì, G. Pontone, G. Valbusa, C. Vergara. Personalized pressure conditions and calibration for a predictive computational model of coronary and myocardial blood flow. *Annals of Biomedical Engineering* (2024) 52: 1297–1312  
<https://doi.org/10.1007/s10439-024-03453-9>
- A. Tonini, C. Vergara, **F. Regazzoni**, L. Dede', R. Scrofani, C. Cogliati, A. Quarteroni. A mathematical model to assess the effects of COVID-19 on the cardiocirculatory system. *Scientific Reports* (2024) 14: 8304  
<https://doi.org/10.1038/s41598-024-58849-3>
- P. C. Africa, R. Piersanti, **F. Regazzoni**, M. Bucelli, M. Salvador, M. Fedele, S. Pagani, L. Dede', A. Quarteroni. lifex-ep: a robust and efficient software for cardiac electrophysiology simulations. *BMC Bioinformatics* (2023) 24: 389  
<https://doi.org/10.1186/s12859-023-05513-8>



- F. Mazhar, C. Bartolucci, **F. Regazzoni**, L. Dede', A. Quarteroni, C. Corsi, S. Severi. A Detailed Mathematical Model of the Human Atrial Cardiomyocyte: Integration of Electrophysiology and Cardiomechanics. *The Journal of Physiology* (2023, in press)  
<https://doi.org/10.1113/JP283974>
- A. Zingaro, C. Vergara, L. Dede', **F. Regazzoni**, A. Quarteroni. A comprehensive mathematical model for cardiac perfusion. *Scientific Reports* (2023) 13, 14220  
<https://doi.org/10.1038/s41598-023-41312-0>
- L. Ruffino, A. Santoro, S. Sparvieri, **F. Regazzoni**, D. Adebo, A. Quarteroni, C. Vergara, A. Corno. Computational analysis of cardiovascular effects of COVID-19 infection in children. *Journal of Pediatric Advance Research* (2023) 2(2), 1–10  
<http://dx.doi.org/10.46889/JPAR.2023.2204>
- M. Bucelli, **F. Regazzoni**, L. Dede', A. Quarteroni. Preserving the positivity of the deformation gradient determinant in intergrid interpolation by combining RBFs and SVD: application to cardiac electromechanics. *Computer Methods in Applied Mechanics and Engineering* (2023) 417(B), 116292  
<https://doi.org/10.1016/j.cma.2023.116292>
- M. Fedele, R. Piersanti, **F. Regazzoni**, M. Salvador, P. C. Africa, M. Bucelli, A. Zingaro, L. Dede', A. Quarteroni. A comprehensive and biophysically detailed computational model of the whole human heart electromechanics. *Computer Methods in Applied Mechanics and Engineering* (2023) 410, 115983  
<https://doi.org/10.1016/j.cma.2023.115983>
- A. Quarteroni, L. Dede', **F. Regazzoni**, C. Vergara. A mathematical model of the human heart suitable to address clinical problems. *Japan Journal of Industrial and Applied Mathematics* (2023)  
<https://doi.org/10.1007/s13160-023-00579-6>
- M. Salvador, **F. Regazzoni**, L. Dede', A. Quarteroni. Fast and robust parameter estimation with uncertainty quantification for the cardiac function. *Computer Methods and Programs in Biomedicine* (2023) 231, 107402  
<https://doi.org/10.1016/j.cmpb.2023.107402>
- M. Salvador, **F. Regazzoni**, S. Pagani, L. Dede', A. Quarteroni. Electromechanical modeling of cardiac arrhythmias. *ARGESIM Report* (2022) 17, 13–14  
<https://doi.org/10.11128/arep.17.a17074>
- S. Pagani, **F. Regazzoni**, M. Salvador, D. Fraulin, F. Zacchei, A. Quarteroni. Physics-informed Neural Networks for parameter estimation in cardiac mechanics. *ARGESIM Report* (2022) 17, 61–62  
<https://doi.org/10.11128/arep.17.a17074>
- **F. Regazzoni**, M. Salvador, L. Dede', A. Quarteroni. Neural networks based real-time simulations of cardiac electromechanics. *ARGESIM Report* (2022) 17, 27–28  
<https://doi.org/10.11128/arep.17.a17074>

- **F. Regazzoni**, S. Pagani, A. Quarteroni. Universal Solution Manifold Networks (USM-Nets): non-intrusive mesh-free surrogate models for problems in variable domains. *ASME Journal of Biomechanical Engineering* (2022) 144(12), 121004  
<https://doi.org/10.1115/1.4055285>
- F. Mazhar, **F. Regazzoni**, C. Bartolucci, C. Corsi, L. Dede', A. Quarteroni, S. Severi. A Novel Human Atrial Electromechanical Cardiomyocyte Model with Mechano-Calcium Feedback Effect. *Proceedings of Computing in Cardiology* (2022)  
<http://dx.doi.org/10.22489/CinC.2022.195>
- S. Stella, **F. Regazzoni**, C. Vergara, L. Dede', A. Quarteroni. A fast cardiac electromechanics model coupling the Eikonal and the nonlinear mechanics equations. *Mathematical Models and Methods in Applied Sciences* (2022) 32(8), 1531–1556  
<https://doi.org/10.1142/S021820252250035X>
- **F. Regazzoni**, M. Salvador, L. Dede', A. Quarteroni. A machine learning method for real-time numerical simulations of cardiac electromechanics. *Computer Methods in Applied Mechanics and Engineering* (2022) 393, 114825  
<https://doi.org/10.1016/j.cma.2022.114825>
- **F. Regazzoni**, M. Salvador, P. C. Africa, M. Fedele, L. Dede', A. Quarteroni. A cardiac electromechanics model coupled with a lumped-parameter model for closed-loop blood circulation. *Journal of Computational Physics* (2022) 457, 111083  
<https://doi.org/10.1016/j.jcp.2022.111083>
- R. Piersanti, **F. Regazzoni**, M. Salvador, A. F. Corno, L. Dede', C. Vergara, A. Quarteroni. 3D-0D closed-loop model for the simulation of cardiac biventricular electromechanics. *Computer Methods in Applied Mechanics and Engineering* (2022) 391, 114607  
<https://doi.org/10.1016/j.cma.2022.114607>
- M. Salvador, **F. Regazzoni**, S. Pagani, L. Dede', N. Trayanova, A. Quarteroni. The role of mechano-electric feedbacks and hemodynamic coupling in scar-related ventricular tachycardia. *Computers in Biology and Medicine* (2022) 142, 105203  
<https://doi.org/10.1016/j.combiomed.2021.105203>
- **F. Regazzoni**, S. Pagani, A. Cosenza, A. Lombardi, A. Quarteroni. A physics-informed multi-fidelity approach for the estimation of differential equations parameters in low-data or large-noise regimes. *Atti della Accademia Nazionale dei Lincei, Classe di Scienze Fisiche, Matematiche e Naturali. Rendiconti Lincei - Matematica e Applicazioni* (2021) 32 (3), 437–470  
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- **F. Regazzoni**, L. Dede', A. Quarteroni. Biophysically detailed mathematical models of multiscale cardiac active mechanics. *PLOS Computational Biology* (2020) 16(10), e1008294  
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- **F. Regazzoni**, L. Dede', A. Quarteroni. Active force generation in cardiac muscle cells: mathematical modeling and numerical simulation of the actin-myosin interaction. *Vietnam Journal of Mathematics* (2020) 49, 87-118  
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- **F. Regazzoni**, L. Dede', A. Quarteroni. Machine learning of multiscale active force generation models for the efficient simulation of cardiac electromechanics. *Computer Methods in Applied Mechanics and Engineering* (2020) 370, 113268  
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- **F. Regazzoni**, N. Parolini, M. Verani. Topology optimization of multiple anisotropic materials, with application to self-assembling diblock copolymers. *Computer Methods in Applied Mechanics and Engineering* (2018) 338, 562–596  
<https://doi.org/10.1016/j.cma.2018.04.035>
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- M. Bruggi, N. Parolini, **F. Regazzoni**, M. Verani. Topology optimization with a time-integral cost functional. *Finite Elements in Analysis & Design* (2017) 140C, 11–22  
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#### Under review

- **F. Regazzoni**. Stabilization of staggered time discretization schemes for 0D-3D fluid-structure interaction problems.
- **F. Regazzoni**. An optimally convergent Fictitious Domain method for interface problems.
- F. Caforio, **F. Regazzoni**, S. Pagani, E. Karabelas, C. Augustin, G. Haase, G. Plank, A. Quarteroni. Physics-informed Neural Network Estimation of Material Properties in Soft Tissue Nonlinear Biomechanical Models.
- E. Capuano, **F. Regazzoni**, M. Maines, S. Fornara, V. Locatelli, D. Catanzariti, S. Stella, F. Nobile, M. Del Greco, C. Vergara. Personalized Computational Electro-mechanics Simulations to Optimize Cardiac Resynchronization Therapy
- E. Zappon, M. Salvador, R. Piersanti, **F. Regazzoni**, L. Dede', A. Quarteroni. An integrated heart-torso electromechanical model for the simulation of electrophysiological outputs accounting for myocardial deformation
- M. Bucelli, **F. Regazzoni**, L. Dede', A. Quarteroni. Robust radial basis function interpolation based on geodesic distance for the numerical coupling of multiphysics problems

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#### Referee activity

##### Review Editor for the following journals

- Frontiers in Physiology (Section *Computational Physiology and Medicine*)

##### Referee for the following journals

- (4 papers) Computer Methods in Applied Mechanics and Engineering
- (3 papers) International J. for Numerical Methods in Biomedical Engineering
- (2 papers) Mathematical Biosciences and Engineering
- (2 papers) Mathematics
- (2 papers) Applied Mathematics and Computation

- (2 papers) *Frontiers in Physiology*
- (1 paper) *Journal of Computational Physics: X*
- (1 paper) *Nature Communications Biology*
- (1 paper) *npj Computational Materials*
- (1 paper) *Computer Methods in Biomechanics and Biomedical Engineering*
- (1 paper) *Computers and Fluids*
- (1 paper) *Computers in Biology and Medicine*
- (1 paper) *Journal of Theoretical Biology*
- (1 paper) *Biocybernetics and Biomedical Engineering*
- (1 paper) *Zeitschrift für Angewandte Mathematik und Mechanik*
- (1 paper) *Mathematics in Action*
- (1 paper) *Computational Methods in Applied Mathematics*
- (1 paper) *ASME Journal of Biomechanical Engineering*

**Referee for the following funding agencies**

- French National Research Agency
- Icelandic Research Fund
- National Science Centre Poland

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### Funded research projects

- 2023–2025 **Principal Investigator**, *SIDDMs: shape-informed data-driven models for parametrized PDEs, with application to computational cardiology*, Italian Ministry of Education, University and Research, MIUR PRIN 2022 PNRR, 224 873.44 €
- 2023–2026 **Participant (co-investigator)**, *DESTRO - Dextrous, strong yet soft robots*, MAECI - Ministero degli Affari Esteri e della Cooperazione Internazionale, 395 396 €
- 2023–2024 **Participant**, *Modelli matematici e metodi numerici per la medicina computazionale in patologie cardiovascolari*, Research Project GNCS - INdAM, 2300 €
- 2022–2023 **Principal Investigator**, *Development of synergies between Scientific Computing and Machine Learning for biomedical applications*, Research Project GNCS - INdAM, 2400 €
- 2020–2022 **Member**, *Mathematical modeling of the effects of COVID-19 on the cardiac function*, Italian Ministry of Education, University and Research, MIUR FISR2020IP\_03420
- 2019–2023 **Member**, *iHEART - An Integrated Heart Model for the simulation of the cardiac function*, European Research Council (ERC) grant agreement No 740132, P.I. Prof. A. Quarteroni
- 2019–2022 **Member**, *Mathematics of active materials: From mechanobiology to smart devices*, Italian Ministry of Education, University and Research, MIUR PRIN17 2017KL4EF3

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### Membership in scientific societies

I am currently member or I have been member of the following societies.

- **EMS** – European Mathematical Society
- **IACM** – International Association for Computational Mechanics
- **ESB** – European Society of Biomechanics
- **VPHi** – Virtual Physiological Human Institute
- **SIMAI** – Società Italiana di Matematica Applicata e Industriale (Italian Society of Applied and Industrial Mathematics)
- **Polimi Alumni** – International network of former Politecnico di Milano students
- **UMI** – Unione Matematica Italiana (Italian Mathematical Union)
- **GNCS** – Gruppo Nazionale per il Calcolo Scientifico (National Group for Scientific Computing), INdAM – Istituto Nazionale di Alta Matematica
- **ASP Alumni** – International network of former ASP (Alta Scuola Politecnica) students
- **AIM** – Associazione Ingegneri Matematici (Mathematical Engineers Association)

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## Research interests

My research interests focus on the numerical approximation of PDEs for multiphysics problems and on the mathematical-physical modeling of multiscale problems, in particular in the field of cardiac modeling. I am also interested in the combined use of physics-based and data-driven modeling and in the application of Machine Learning in the fields of Scientific Computing and Reduced Order Modeling.

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## Teaching

### PhD courses

2023-2024 **Lecturer**, *Foundations and Applications of Machine Learning in Scientific Computing*, Politecnico di Torino, 21 h, English language

### MSc courses

2023-2024, **Teaching assistant**, *Numerical Analysis for Partial Differential Equations (Mathematical Engineering)*, Prof. Paola Antonietti, 48 h, 10 CFU, English language

2022-2023, **Teaching assistant**, *Numerical Analysis for Partial Differential Equations (Mathematical Engineering)*, Prof. Alfio Quarteroni, 48 h, 10 CFU, English language

2022-2023, **Teaching assistant**, *Numerical Analysis for Machine Learning (Mathematical Engineering)*, Prof. Edie Miglio, 33 h, 10 CFU, English language

2021-2022, **Teaching assistant**, *Numerical Analysis for Partial Differential Equations (Mathematical Engineering)*, Prof. Alfio Quarteroni, 48 h, 10 CFU, English language

2021-2022, **Course projects tutor**, *Numerical Analysis for Partial Differential Equations (Mathematical Engineering)*, Prof. Alfio Quarteroni, 20 h, 10 CFU, English language

2021-2022, **Teaching assistant**, *Numerical Analysis for Machine Learning (Mathematical Engineering)*, Prof. Edie Miglio, 33 h, 10 CFU, English language

2020-2021, **Teaching assistant**, *Numerical Analysis for Partial Differential Equations* (Mathematical Engineering), Prof. Alfio Quarteroni, 48 h, 10 CFU, English language

2020-2021, **Course projects tutor**, *Numerical Analysis for Partial Differential Equations* (Mathematical Engineering), Prof. Alfio Quarteroni, 20 h, 10 CFU, English language

2020-2021, **Teaching assistant**, *Numerical Analysis for Machine Learning* (Mathematical Engineering), Prof. Edie Miglio, 33 h, 10 CFU, English language

2019-2020, **Teaching assistant**, *Numerical Analysis for Partial Differential Equations* (Mathematical Engineering), Prof. Alfio Quarteroni, 48 h, 10 CFU, English language

2019-2020, **Course projects tutor**, *Numerical Analysis for Partial Differential Equations* (Mathematical Engineering), Prof. Alfio Quarteroni, 20 h, 10 CFU, English language

2018-2019, **Course projects tutor**, *Numerical Analysis for Partial Differential Equations* (Mathematical Engineering), Prof. Paola Antonietti, 20 h, 10 CFU, English language

2017-2018, **Teaching assistant**, *Numerical Methods for Partial Differential Equations* (Civil Engineering), Prof. Luca Bonaventura, 48 h, 12 CFU, English language

#### **BSc courses**

2023-2024, **Lecturer**, *Numerical Methods* (Biomedical Engineering), 20 h, 5 CFU, Italian language

2022-2023, **Lecturer**, *Numerical Methods* (Biomedical Engineering), 20 h, 5 CFU, Italian language

2020-2021, **Teaching assistant**, *Numerical Methods* (Biomedical Engineering), Prof. Alfio Quarteroni, 20 h, 5 CFU, Italian language

2017-2018, **Teaching assistant**, *Applied Numerical Analysis* (Aerospace Engineering), Prof. Luca Dede', 48 h, 10 CFU, Italian language

2016-2017, **Teaching assistant**, *Applied Numerical Analysis* (Aerospace Engineering), Prof. Luca Dede', 48 h, 10 CFU, Italian language

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#### National or international patents

##### **Approved**

- Office: UIBM - Ufficio Italiano Brevetti e Marchi
- Application n.: 102020000015619 (Date: 29/06/2020)
- Inventors: Dede' Luca, Quarteroni Alfio, Regazzoni Francesco
- Title: *Metodo implementato mediante computer per la generazione di un modello matematico a complessità computazionale ridotta*

##### **Pending**

- Office: World Intellectual Property Organization
- Application n.: WO 2022/003509 A1 (Date: 06/01/2022)
- Inventors: Dede' Luca, Quarteroni Alfio, Regazzoni Francesco
- Title: *Computer-implemented method for the generation of a mathematical model with reduced computational complexity*

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## Software contributions

My GitHub profile (<https://github.com/FrancescoRegazzoni>) contains some software codes that I made publicly available. A list of the libraries I contributed to is reported below.

- Main developer **model-learning**  
<http://model-learning.rtf.d.io/>  
Open source MATLAB library for Machine Learning and data-driven discovery of differential equations and for Model Order Reduction of time-dependent problems.
- Main developer **cardioemulator**  
<http://cardioemulator.rtf.d.io/>  
Open source PYTHON library that allows to construct zero-dimensional emulators of the cardiac electromechanical function.
- Contributor **life<sup>x</sup>**  
<https://lifex.gitlab.io>  
High-performance Finite Element library mainly focused on mathematical models and numerical methods for cardiac applications, written in C++ (C++17 standard) and based on the deal.II finite element core.
- Contributor **LifeV**  
<https://bitbucket.org/lifev-dev/lifev-release/wiki/Home>  
Open source C++ library for the numerical solution of PDEs with the Finite Element Method (FEM), with a focus on applications in life sciences.

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## Divulcation activities

- Participation in the podcast “Il cuore matematico: Alfio Quarteroni racconta iHeart”.
- “Un glossario per l’intelligenza artificiale: da Algoritmo a Unsupervised Learning” (A glossary for artificial intelligence: from Algorithm to Unsupervised Learning). Article on [www.agendadigitale.eu](http://www.agendadigitale.eu).
- “IA in ambito industriale: i domini di applicazione” (AI in Industry: application domains). Article on [www.agendadigitale.eu](http://www.agendadigitale.eu).
- “Intelligenza artificiale: i concetti chiave per comprenderla meglio” (Artificial Intelligence: key concepts to better understand it). Article on [www.agendadigitale.eu](http://www.agendadigitale.eu).
- “A twin heart”. Interview by F. Pietrangeli on *Frontiere – Journey into the research world*.
- MEETmeTONIGHT – “Faccia a Faccia con la Ricerca” (Face to face with Research).
- “The role of artificial intelligence and machine learning in the iHEART project”. Interview by S. Moraca on iHEART YouTube Channel.

*In compliance with the Italian legislative Decree no. 196 dated 30/06/2003, I hereby authorize you to use and process my personal details contained in this document.*