

PERSONAL INFORMATION

Massimiliano Martinelli

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EMPLOYEMENTS

November 30, 2018 – Today

Researcher (permanent position)

Istituto di Matematica Applicata e Tecnologie Informatiche “Enrico Magenes” - CNR, Pavia

June 3, 2014 – November 29,
2018

Technologist (temporary position)

Istituto di Matematica Applicata e Tecnologie Informatiche “Enrico Magenes” - CNR, Pavia

Object of the employment contract: *“Development and maintenance of object-oriented libraries for the numerical simulation of partial differential equations with isogeometric analysis, with particular attention to nonlinear elasticity. Interface with CAD systems or with solvers of various kinds, parallelization and testing on various problems of application interest”.*

January 7, - May 31, 2014

Research grant

Istituto di Matematica Applicata e Tecnologie Informatiche “Enrico Magenes” - CNR, Pavia

Grant subject: “Development of isogeometric methods and their applications in the field of nonlinear elasticity”.

January 1, 2011 - December 31,
2013

Collaboration agreement

Department of Mathematics - Università degli Studi di Pavia

Object of the contract: *“Isogeometric discretizations for the continuum mechanics”.*

January 1, 2010 - December 31,
2010:

Research grant

Department of Mathematics - Università degli Studi di Pavia

Grant subject: “Isogeometric analysis: algorithms and their implementation”.

January 1, 2008 - December 31,
2008:

Research grant

INRIA-Sophia Antipolis (Francia)

My work concerned the development and the adaptation of existing CFD codes for calculating the *adjoint state* of non-stationary flows, using techniques and programs for Automatic Differentiation. Responsible: Jean-Antoine Desideri.

January 1, 2007 - December 31,
2007:

Research grant

INRIA-Sophia Antipolis (Francia)

My work concerned the study and development of new methods and algorithms for calculating Hessian matrices of functions subject to non-linear constraints, using techniques and programs for Automatic Differentiation. Responsible: Alain Dervieux.

TEACHING ACTIVITIES

- Academic year 2023-2024 **Course: “Applied Mathematics” (48 hours, 6 CFU). Master’s degree in “Civil Engineering for Mitigation of Risk from Natural Hazards”**
Università degli Studi di Pavia.
- Academic year 2022-2023 **Course: “Applied Mathematics” (48 hours, 6 CFU). Master’s degree in “Civil Engineering for Mitigation of Risk from Natural Hazards”**
Università degli Studi di Pavia.
- Academic year 2021-2022 **Course: “Elements of Scientific Computing for Engineering” (84 hours, 12 CFU). Degree course in Civil and Environmental Engineering.**
Università degli Studi di Pavia.
- Academic year 2020-2021 **Course: “Elements of Scientific Computing for Engineering” (84 hours, 12 CFU). Degree course in Civil and Environmental Engineering.**
Università degli Studi di Pavia.
- Academic year 2019-2020 **Course: “Elements of Scientific Computing for Engineering” (56 hours, 12 CFU). Degree course in Civil and Environmental Engineering.**
Università degli Studi di Pavia.
- Academic year 2014-2015 **15 seminars for the “Mathematical Analysis” course. Degree course in Civil and Environmental Engineering.**
Università degli Studi di Pavia.
- Academic year 2013-2014 **15 seminars for the “Mathematical Analysis 1” course. Degree course in Construction Engineering and Architecture.**
Università degli Studi di Pavia.
- Academic year 2012-2013 **Course: “Mathematical Models and Numerical Computations (Numerical computations)”**
Università degli Studi di Pavia.
- Academic year 2012-2013 **4 seminars for the “Mathematical Analysis 1” course. Degree course in Construction Engineering and Architecture.**
Università degli Studi di Pavia.
- Academic year 2011-2012: **4 seminars for the “Mathematical Analysis 1” course. Degree course in Construction Engineering and Architecture.**
Università degli Studi di Pavia.
- Academic year 2009-2010: **Course: “Mathematics”**

Faculty of Agriculture - Università Politecnica delle Marche (Ancona).

Academic year 2008-2009: **Course: “Analytical and Numerical Solutions Applied to Environmental Engineering”**

Faculty of of Engineering - Università Politecnica delle Marche (Ancona).

PARTICIPATION IN RESEARCH PROJECTS

2015-2022 **CHANGE**

European Research Council

Research project H2020 “New CHallenges for (adaptive) PDE solvers: the interplay of ANalysis and Geometry - CHANGE”, grant agreement n. 694515, coordinated by Prof. A. Buffa (EPFL).

2013-2018 **CAxMan**

Horizon 2020

Computer Aided Technologies for Additive Manufacturing. Grant agreement ID: 680448.

EDUCATION

January 2004 - December 2007 **PhD. in “Mathematics for the Technology and the Industry”**

Scuola Normale Superiore di Pisa

Thesis: “Sensitivity Evaluation in Aerodynamic Optimal Design”.

Final mark: 70/70 cum laude

Supervisors: F. Beux (Scuola Normale Superiore, Pisa), A. Dervieux (INRIA Sophia Antipolis).

Examining commission: Prof. M. Giles (Oxford University), Prof. M. Masmoudi (Université Paul Sabatier, Toulouse), Prof. S. Marmi (Scuola Normale Superiore, Pisa), Prof. J. Blum (Université de Nice - Sophia Antipolis).

Note: The thesis was carried out in co-supervision with the University of Nice-Sophia Antipolis, from which I obtained the title of “Docteur en Sciences/spécialité: Mathématiques”.

January 2003 - December 2003 **Master of II level in Mathematics for the Applications**

Università degli Studi di Bologna

Internship at the “Quantitative Finance” unit of Capitalia S.p.a. (Rome), where I worked on the development of a computational library for the pricing and hedging of complex financial derivatives. In particular, I worked on MonteCarlo and Quasi-MonteCarlo methods for integrating functions in high-dimensional spaces.

Academic year 1999-2000 **Master Degree in Astronomy**

Università degli Studi di Bologna

Final mark: 110/110 cum laude

Thesis: “Modello di emissione polarizzata di sincrotrone Galattico e tecniche di rimozione da CMBP” (“Galactic synchrotron polarized emission model and CMBP removal techniques”)

Supervisor: Prof. Antonio Messina

PERSONAL SKILLS

Mother tongue Italian

Other languages	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken interaction	Spoken production	
English	C1	C1	C1	C1	C1

- IT skills**
- Maintainer and main developer of the Rust library “FTL-Functional Tensor Library” for “functional- and tensor-train” decomposition (<https://gitlab.com/max.martinelli/functional-tensor-library>)
 - Maintainer and main developer of the C++20 library “IGATOOLS” (<http://www.igatools.org>) for the numerical solution of partial differential equations with isogeometric methods.
 - Excellent knowledge of Unix-like systems (Linux, macOS). Good knowledge of Windows systems.
 - Excellent knowledge of the following programming languages: Rust, C++20, C, Matlab, Octave, Bash.
 - Good knowledge of the following programming languages: Fortran, Python.
 - Excellent knowledge of the following compilers: Intel (icc, icpc, ifort), GNU (gcc, g++, gfortran) and CLang/LLVM
 - Excellent knowledge of the following libraries: Boost, Eigen, Trilinos, Intel MKL, Intel TBB, BLAS, LAPACK, ATLAS, PETSc, SPARSEKIT, MTL4, GSL, OpenMP, VTK.
 - Good knowledge of the geometric modeler IRIT.
 - Good knowledge of the following programs for symbolic computation: Maple, Mathematica.
 - Excellent knowledge of the following tools/programs for software development: VSCode, git, gdb, valgrind, cargo.

SCIENTIFIC INTERESTS

Low-rank/functional tensor train decompositions and applications to multi-dimensional quadrature and to numerical solution of ODEs and PDEs. Isogeometric analysis and algorithms for efficient quadrature. Numerical methods for the solution of partial differential equations. High performance computing Development and optimization of code/libraries for scientific computing. High-order differentiation with automatic differentiation programs.

PROFESSIONAL NETWORK

- Scientific collaborations**
1. G. M. Manzini, Los Alamos National Laboratory (USA)
 2. A. Buffa, Ecole Polytechnique Fédérale de Lausanne
 3. G. Sangalli, Università degli Studi di Pavia
 4. C. Lovadina, Università degli Studi di Pavia
 5. P. Antolin, Ecole Polytechnique Fédérale de Lausanne
 6. L. Tamellini, IMATI - CNR, Pavia
 7. M. Tani, IMATI - CNR, Pavia
 8. C. Giannelli, Università degli Studi di Firenze
 9. T. Kanduč, Università di Ljubljana
 10. M. S. Pauletti, IMAL - CONICET, Santa Fe (Argentina)
 11. L. Beirão da Veiga, Università degli Studi di Milano-Bicocca
 12. Alain Dervieux, INRIA Sophia Antipolis - Méditerranée (Francia)
 13. Régis Duvigneau, INRIA Sophia Antipolis - Méditerranée (Francia)

- Scientific visits**
1. *Los Alamos National Laboratories, Los Alamos (New Mexico, USA), Dr. G. M. Manzini: July 3-23, 2023.*
 2. *Instituto de Matemática Aplicada del Litoral (IMAL) - CONICET, Santa Fe (Argentina), Dr. M. S. Pauletti: March 15-23, 2017.*
 3. *Instituto de Matemática Aplicada del Litoral (IMAL) - CONICET, Santa Fe (Argentina), Dr. M. S. Pauletti: August 6-13, 2015.*

PUBLICATIONS

- Papers in preparation or submitted**
1. M. Martinelli, G. M. Manzini. A Functional Tensor Train Library in Rust for Numerical Applications.
 2. A. Bressan, M. Martinelli, G. Sangalli. Redundant B-splines for flexible and efficient Isogeometric Analysis.
 3. L. Seelinger et. al. Democratizing Uncertainty Quantification.
- Papers on international journals (peer-reviewed)**
1. C. Giannelli, T. Kanduč, M. Martinelli, G. Sangalli, M. Tani. Weighted quadrature for hierarchical B-splines. *Computer Methods in Applied Mechanics and Engineering*, Vol.400, 2022, <https://www.sciencedirect.com/science/article/pii/S0045782522004960>.
 2. L. Tamellini, M. Chiumenti, C. Altenhofen, M. Attene, O. Barrowclough, M. Livesu, F. Marini, M. Martinelli, V. Skytt. Parametric shape optimization for combined additive-subtractive manufacturing. *JOM*, Vol. 1, pp. 448-457, 2020.
 3. P. Antolín, A. Buffa, M. Martinelli. Isogeometric Analysis on V-reps: first results. *Computer Methods in Applied Mechanics and Engineering*, 355, pp. 976–1002, 2019.
 4. M. S. Pauletti, M. Martinelli, N. Cavallini, P. Antolín. IGATOOLS: an isogeometric analysis library. *SIAM J. Sci. Comput.*, vol. 37(4), pp. 465–496, 2015.
 5. P. Antolin, A. Buffa, F. Calabrò, M. Martinelli, G. Sangalli. Efficient Matrix Computation for Tensor-Product Isogeometric Analysis: The use of Sum Factorization. *Computer Methods in Applied Mechanics and Engineering*, vol. 285, pp. 817–828, 2015.
 6. L. Beirão da Veiga, A. Buffa, C. Lovadina, M. Martinelli, and G. Sangalli. An isogeometric method for the Reissner-Mindlin plate bending problem. *Computer Methods in Applied Mechanics and Engineering*, vol. 209-212, pp. 45-53, 2012.
 7. A. Dervieux, M. Martinelli, L. Hascoët, V. Pascual, A. Belme. AD-based perturbation methods for uncertainties and errors. *International Journal of Engineering Systems Modelling and Simulation*, vol.2(1-2):65-74, 2010, Inderscience Enterprise Ltd.
 8. M. Martinelli, R. Duvigneau. On the use of second-order derivatives and metamodel-based Monte-Carlo for uncertainty estimation in aerodynamics. *Computer & Fluids*, Vol. 39, No 6, 2010.
 9. M. Martinelli, F. Beux, Multi-level gradient-based methods and parametrisation in aerodynamic shape design. *Revue Européenne de Mécanique Numérique - European Journal of Computational Mechanics*, vol.17(1-2):169-197, 2008, Hermes Science Publications - Lavoisier.
- Book chapters**
10. N. Cavallini, O. Weeger, M. S. Pauletti, M. Martinelli, P. Antolín. Effective integration of sophisticated operators in isogeometric analysis with igatools. *Lecture Notes in Computational Science and Engineering*, vol. 107, pp. 209–230, 2015.
 11. R. Duvigneau, M. Martinelli, P. Chandrashekarappa. Estimation d’incertitude en aérodynamique” Optimisation Multidisciplinaire en Mécanique 2, Hermes Science Publications - Lavoisier, 2008.
 12. M. Martinelli, L. Hascöet. Tangent-on-Tangent vs. Tangent-on-Reverse for Second Differentiation of Constrained Functionals. *Advances in Automatic Differentiation, Lecture Notes in Computational Science and Engineering*, vol. 64, Springer, 2008.

- Conference proceedings**
13. Martinelli, M., Manzini, G. A Functional Tensor Train Library in RUST for Numerical Integration and Resolution of Partial Differential Equations. In: Lirkov, I., Margenov, S. (eds) Large-Scale Scientific Computations. LSSC 2023. Lecture Notes in Computer Science, vol 13952. Springer, Cham. https://doi.org/10.1007/978-3-031-56208-2_22
 14. M. Martinelli, R. Duvigneau. Comparison of second-order derivatives and metamodel-based Monte-Carlo approaches to estimate statistics for robust design of a transonic wing. AIAA 2008-2071, Proceedings of the 10th AIAA Non-Deterministic Approaches Conference, April 7-10, 2008, Schaumburg (IL), USA.
 15. M. Martinelli, C. Praveen & R. Duvigneau. On the estimation of drag uncertainty. Proceedings of the 43rd AAAF Congress on Applied Aerodynamics, March 10 - 12, 2008, Poitiers, France.
 16. M. Martinelli, L. Hascœt, A. Dervieux. Strategies for computing second-order derivatives in CFD design problems. Proc. of West-East High Speed Flow Field Conference", Mosca, Russia, 19-22 November 2007.
 17. M. Martinelli, F. Beux. Multilevel gradient method with Bézier parametrisation for aerodynamic shape optimisation. Communications to SIMAI Conferences (ISSN 1827-9015).
 18. M. Martinelli, F. Beux. Optimum shape design through multilevel gradient-based method using Bézier parametrisation. The Fourth International Conference on Computational Fluid Dynamics, 10-14 July 2006, Ghent, Belgium.
 19. M. Martinelli, F. Beux. Multilevel gradient-based methods in aerodynamic shape design. ESAIM: PROCEEDINGS, (22):175-180, October 2007, EDP Sciences.
- Software**
20. M. Martinelli, M. S. Pauletti, P. Antolin. *IGATOOLS: an isogeometric analysis library v.1.99.* <http://www.igatools.org>, 2012-2016.
- Thesis**
21. M. Martinelli. Sensitivity Evaluation in Aerodynamic Optimal Design. Tesi di Perfezionamento in "Matematica per la Tecnologia e l'Industria", Scuola Normale Superiore di Pisa, 2007.
 22. M. Martinelli. Modello di emissione polarizzata di sincrotrone Galattico e tecniche di rimozione da CMBP. Tesi di Laurea in Astronomia, Università degli Studi di Bologna, 2001.

CONFERENCES

- Invited talks
1. "A Functional Tensor Train Library in RUST for Numerical Integration and Resolution of Partial Differential Equations". Large-Scale Scientific Computations (LSSC) 2023, Sozopol (Bulgaria), June 5-9, 2023.
 2. "Weighted quadrature rules for hierarchical B-splines". Eccomas 2022: 8th European Congress on Computational Methods in Applied Sciences and Engineering, Oslo (Norway), June 5-9, 2022.
 3. "Weighted quadrature rules for hierarchical B-splines". VIGA 2021: Virtual International conference on Isogeometric Analysis, Lyon (France), September 26-29, 2021.
 4. "New automatic approaches for IGA on trimmed 2D and 3D domains". IGA2018: Integrating Design and Analysis, Austin (Texas, USA), October 10-12, 2018.
 5. "IGATOOLS: a general purpose C++14 library for Isogeometric Analysis". PDESoft2016, University of Warwick (Gran Bretagna), July 4-8, 2016.
 6. "Efficient matrix assembly for isogeometric analysis using IGATOOLS". 3rd International Conference on Isogeometric Analysis, Throndeim (Norvegia), June 1-3, 2015.
 7. "Efficient matrix assembly for isogeometric analysis using IGATOOLS". 6th International Conference on Computational Methods in Applied Mathematics (CMAM 6), St. Wolfgang (Austria), September 28, -October 4, 2014.
 8. "Using IGATOOLS in industrial environments: integration with existing CAD systems and Finite Element solvers ". 11th World Congress on Computational Mechanics (WCCM XI), Barcelona (Spagna), July 20-25, 2014.
 9. "Isogeometric techniques for elastic problems". 17th European Conference on Mathematics for Industry 2012, Centre for Mathematical Sciences, Lund (Svezia), July 23-27, 2012.
 10. "GeoPDEs++: a new code for Isogeometric Analysis". "Isogeometric Analysis 2011: Integrating Design and Analysis", The University of Texas at Austin, Texas (USA), 13-15 January 2011.
 11. "Error correction of numerical solutions using Automatic Differentiation and adjoint states". 4th NODESIM meeting, CIMNE-Barcelona Supercomputing Center, Barcelona (SP), 24-25 November 2008.
 12. "Applications of adjoint states to several problems in computational fluid dynamics". 1st INRIA/LJAD seminar, INRIA, Sophia Antipolis (France), October 14, 2008.
 13. "Tangent-on-Tangent vs. Tangent-on-Reverse for Second Differentiation of Constrained Functionals". 5th International Conference on Automatic Differentiation, Bonn (Germania), August 11-15, 2008.
 14. "Adjoint methods for unsteady problems using Automatic Differentiation". 3rd NODESIM meeting, QinetiQ, Farnborough (UK), May 20-21, 2008.
 15. "Comparison of second-order derivatives and metamodel-based Monte-Carlo approaches to estimate statistics for robust design of a transonic wing". 10th AIAA Non-Deterministic Approaches Conference, Schaumburg, IL (USA), April 7-10, 2008.
 16. "Second Derivatives of constrained functional using Adjoint methods and Automatic Differentiation". 2nd NODESIM meeting, INRIA, Sophia-Antipolis (France), 26-27 November 2007.
 17. "Second derivatives via Tangent-on-Tangent and Tangent-on-Reverse". 6th European AD Workshop, INRIA, Sophia Antipolis, 15-16 November 2007.
 18. "Hessian computation of constrained functionals using Automatic Differentiation". 5th European AD Workshop, University of Hertfordshire, Hatfield (UK), May 21-22, 2007.
 19. "Perturbation techniques in not-deterministic simulations with Adjoint methods and Automatic Differentiation". 1st NODESIM meeting, Dassault Aviation, Paris (France), May 10-11, 2007.
 20. "Multilevel gradient method with Bézier parametrisation for aerodynamic shape optimisation". 8th SIMAI Congress, Baia Samuele (Italy), May 22-26, 2006.