



Marco Frego

Curriculum Vitæ

Education

- 2010–2014 **PhD in Mechatronics - Dottorato di Ricerca in Meccatronica**, *University of Trento*, Trento.
Thesis: Numerical Methods for Optimal Control Problems with Applications to Autonomous Vehicles, rel. prof. E. Bertolazzi and F. Biral.
- 2008–2010 **M.S. in Mathematics - Laurea Specialistica in Matematica**, *University of Trento*, Trento, *110/110 cum laude*. Awarded with *Diploma Supplement and Borsa di Merito*.
Thesis: Decoding error probability and related bounds (in Italian), rel. prof. M. Sala.
- 2004–2008 **B.S. in Mathematics - Laurea Triennale in Matematica**, *University of Trento*, Trento, *108/110*.
Thesis: Key Schedule and Symmetric Cryptography (in Italian), rel. prof. A. Caranti.
- 1999–2004 **Liceo Classico (Classical Lyceum)**, Liceo Classico Statale G. Carducci, Bolzano, *100/100*.
 - Award Dante Alighieri for Italian language
 - Award Virgilio for translations from ancient Greek and Latin.Thesis: Plague in literature (in Italian), rel. prof. M. Bianchin.

Experiences

- 2020–2023 **RTD-A**, *Free University of Bolzano - FaST*, Bolzano.
Research in the area of robotics and automation, ref. prof. A. Peer
Teaching: course of Systems and Control Lab.
- 2018–2020 **Post-Doc**, *University of Trento - DII/DISI*, Trento.
Research in the area of robotics, EIT-Digital Project Award, PI prof. L. Palopoli.
Research in the area of autonomous vehicles, EU Project Safe Strip <http://safestrip.eu/>, PI prof. F. Biral
Teaching: contract professorship in Numerical Analysis, ref. prof. E. Bertolazzi.
- 2017–2018 **Post-Doc**, *University of Trento - DISI*, Trento.
Research in the area of robotic walking assistant for elder adults, EU Project Acanto, <http://www.ict-acanto.eu>, ref. prof. L. Palopoli.
Research in the area of autonomous vehicles, EU Project Safe Strip <http://safestrip.eu/>, ref. prof. F. Biral
Teaching: contract professorship in Numerical Analysis, ref. prof. E. Bertolazzi.

- 2015–2017 **Post-Doc**, *University of Trento - DISI*, Trento.
Research in the area of Hybrid Control System (HCS), steering a robotic autonomous car on a known track, prof. L. Zaccarian.
- 2014–2015 **Post-Doc**, *Technische Universität Hamburg-Harburg (Hamburg University of Technology)*, Hamburg, Germany.
Instructor of Linear Algebra and researcher in Numerical Linear Algebra, Hierarchical Matrices, Scientific Parallel Computing, prof. S. LeBorne
- 2015 **Developer**, *DII - Univ. of Trento*, Trento.
Smoothing noise affected sampled data.
- 2010-2011 **Developer**, *Lab. of Mechatronics of Univ. of Trento*, Trento.
Design and speed-up optimization of a human garment for 3D body reconstruction with implementation of Error Correcting Codes. The project is now adopted in Hospital Santa Chiara, Trento, for physical therapy and rehabilitation. EU Project Veritas <http://veritas-project.eu/>
- 2010 **Consultancy agreement**, *Lab. of Industrial Mathematics and Cryptography*, Trento.
With prof. M. Sala, on the security of a system of electronic payment for a third party.
- 2009 **Stage**, *Integrated Device Technology IDT*, Milan, Decoding performances of cyclic codes of long length (16000 bits) applied in solid state disk SSD.

PhD and Post-Doc activities

- Main Research** Path planning of vehicle trajectories with clothoid curves, cubic splines (smoothing, interpolation, exact length) for non holonomic robots. Study of semi-analytic techniques that reduce the computational burden of trajectory optimisation on lean hardware (embedded systems). The application of these techniques is in the field of assistive robots (walkers) and to autonomous vehicles, within the framework of the interaction human-machine.
- Related research** The focus are OCP problems related to mechanical systems with the indirect variational approach and their related implications in numerical linear algebra. Manoeuvre optimization of vehicles, comparison of the available open-source OCP software (ACADO, ICLOCS, GPOPS) tested on critical examples. Contribution in the development of the OCP software of Univ. of Trento XOptima. The main application of those techniques is in the development of assistive robots like human walkers.
- Other interests** Application of Error Correcting Codes (ECC) and Cryptography, Groebner Bases. Astrodynamics, participations to the Global Trajectory Optimization Competition (GTOC), Finite Element Method.

Patents

- Patent** Dispositivo e metodo per la ricostruzione discreta di forma e posizione tridimensionale. N.0001423079 Ministero dello Sviluppo Economico, Ufficio Italiano Brevetti e Marchi. A device for the discrete 3D reconstruction of shapes and positions.

Projects

EU - FSE 2020/21 Automation with Programmable Logic Controllers - with prof. A. Peer and her collaborators.

Teaching Experience

Acad. Year 2020/2021 Lecturer for the course of *Systems and Control Lab*, in English, for the Bachelor degree in Automation, Free Univ. of Bolzano

Acad. Year 2019/2020 Lecturer/Assistant for the course of *Computational Methods for Mechatronics*, in English, for the Laurea Magistrale (Master degree) in Mechatronics, Univ. of Trento

Acad. Year 2018/2019 Lecturer/Assistant for the course of *Computational Methods for Mechatronics*, in English, for the Laurea Magistrale (Master degree) in Mechatronics, Univ. of Trento

Acad. Year 2017/2018 Docente con titolarità for the course of *Fondamenti di Informatica e Calcolo Numerico* (prof. in Numerical Analysis), in Italian, for the Laurea Triennale in Ingegneria Industriale, (Bachelor degree in Industrial Engineering) Univ. of Trento

Acad. Year 2017/2018 Lecturer/Assistant for the course of *Computational Methods for Mechatronics*, in English, for the Laurea Magistrale (Master degree) in Mechatronics, Univ. of Trento

Acad. Year 2016/2017 Docente con titolarità for the course of *Fondamenti di Informatica e Calcolo Numerico* (prof. in Numerical Analysis), in Italian, for the Laurea Triennale in Ingegneria Industriale, (Bachelor degree in Industrial Engineering) Univ. of Trento

Acad. Year 2015/2016 Lecturer/Assistant for the course of *Fondamenti di Informatica e Programmazione*, in Italian, for the Laurea Triennale in Ingegneria Industriale, Univ. of Trento

Acad. Year 2014/2015 Lecturer for the course of *Numerical Linear Algebra*, in German and English, for the Bachelor Degree in Engineering at the Technical University of Hamburg (TUHH), Germany

Acad. Year 2013/2014 Lecturer/Assistant for the course of *Numerical Methods for Dynamic Systems and Control*, in English, for the Laurea Magistrale in Mechatronics, Univ. of Trento

Instructor for the course of *Mathematics and Statistics I*, in Italian, for the Laurea Triennale in Biotechnology, Univ. of Trento

Acad. Year 2012/2013 Lecturer/Assistant for the course of *Numerical Methods for Dynamic Systems and Control*, in English, for the Laurea Magistrale in Mechatronics, Univ. of Trento

Instructor for for the course of *Mathematics and Statistics I*, in Italian, for the Laurea Triennale in Biotechnology, Univ. of Trento

Acad. Year 2011/2012 Lecturer/Assistant for the course of *Numerical Methods for Dynamic Systems and Control*, in English, for the Laurea Magistrale in Mechatronics, Univ. of Trento

Acad. Year 2010/2011 Instructor for the course of *Coding Theory*, in English, for the Laurea Magistrale in Mathematics, Univ. of Trento

[Further Data, Entrepreneurship, etc.](#)

MathNow Co-founder of the Laboratory of Industrial Mathematics and Cryptography, with prof. M. Sala and prof. E. Bertolazzi.

Academic Formation

Doctoral Courses

- Control System Design and Implementation, held by prof. J.Conklin (Univ. Stanford)
- Nonlinear dynamic optimization, held by prof. M.Diehl (Optec and Univ. Leuven)
- Scientific programming in C / C++, held by prof. E.Bertolazzi (Univ. Trento)
- Mathematical Control Theory, held by prof. F.Bagagiolo (Univ. Trento)
- Advanced Differential Cryptanalysis, held by prof. M.Sala (Univ. Trento)
- Object oriented modeling, held by prof. Casella and Ferretti (Politecnico Milan)
- Numerical Optimization, held by prof. E.Bertolazzi (Univ. Trento)
- Mathematical Methods for Engineering, held by prof. A.Valli (Univ. Trento)
- Solution of optimal control problems: theory and applications, held by prof. E.Bertolazzi and F.Biral (Univ. Trento)
- Security of stream ciphers, held by prof. M.Sala (Univ. Trento)

Advanced Seminars, Workshops and Conferences

- Workshop Cryptography and Computer Algebra, 2008, Univ. Pisa
- PhD School Groebner bases, Geometric codes and Order Domains, 2008, held by prof. M.Sala and O.Geil (Aalborg Univ. Denmark)
- Workshop On block ciphers and their security, 2009, Univ. Trento
- PhD School Criteri matematici per la sicurezza dei crittosistemi, 2009, Univ. Trento
- Workshop BunnyTn2011, 2011, Univ. Trento
 - Seminar The Data Analysis and Final Results for the Gravity Probe B Experiment, 2011, Univ. Stanford
- Workshop La crittografia nei telefonini anti intercettazione, 2011, Univ. Trento
- Workshop Crittografia a chiave pubblica: oltre RSA, 2011, Univ. Trento
- Workshop Pagamenti elettronici e online banking: effettiva sicurezza crittografica, 2011, Univ. Trento
- Workshop Matematica applicata MATAPP 2011, 2011, Univ. Trento
- Workshop BunnyTn2011 II, 2011, Univ. Trento
- Workshop Critto PEC, crittografia nella posta elettronica certificata, 2012, Univ. Trento
- Workshop BunnyTn2012, 2012, Univ. Trento
 - Seminar Methods and codes for bound-constrained nonlinear systems, 2012, Univ. Florence
- Workshop E-payment security, 2013, Univ. Trento
- Workshop Cloud Computing, 2013, Univ. Trento
 - Seminar Advanced stability control of electric vehicle with in-wheel motor and active steering system, 2013, Univ. Tokyo
 - Seminar Recursive Low-Rank Truncation, 2014, Max Planck Institut für Mathematik in den Naturwissenschaften.
 - Seminar \mathcal{H}^2 -matrix method for boundary integral equations, 2014, Univ. Kiel.
- Workshop M.E.G.A., Effective Methods in Algebraic Geometry, 2015, Univ. Trento

- Conference ECC, European Control Conference (Chair), 2016, Aalborg, DK
- Conference CDC, Conference on Decision and Control, 2016, Las Vegas, USA
- Conference MSC-CCA, MultiConference on Systems and Control - Conference on Control and Applications, 2016, Buenos Aires, Argentina
- Workshop Controllability and Hysteresis, 2016, Univ. Trento
- Conference OptHySys, Optimization and Hybrid Systems, 2017, Univ. Trento
- Conference Cryptography and Coding, Institute of Mathematics and Applications (IMA), 2017, Univ. of Oxford, Oxford, UK
- Conference International Conference on Robotics and Automation (ICRA-2018), 2018, IEEE, Brisbane, Australia
- Conference European Control Conference (ECC-2018) - (chair), 2018, IFAC-IEEE, Limassol, Cyprus
- Conference Numerical Mathematics and its Applications (NuMa-2018), 2018, University of Torino, Turin, Italy
- Conference Meeting on Applied Scientific Computing and Tools (MASCOT2018), 2018, University of Rome - La Sapienza, Rome, Italy
- Conference European Control Conference (ECC-2020), 2020, IFAC-IEEE, St. Petersburg, Russia
- Conference International Conference on Robotics and Automation (ICRA-2020), 2020, IEEE, Paris, France
- Conference International Conference on Intelligent Robots and Systems (IROS-2020), 2020, IEEE, Las Vegas, USA

Languages

- Italian **Mother tongue**
- English **C1**
- German **C1**

Computer skills

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|-----------|--------------------------|--------------|-----------------------------|
| C/C++ | for scientific computing | Matlab,Maple | for scientific computing |
| Ruby | for scientific computing | Bash | for scripting in Unix |
| MAGMA | for finite fields | OCP oriented | Pins/XOptima, ICLOCS, GPOPS |
| Singular | for Groebner bases | ACADO | C++ interface for OCP |
| LaTeX | for typesetting | MS Office | for wysiwyg editing |
| Asymptote | for vector graphics | TIKZ | for vector graphics |
| Adobe | Photoshop/Illustrator | Dreamweaver | for web pages |

Social Mathematics - Reviewer

I collaborate with the mathematical and robotic community as referee/reviewer for

Mathematical Reviews (MR-AMS), IFAC-ECC European Control Conference, IEEE-IROS International conference on intelligent Robots and Systems, IEEE-IV intelligent vehicles, IFAC symposiums, IEEE-RAL Robotics and Automation Letters, IEEE-TAC Transactions of Automatic Control

References

Prof. A.Peer, Faculty of Science and Technology, Free Univ. of Bolzano, Laboratory for Human-centred Technology, e-mail: angelika.peer@unibz.it

Prof. L.Palopoli, Dipartimento di Scienza e Ingegneria dell'Informazione, Univ. Trento, Laboratory of Embedded Systems, e-mail: luigi.palopoli@unitn.it

Prof. L.Zaccarian, Dipartimento di Ingegneria Industriale, Univ. Trento, e-mail: luca.zaccarian@unitn.it, webpage <http://homepages.laas.fr/lzaccari/>

Prof. M.Sala, Dipartimento di Matematica, Univ. Trento, Laboratory of Industrial Mathematics and Cryptography, e-mail: maxsalacodes@gmail.com, webpage <http://www.science.unitn.it/~sala/>

Prof. E.Bertolazzi, Dipartimento di Ingegneria Industriale, Univ. Trento, e-mail: enrico.bertolazzi@unitn.it, webpage www.ing.unitn.it/~bertolaz/

Prof. F.Biral, Dipartimento di Ingegneria Industriale, Univ. Trento, e-mail: francesco.biral@unitn.it

Prof. D.Fontanelli, Dipartimento di Ingegneria Industriale, Univ. Trento, e-mail: daniele.fontanelli@unitn.it