Franco Coltraro, PhD

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Summary

I am a postdoctoral researcher at the Institute of Robotics and Industrial Informatics (IRI, CSIC-UPC). My research addresses the dynamics and control of deformable objects in robotic manipulation, with a focus on cloth. My work bridges applied mathematics and robotics through the development of differential equation-based models and the use of numerical methods and constrained optimization to simulate and control complex physical phenomena. I am a person full with curiosity and enthusiasm for new things with very good communication and personal skills.

My scientific contributions encompass 6 journal articles (all Q1 journals and 3 of them D1), 1 book chapter and 2 proceeding papers. I have given several conferences in (inter)national venues (including 3 invited talks) and have recently participated in a technology transfer project. Part of my work has also been teaching undergraduate mathematics courses, directing students in final degree projects (both bachelor's and master's) and introducing them to do research.

I started my PhD in 2018 after working in the private sector as a Data Scientist. My PhD thesis was developed as part of a prestigious European project (CLOTHILDE granted by the European Research Council) and was awarded by the *Institut d'Estudis Catalans* as the best PhD thesis in Engineering Sciences done in Catalonia during the period 2018-2023.

Work experience

- **Post-doctoral researcher** (Momentum CSIC)
  Institute of Robotics and Industrial Informatics IRI, CSIC-UPC.
  From: *July 2023 – current.*
  Project: physical simulation and modeling of textiles for planing their robotic manipulation.
  Development of predictive algorithms based on geometrical and topological methods.

- **Technology transfer**
  Real Federación Española de Fútbol (Spanish Football Federation).
  From: *September 2022 – June 2023.*
  Project: computation of a valid double round-robin tournament for LaLiga first division.
  Solution of mixed-integer optimization problems with Gurobi using *fix-and-relax* techniques.

- **PhD student in Applied Mathematics, FME**
  Universitat Politècnica de Catalunya (UPC).
  From: *April 2018 – April 2023.*
  Project: set a mathematical framework useful for cloth representation and manipulation
  using techniques from Differential Geometry, ODEs and Computational Topology.

- **Data science analyst**
  Minsait (by Indra).
  From: *September 2017 – April 2018.*
  Project: development of Machine Learning algorithms, Graph Theory models and
  Text Mining procedures for fraud detection in public administrations.

- **Research intern**
  Grupo de Comunicaciones Ópticas y Arquitectura Computadores (UPC).
  From: *September 2016 – July 2017.*
  Project: Development of mathematical models based on Differential Equations
  for the simulation of big scale Telecommunication Networks (Queuing theory).

- **Research internship (JAE Intro 2016 at CSIC)**
  Institut de Robòtica i Informàtica Industrial, CSIC-UPC.
  From: *October 2016 – December 2016.*
  Project: application of Computer Vision techniques to Computational Neuroscience,
  for the identification of synaptic partners in brain images.

Education

- **PhD in Applied Mathematics** at Universitat Politècnica de Catalunya (UPC).
  Started: April, 2018. *Defended*: 30th March, 2023.
  Doctoral thesis: *Robotic Manipulation of Cloth: Mechanical Modeling and Perception*.
  Grade: Excellent with *Cum Laude* distinction.
  Awarded with *Premi IEC de la Secció de Ciències i Tecnologia de Ciències de l'Enginyeria*.
  `http://hdl.handle.net/10803/688226`

- **Master in Advanced Mathematics and Mathematical Engineering** (MAMME), 2017.
  Universitat Politècnica de Catalunya (UPC).
  Fields: Modelling and Analysis in Science, Engineering and Statistics.
  Average grade: 8.9/10.
  Master thesis: *A logistic queue model for network traffic modelling and simulation*.
  `https://upcommons.upc.edu/handle/2117/106777`

- **Bachelor degree in Pure Mathematics** (2016) at Universidad Complutense de Madrid (UCM).
  Focus: Differential Geometry, Differential equations.
  Average grade: 9.40/10.
  Bachelor thesis: *Teorema de Poincaré-Hopf*.
  `https://docta.ucm.es/entities/publication/1471f359-a937-452c-ac13-caf0bb387cce`

Publications

Note: all Journal Impact Factors (JIF) are taken from the Journal Citation Reports (JCR).

Journal articles

- Franco Coltraro, Jaume Amorós, Carme Torras and Maria Alberich-Carramiñana: **A practical aerodynamic model for dynamic textile manipulation in robotics**. *Mechanism and Machine Theory*, Vol 209 (2025) 105993, ISSN 0094-114X. DOI: `https://doi.org/10.1016/j.mechmachtheory.2025.105993`.
  JIF: **4.5**, JIF quartile: **Q1**, JIF percentile: **82.2** (33/183). In Engineering, Mechanical (2023).

- Franco Coltraro, Júlia Borràs, Maria Alberich-Carramiñana and Carme Torras: **Tracking cloth deformation: a novel dataset for closing the sim-to-real gap for robotic cloth manipulation learning**. *International Journal of Robotics Research* (2025). DOI: `https://doi.org/10.1177/02783649251317617`
  JIF: **7.5**, JIF quartile: **Q1**, JIF percentile: **88** (6/46). In Robotics (2023).

- Franco Coltraro, Jaume Amorós, Maria Alberich-Carramiñana and Carme Torras: **A novel collision model for inextensible textiles and its experimental validation**. *Applied Mathematical Modelling*, Vol. 128 (2024); pp 287-308, ISSN 0307-904X. DOI: `https://doi.org/10.1016/j.apm.2024.01.030`.
  JIF: **4.4**, JIF quartile: **D1**, JIF percentile: **93** (10/135). In Mathematics, Interdisciplinary Applications (2023).

- Franco Coltraro, Josep Fontana, Jaume Amorós, Maria Alberich-Carramiñana, Júlia Borràs and Carme Torras: **A Representation of Cloth States based on a Derivative of the Gauss Linking Integral**. *Applied Mathematics and Computation*, Vol. 457 (2023), 128165. DOI: `https://doi.org/10.1016/j.amc.2023.128165`.
  JIF: **3.5**, JIF quartile: **D1**, JIF percentile: **97.1** (10/331). In Mathematics, Applied (2023).

- Franco Coltraro, Jaume Amorós, Maria Alberich-Carramiñana and Carme Torras: **An inextensible model for the robotic manipulation of textiles**. *Applied Mathematical Modelling*, Vol. 101 (2022), pp 832-858. DOI: `https://doi.org/10.1016/j.apm.2021.09.013`.
  JIF: **5**, JIF quartile: **D1**, JIF percentile: **91.1** (10/107). In Mathematics, Interdisciplinary Applications (2022).

- Marc Ruiz, Franco Coltraro and Luis Velasco: **CURSA-SQ: A methodology for service-centric traffic flow analysis** *Journal of Optical Communications and Networking (IEEE/OSA)*, vol. 10 (2018), pp. 773-784. DOI: `https://doi.org/10.1364/JOCN.10.000773`
  JIF: **3.9**, JIF quartile: **Q1**, JIF percentile: **81.58** (11/57). In Computer Science, Hardware and Architecture (2018).

Datasets

- Franco Coltraro, Júlia Borràs: **Tracking cloth deformation: a novel dataset for closing the sim-to-real gap for robotic cloth manipulation learning**. `https://zenodo.org/records/14644526`.

Book chapters

- Maria Alberich-Carramiñana, Jaume Amorós and Franco Coltraro. **Developable surfaces with prescribed boundary**. *Trends in Mathematics*, vol 15, pp. 127-132. Springer-Birkhäuser, 2021. DOI: `https://doi.org/10.1007/978-3-030-84800-2_21`

Proceedings

- Franco Coltraro, Jaume Amorós, Maria Alberich-Carramiñana and Carme Torras: **Reconstruction of sampled surfaces with boundary via Morse theory**. *Proceedings of CEIG'23 - Spanish Computer Graphics Conference (2023)*. The Eurographics Association, ISBN 978-3-03868-230-1. DOI: `https://doi.org/10.2312/ceig.20231146`

- Maria Alberich-Carramiñana, Jaume Amorós, Franco Coltraro, Carme Torras, and Miquel Verdaguer: **Morse cell decomposition and parametrization of surfaces from point-clouds**. *Proceedings of XVII EACA 2022 (Encuentro Álgebra Computacional y Aplicaciones)*, pp 35-38. DOI: `http://dx.doi.org/10.6035/INFiTEC.51`

Pre-prints

- Franco Coltraro, Marc Ruiz, Luis Velasco: **The logistic queue model: theoretical properties and performance evaluation**. *arXiv pre-print*: `https://arxiv.org/abs/2405.17528`

Under review

- Franco Coltraro, Jaume Amorós, Maria Alberich-Carramiñana and Carme Torras: **Topological reconstruction of sampled surfaces via Morse theory**. *Submitted to Journal of Computational and Applied Mathematics*. arXiv pre-print: `https://arxiv.org/abs/2405.17257`

Selected imparted conferences

- **Reconstruction of sampled surfaces with boundary via Morse theory**. *Spanish Computer Graphics Conference CEIG'23*. Palma de Mallorca, Spain. July 5th, 2023.

- **Contacts, friction and self-collisions for inextensible cloth**. *XXVII CEDYA 2022 (Congreso de Ecuaciones Diferenciales y Aplicaciones)*. Zaragoza, Spain. July 21th, 2022.

- **Morse cell decomposition and parametrization of surfaces from point-clouds**. *XVII EACA 2022 (Encuentro Álgebra Computacional y Aplicaciones)*. Castellón, Spain. June 21th, 2022.

- **Collisions and friction for inextensible cloth simulation**. *Conference Women in Geometry and Topology (organized by GEOMVAP)*. Barcelona, Spain. September 26th, 2019.

Invited talks

- **Modelling inextensible textiles by geometrical constraints tailored to robotic manipulation**. *Special Semester on Rigidity and Flexibility: Kinematic Aspects of Robotics.* Linz, Austria. May 2nd, 2024 (joint talk with Maria Alberich).

- **Constrained dynamics: methods, numerics and examples.** *Learning Week II: Industrial skills and advanced topics in ML (Doctoral Network: GRAPES Learning, processing and optimising shapes).* Barcelona, Spain. September 8th, 2023.

- **Experimental validation of an inextensible cloth model**. *AICA 2022 (Applications to Industry of Computational Algebra).* Barcelona, Spain. November 10th, 2022.

Awards

- **Premi IEC de la Secció de Ciències i Tecnologia de Ciències de l'Enginyeria** (en honor d'Isabel de P. Trabal i Tallada). Triennial award of 3.000 euros given by the Institut d'Estudis Catalans to the best PhD thesis on Science applied to Engineering done in Catalan territory during the last 5 years prior to 2023, April 2024.

- **Beca de Excelencia de la Comunidad de Madrid** Monetary Award for great university grades. 2012/2013, 2013/2014 and 2015/2016.

Languages and skills

- Spanish (native), English (C1-C2), German (B2), Catalan (B1) and Italian (oral).

- Python, MATLAB, R, SQL, Neo4j and LaTeX.

Participation in funded research projects

- **MOMENTUM: Virtual prototyping for robotic manipulation of garments: enhancing the capabilities of the CLOTHILDE cloth simulator**. *Financing:* Consejo Superior de Investigaciones Científicas (CSIC). *Grant number:* MMT24-IRII-01. *Duration:* 20/12/2024 until 19/12/2028. *P.I.:* Carme Torras and Maria Alberich. `https://www.iri.upc.edu/project/show/339`. *Members:* 3. *Endowment:* 400 000 euros.

- **Confección de un calendario para la primera división de fútbol**. *Financing:* Real Federación Española de Futbol. *Technology transfer project. Duration:* 01/09/2022 until 20/06/2023. *P.I.:* Carles Bonet and Antoni Susín. *Members:* 3. *Endowment:* 50 000 euros.

- **ClothIRI: Robotic Cloth Manipulation at IRI**. *Financing:* Consejo Superior de Investigaciones Científicas (CSIC). *Grant number:* 202350E080. *Duration:* 17/03/2023 until 16/03/2026. *P.I.:* Carme Torras. `https://www.iri.upc.edu/project/show/305`. *Members:* 4. *Endowment:* 200 000 euros.

- **SGR RobIRI: Grup consolidat de Percepció i Manipulació Robotitzada de l'IRI**. *Financing:* Generalitat de Catalunya. *Grant number:* 2021-SGR-00514. *Duration:* 01/01/2022 until 31/12/2024. *P.I.:* Carme Torras. `https://www.iri.upc.edu/project/show/306`. *Members:* 27. *Endowment:* 60 000 euros.

- **CLOTH manIpulation Learning from DEmonstrations - UPC**. *Financing:* European Research Council (ERC). Linked 3rd party project. *Grant number:* H2020-741930- CLOTHILDE. *Duration:* 01/01/2018 until 31/12/2023. *P.I.:* Maria Alberich. `https://clothilde.iri.upc.edu/` *Members:* 3. *Endowment:* 305 125 euros.

Teaching

- **Differential Equations** in Bachelor's degree in Industrial Technology Engineering.
  First semester of academic year 2024/2025, 6 ETCS.

- **Calculus II** in Bachelor's degree in Industrial Technology Engineering.
  Second semester of academic year 2023/2024 and 2024/2025, 6 ETCS.

- **Algebra and Geometry** in Bachelor's degree in Industrial Technologies and Economic Analysis (course coordinator).
  First semester of academic year 2023/2024, 6 ETCS.

- **Geometry** in Bachelor's degree in Industrial Technology Engineering.
  First and second semester of academic year 2022/2023, 12 ETCS each.

Direction of introduction to research grants

- María Lucía Aparicio García. **Interactive cloth simulation in a Virtual Reality environment**.
  From October 2024 until June 2025 at IRI (CSIC-UPC). Grant *INIREC-5558*.

- Arnau Dols Férrez. **Towards a new paradigm for regression and classification problems using computational topology**. From January 2024 until July 2024 at IRI (CSIC-UPC). Grant *JAE INTRO Artificial-Intelligence-HUB* (JAEICU23EX-AIHUB 12). Co-directed with Maria Alberich.

- Roger Gómez López. **Creation of a virtual reality framework for simulation of realistic garments**. From May 2023 until January 2024 at IRI (CSIC-UPC). Grant *INIREC-UPC*.

Directed Bachelor and Master theses

- Julen Antonio Echevarria, April 2022. **Manipulació robòtica de tela: percepció i ajust de model**. *Bachelor Thesis*. UPC, Grau en Enginyeria en Tecnologies Industrials.

- José Maria Julià, February 2022. **Primeros pasos en el control de la tela por simulación isométrica**. *Master Thesis*. UPC, Màster Universitari en Enginyeria Industrial.

- Román Arañó Llach, July 2020. **Validación del modelo de tela del proyecto Clothlide mediante la simulación y el cálculo numérico**. *Bachelor Thesis*. UPC, Grau en Enginyeria en Tecnologies Industrials.

Scholarships

- **Beca NILS Ciencia y Sostenibilidad**
  Financial aid received in the framework of a one-year Erasmus+ stay at the University of Oslo in Norway during the academic year 2014/2015.

- **Beca de Iniciación a la Investigación de la UCM**
  Study of multivariate complex analysis techniques. Supervised by María del Socorro Ponte Miramonte in the academic year 2015/2016.

- **Severo Ochoa ICMAT: Introducción a la Investigación 2016**
  Development of computational techniques for the study of non-autonomous bi-dimensional dynamical systems. Supervised by Ana María Mancho.