

Francesco Mascari

he/him — PhD Student

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in francesco-mascari

I am currently working as a PhD student in Statistics and Computer Science at Bocconi University in Milan.
My main research interests are Bayesian Nonparametrics, Reproducing Kernel Hilbert Spaces, Wasserstein Distance, and Random Measures.

Education

PhD in Statistics and Computer Science <i>Bocconi University, Milan, Italy</i>	2021 – ongoing
MSc in Mathematics for Life and Data Sciences, <i>cum laude</i> <i>University of Trento, Trento, Italy</i>	2018 – 2021
BSc in Mathematics, <i>cum laude</i> <i>University of Bologna, Bologna, Italy</i>	2015 – 2018
High School Diploma in Scientific Studies, <i>cum laude</i> <i>Liceo Scientifico Copernico, Bologna, Italy</i>	2010 – 2015

PhD Research Project

Title: *Hilbert-based Indices of Dependence between Random Probability Measures for Distributional Data and Bayesian Nonparametrics*

Advisor: Prof. Hugo Lavenant, *Bocconi University*

Co-advisor: Prof. Marta Catalano, *Luiss University*

First paper (*submitted*): : Measuring Partial Exchangeability with Reproducing Kernel Hilbert Spaces.

In Bayesian multilevel models, the data are structured in interconnected groups, and their posteriors borrow information from one another due to prior dependence between latent parameters. However, little is known about the behaviour of the dependence a posteriori. In this work, we develop a general framework for measuring partial exchangeability for parametric and nonparametric models, both a priori and a posteriori. We define an index that detects exchangeability for common models, is invariant by reparametrization, can be estimated through samples, and, crucially, is well-suited for posteriors. We achieve these properties through the use of Reproducing Kernel Hilbert Spaces, which map any random probability to a random object on a Hilbert space. This leads to many convenient properties and tractable expressions, especially a priori and under mixing. We apply our general framework to i) investigate the dependence a posteriori for the hierarchical Dirichlet process, retrieving a parametric convergence rate under very mild assumptions on the data; ii) eliciting the dependence structure of a parametric model for a principled comparison with a nonparametric alternative.

Second paper (*pre-print*): Hilbert-Based Correlation Indices for Distributional Data.

We present a unified mathematical framework for defining correlation indices when data are probability measures using Hilbert space embeddings. This approach allows us to reinterpret existing Wasserstein and kernel-based correlation indices, and suggests new strategies by extending the notions of Kernelized Canonical Correlation and Centered Kernel Alignment to the space of probability measures. We analyze these indices at the extreme values and demonstrate their practical utility by examining their behavior on synthetic data and in hierarchical clustering in cortical regions for functional brain imaging data.

MSc Thesis

Title: *A Micro-macro Connection: The Valuable Relation between Large Deviations for Diffusion Processes and Wasserstein Gradient Flows*

Supervisors: Prof. Carlo Orrieri, *University of Pavia*; Dr. Giovanni Conforti, *École Polytechnique*

Abstract: This work aims to present the passage from the microscopic stochastic description of a system of particles to its macroscopic description as a Fokker-Planck equation. After a brief introduction to some basics in Convex Analysis and Measure Theory, a complete review of optimal transport and Wasserstein metric, on the one hand, and of large deviations for path measures of diffusion processes, on the other, is displayed. A thorough description of the gradient flow formulation for the Fokker-Planck equation is then analyzed with a particular interest in the JKO functional, which is shown to be equivalent in Γ -convergence to the rate functional arising in the large deviation principle for a system of independent Brownian particles.

Ongoing Research Projects

Measuring Partial Exchangeability with Reproducing Kernel Hilbert Spaces

with M. Catalano and H. Lavenant

Hilbert-Based Similarity Indices When Data Are Probability Measures

with M. Catalano and H. Lavenant

Research Experience

Contract Researcher <i>Bocconi University, Milan, Italy</i>	Sep 2025 – ongoing
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Visiting PhD Student <i>Luiss University, Rome, Italy</i>	Oct 2024 – Jan 2025
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Other Exchange or Visiting Programs

Erasmus+ Traineeship
École Polytechnique, Palaiseau, France

Oct 2020 – Feb 2021

Erasmus+ Study
Cardiff University, Cardiff, Wales, UK

Jan – Jun 2018

Talks, Posters, and Conferences

Invited Talks

4th Italian Meeting on Probability and Mathematical Statistics

Jun 2024

Sapienza University of Rome, Rome, Italy

Measuring Dependence under Partial Exchangeability with Reproducing Kernel Hilbert Spaces

Contributed Talks

BAYSM 2025

Apr 2025

Online

Measuring Partial Exchangeability with Reproducing Kernel Hilbert Spaces

Posters

BNP 14 World Meeting

Jun 2025

University of California, Los Angeles, Los Angeles, USA

Travel Award, Best Poster Award

Measuring Partial Exchangeability with Reproducing Kernel Hilbert Spaces

Early Career Workshop on Nonparametric Statistics

May 2025

Luiss University, Rome, Italy

Measuring Partial Exchangeability with Reproducing Kernel Hilbert Spaces

2024 ISBA World Meeting

Jul 2024

Ca' Foscari University of Venice, Venice, Italy

Measuring Dependence under Partial Exchangeability with Reproducing Kernel Hilbert Spaces

BAYSM 2024

Jun 2024

Ca' Foscari University of Venice, Venice, Italy

Measuring Dependence under Partial Exchangeability with Reproducing Kernel Hilbert Spaces

Other Conferences, Workshops and Schools

Summer School on Optimal Transport, Stochastic Analysis and Applications to Machine Learning

Jun 2024

KAIST, Daejeon, South Korea

2023 LMS Invited Lecture Series

Jul 2023

Durham University, Durham, England, UK

Turin-Bath PhD Workshop in Applied Probability and Statistics

Jun 2023

Collegio Carlo Alberto, Turin, Italy

Workshop Mathematical Statistics

Apr 2023

Bocconi University, Milan, Italy

Optimal Transport and Applications

Oct 2022

University of Pisa, Pisa, Italy

Summer School in Mathematics of Machine Learning

Jul 2022

Scuola Matematica Interuniversitaria, Cortona, Italy

Summer School in Advanced Statistics and Probability: Random Structures and Combinatorial Statistics

Jul 2022

Lake Como School of Advanced Studies, Como, Italy

Stochastic Games and Martingale Optimal Transport

May 2022

University of Milan, Milan, Italy

Summer School in Geometric Statistics

Sep 2019

University of Toulouse III, Toulouse, France

Teaching

Machine Learning – Module I – Introduction (30677)

Spring 2025

BSc International Politics and Government, Bocconi University

Quantitative Methods For Social Sciences – Module II – Data Analytics (30673)

Spring 2025

BSc International Politics and Government, Bocconi University

Teaching Assistantships

Statistics (30001)

Fall 2025

BSc International Economics and Management, Bocconi University

Bayesian Statistical Methods (20231)	Fall 2025
<i>MSc Data Science and Business Analytics, Bocconi University</i>	
Mathematics – Module 1 – Theory and Methods (30448)	Fall 2025
<i>BSc Economic and Social Sciences, Bocconi University</i>	
Applied Stochastic Processes (30515)	Spring 2024
<i>BSc Economics, Management and Computer Science, Bocconi University</i>	
Foundations of Data Science (30607)	Spring 2024
<i>BSc Economics, Management and Computer Science, Bocconi University</i>	
Optimization (20603)	Spring 2024
<i>MSc Data Science and Business Analytics, Bocconi University</i>	
Mathematics – Module 2 – Applied (30063)	Spring 2024
<i>BSc Economia Aziendale e Management, Bocconi University</i>	
Statistics (30001)	Fall 2023
<i>BSc International Economics and Finance, Bocconi University</i>	
Bayesian Statistical Methods (20231)	Fall 2023
<i>MSc Data Science and Business Analytics, Bocconi University</i>	
Mastering Data for Insurance	Spring 2023
<i>SDA Bocconi</i>	
Optimization (20603)	Spring 2023
<i>MSc Data Science and Business Analytics, Bocconi University</i>	
Mathematics – Module 2 – Applied (30063)	Spring 2023
<i>BSc International Economics and Finance, Bocconi University</i>	
Advanced Analysis and Optimization – Module 1 (30551)	Fall 2022
<i>BSc Mathematical and Computing Sciences for Artificial Intelligence, Bocconi University</i>	
Mathematics and Statistics II (145105)	Spring 2020
<i>BSc Biomolecular Sciences and Technologies, University of Trento</i>	
Calculus A (145503)	Fall 2019
<i>BSc Mathematics, University of Trento</i>	
Calculus I (145432)	Fall 2019
<i>BSc Physics, University of Trento</i>	

Other teaching activities

Workshop Instructor	Summer 2023
<i>Data Science Lab, Bocconi University</i>	
Workshop Instructor	Summer 2023
<i>Data Science Lab, Bocconi University</i>	
Math Help Desk for Applicant Refugee Students and Asylum Seekers	Spring 2020
<i>University of Trento</i>	

Other activities

Volunteering

PhD Representative in the PhD Board	2022 – 2025
<i>Department of Decision Sciences, Bocconi University, Milan, Italy</i>	
Student Representative in the Department Council	2016 – 2018
<i>Department of Mathematics, University of Bologna, Bologna, Italy</i>	
Student Representative in the BSc Board	2016 – 2018
<i>BSc Mathematics, University of Bologna, Bologna, Italy</i>	
Student Representative in the School Board	2013 – 2014
<i>Liceo Scientifico Copernico, Bologna, Italy</i>	