

## Brief presentation

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During my Ph.D. I focused on the study of Euclidean disordered systems, i.e. systems in which quenched disorder appears in the form of a random point process in Euclidean space. I studied analytically and numerically models of combinatorial optimization problems, amenable to exact solutions in 1d, and models of Euclidean data structure in Data Science and Machine Learning, amenable to exact solutions in the limit of infinite dimension.

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**Future position: Postdoc at Statistical Physics of Computation Laboratory** Starting Fall 2021  
École polytechnique fédérale de Lausanne Lausanne (CH)

- Supervisor: Lenka Zdeborová
- Research topics: Statistical physics of machine learning

**Current position: Ph.D. in Theoretical Physics** 2018 - 2021 (expected)  
Università degli Studi di Milano Milano (IT)

- Supervisor: Sergio Caracciolo
- Research topics: Euclidean random combinatorial optimization, Machine learning, Disordered systems
- Main collaborators: Sergio Caracciolo, Marco Gherardi, Pietro Rotondo, Andrea Sportiello

## Education

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**M.Sc. in Physics (110 cum laude/110)** 2016 - 2018  
Università degli Studi di Milano Milano (IT)

- Thesis supervisor: Sergio Caracciolo
- Thesis title: Random Euclidean bipartite matching with concave cost functions in 1d

**B.Sc. in Physics (110 cum laude/110)** 2013 - 2016  
Università degli Studi di Milano Milano (IT)

- Thesis supervisor: Luca Molinari
- Thesis title: Slater decomposition of fractional quantum Hall states

## Publications

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8. **Self-induced quenched disorder in multimodal cavity quantum electrodynamics.** Erba, Pastore, Rotondo. Physical Review Letters (2021).
7. **The number of optimal matchings in the Euclidean assignment problem on the line.** Caracciolo, Erba\*, Sportiello. Journal of Statistical Physics (2021)
6. **The p-Airy distribution.** Caracciolo, Erba\*, Sportiello. Preprint Arxiv (2020)
5. **Statistical learning theory of structured data.** Pastore, Rotondo, Erba, Gherardi. Physical Review E (2020, Editor's suggestion)
4. **Random geometric graphs in high dimension.** Erba, Ariosto, Gherardi, Rotondo. Physical Review E (2020)

3. **The Dyck bound in the concave 1-dimensional random assignment model.** Caracciolo, D'Achille, Erba\*, Sportiello. Journal of Physics A (2020)
2. **Intrinsic dimension estimation for locally undersampled data.** Erba, Gherardi, Rotondo. Scientific Reports (2019)
1. **Unified Fock space representation of fractional quantum Hall states.** Di Gioacchino, Molinari, Erba, Rotondo. Physical Review B (2017)

\*: authors are listed in alphabetical order. I had a major role in the research projects and writing related to these papers.

## Schools & Internships

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<b>School — Mathematical and Computational Aspects of Machine Learning</b>	10/2019
Ennio De Giorgi center	Pisa (IT)
– Lectures on optimal transport, mean field Bayesian inference, numerical methods in machine learning and approximation theory	
<b>School — Lectures on Statistical Field Theories</b>	02/2019
Galileo Galilei Institute	Firenze (IT)
– Lectures on tensors networks, Floquet physics, Luttinger liquids and transport phenomena in 1d	
<b>Internship — ESRF/ILL International Student Summer Programme</b>	09/2015
European Synchrotron Radiation Facility	Grenoble (FR)
– Lectures on X-ray and neutron physics and on imaging techniques	
– Experimental project with the ID26 - “X-ray absorption and emission spectroscopy” group (PI: Pieter Glatzel) on the measurement of Eu3+ fluorescence spectrum	

## Talks and Posters

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<b>Invited talk   Data structure in machine learning: estimators and models</b>	15/12/2020
Lenka Zdeborová's group, École polytechnique fédérale de Lausanne	Virtual
<b>Invited talk   Intrinsic dimension estimation for locally undersampled data</b>	12/11/2019
Michele Parrinello's group, Università della Svizzera Italiana	Lugano (CH)
<b>Talk   Intrinsic dimension estimation for locally undersampled data</b>	31/10/2019
Complex System Meeting, Università degli Studi di Milano	Milano (IT)
<b>Poster   Intrinsic dimension estimation for locally undersampled data</b>	24/06/2019
XXIV Statistical Physics Meeting, Università degli Studi di Parma	Parma (IT)

## Honors & Awards

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<b>Ph.D Scholarship</b>	2019 - 2021
Awarded by Università degli Studi di Milano	
<b>Excellence Scholarship</b>	2015 - 2017
Awarded by Università degli Studi di Milano to students complying with annual courses requirements	

## Skills

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- **Programming:** Julia, C++, Mathematica, Python
- **M. Learning/Optimization::** PyTorch, Flux, JuMP, CPLEX
- **Tools/Techs:** Bash, LaTeX, Inkscape
- **Web:** HTML, CSS

## Languages

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- **Italian:** Mother tongue
- **English:** Fluent, CEFR C1 (Certifications: Cambridge BULATS C1 (2019), Cambridge FCE B2 (2012))

## Teaching

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### Tutoring for university courses

University of Milan

Spring 2019 - Present

Milano (IT)

- Spring 2021: Mathematical methods in physics (complex and functional analysis)
- Fall 2020: Numerical treatment of experimental data (C++, OOP and numerical methods)
- Fall 2020: Precourse of mathematics for freshmen in physics (basic maths)
- Spring 2020: Mathematical methods in physics (complex and functional analysis)
- Fall 2019: Recovery course of mathematics for freshman in natural sciences (basic maths)
- Spring 2019: Mathematical methods in physics (complex and functional analysis)

### Thesis supervision

University of Milan

Fall 2019

Milano (IT)

- Fall 2019, Sebastiano Ariosto, “Random geometric graphs in high dimension”
- Fall 2019, Mirko Rossini, “Geometry of structured datasets via multi-scale persistency analysis”

### Substitute physics teacher for a secondary public school

Istituto Professionale “L. Einaudi”

20/2016 - 06/2017

Varese (IT)

## Participation to conferences

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### Symposium on Explanation in Neuroscience and Artificial Intelligence

Virtual venue

02/2021

### Brain Criticality Meeting

Virtual venue

10/2020

### Complex Systems Meeting

University of Milan

10/2019

Milano (IT)

### XXIV Statistical Physics Meeting

University of Parma

06/2019

Parma (IT)

### International Conference of Physics Students

Organized by IAPS (International Association of Physics Students)

2016 & 2017

### Italian Conference of Physics Students

Organized by AISF (Italian Association of Physics Students)

2015, 2016 & 2017

## Other experiences

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### **Student job at the office for didactics**

11/2017 - 03/2018

Università degli Studi di Milano, Maths dept.

Milano (IT)

- Responsible for exams' scheduling
- Responsible for the update of the informations on courses, professors and exams on the department websites

### **Secretary and IT contributor**

09/2014 - 12/2017

Italian Association of Physics Students

- Responsible for the bureaucracy of the non-profit association
- Contributor to the development of the public website and the private online database of the association
- Organizer of the PAPAP16 event, a visit to the Gran Sasso national laboratories with 40 participants from all around Europe
- Organizer of outreach events in high schools
- Volunteer for the XXXII International Conference of Physics Students