

Sapienza University of Rome  
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Nationality: Italian  
Date of birth: 29/10/1999

# Francesco D'Amico

## Research interests

- The effect of data structure in training of machine learning models
- Associative memories and Transformer architectures
- Algorithms approximating likelihood for energy based models
- Hard optimization and inference tasks

## Publications

- 2025 Nicoletti F., **D'Amico F.** and Negri M., "Statistical mechanics of vector Hopfield network near and above saturation ", <https://arxiv.org/abs/2507.02586>, under review.
- 2025 **D'Amico F.**, Bocchi D. and Negri M., "Implicit bias produces neural scaling laws in learning curves, from perceptrons to deep networks", <https://arxiv.org/abs/2505.13230>, under review.
- 2025 Angelini M.C., Avila-González M., **D'Amico F.**, Machado D., Mulet R. and Ricci-Tersenghi F., "Algorithmic thresholds in combinatorial optimization depend on the time scaling", <https://arxiv.org/abs/2504.11174>, under review.
- 2025 **D'Amico F.**, Rossi S., Del Bono L. M. and Negri M., "Pseudo-likelihood produces associative memories able to generalize, even for asymmetric couplings", <https://openreview.net/forum?id=T8MsK8lkeJ>, New Frontiers in Associative Memories workshop NFAM, ICLR 2025.
- 2024 **D'Amico F.** and Negri M. , "Self-attention as an attractor network: transient memories without backpropagation", 2024 IEEE Workshop on Complexity in Engineering (COMPENG), Florence, Italy, 2024, pp. 1-6, doi: 10.1109/COMPENG60905.2024.10741429.

## Education

- 2023 - 2026 **PhD in Physics**, *Sapienza university of Rome*.
- Supervisors: Matteo Negri, Chiara Cammarota
  - Most relevant exams: From Ergodicity breaking to algorithmic phase transitions (M. C. Angelini, G. Gradenigo), Statistical field theory (A. Cavagna)

- 2021 – 2023 **Master's Degree in theoretical physics**, *Sapienza University of Rome*.
- Supervisors: Chiara Cammarota, Matteo Negri
  - Thesis' title: "Random Features p-Spin Hopfield Model"
  - Final degree mark: 110/110 cum laude
  - Most relevant exams: Statistical mechanics and critical phenomena (E. Marinari), Statistical mechanics of disordered systems (F. Ricci Tersenghi), Statistical physics and machine learning (C. Cammarota), Advanced machine learning for physics (S. Giagu), Mathematical physics (E. Caglioti), Physics of complex systems (V. Loreto, F. Tria)
- 2021 – 2023 **Master's excellence program**, *Sapienza University of Rome*.
- Quantitative analysis of innovation levels in LLM's (CREF, V. Loreto)
  - Numerical and experimental methods for the study of climate (A. M. Siani)
  - Numerical methods for the study of complex biological systems (A. Giansanti)
- 2018 – 2021 **Bachelor's Degree in physics**, *Sapienza University of Rome*.
- Final mark: 110/110 cum laude
  - Thesis' title: "Topological Vicsek model analyzed with machine learning techniques"
  - Supervisor: S. Giagu
- 2018 – 2021 **Bachelor's excellence program**, *Sapienza University of Rome*.
- Computational Monte Carlo methods for the simulation of Hamiltonian systems (M. C. Angelini)
  - Analytical and computational methods for the analysis of systems solvable by Green's method (D. Barducci)
  - Theoretical study and computational simulation of active matter systems and analysis by machine learning methods (S. Giagu)

## Experience

### Visiting and periods abroad

- 2025 **Visiting PhD student at Complutense university of Madrid**, *Training of RBMs on power-law distributed random features dataset and composite pseudo-likelihood methods*, 01/03 - 31/05.  
Supervisors: B. Seoane, A. Decelle

### Talks

- 2024 **Self-attention as an attractor network: transient memories without back-propagation**, *SISSA journal club, Trieste*, 11/10/2024.

## Conferences, workshops and schools

- 10/2025 **ROccella Conference on INference and AI**, *Roccella Ionica, Italy*.
- 07/2025 **StatPhys29**, *Firenze, Italy*.
- 07/2025 **Learning and optimization in high dimensions**, *Bocconi university, Milano, Italy*.
- 06/2025 **Beg Rohu Summer school "Learning with machines, physics and minds"**, *Saint Pierre Quiberon, France*.
- 10/2024 **ROccella Conference on INference and AI**, *Roccella Ionica, Italy*.
- 07/2024 **Workshop on Complexity in Engineering COMPENG**, *Firenze, Italy*.
- 07/2024 **Cargese Summer school "Complex and glassy systems"**, *Cargese, France*.

## — Languages

Mothertongue	<b>Italian</b>	
Advanced	<b>English</b>	<i>Level C1</i>
Intermediate	<b>Spanish</b>	<i>Level B1</i>
Basic	<b>French</b>	<i>Level A2</i>

## — Digital skills

Professional	<b>Programming:</b> Python, C, C++.
Professional	<b>Scientific packages:</b> PyTorch, Numpy, Scipy, Matplotlib.
Professional	<b>Operating systems:</b> Linux, Windows.
Intermediate	<b>Programming:</b> R, Java