

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

Francesco D'Amico

Research interests

- Data structure role in machine learning and neural scaling laws
- Associative memories and Transformer-class architectures
- Algorithms for approximate likelihoods in energy-based models
- Optimization and inference in hard computational 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 (Journal of Physics A: Mathematical and Theoretical).
- 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 (ICLR 2026).
- 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 (Physical Review X).
- 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, SONY, 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

- 2025 **Scaling laws, from Perceptrons to Deep networks**, (1) *Chimera journal club*, Roma, 07/10/2025, (2) *Statistical mechanics group*, University of Parma, 23/10/2025.
- 2025 **Statistical mechanics of autoregressive models: towards a theory of Self-Attention**, *PhD talks*, *Sapienza University, Roma*, 07/10/2025.
- 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	Italian	
Advanced	English	<i>Level C1</i>
Intermediate	Spanish	<i>Level B1</i>
Basic	French	<i>Level A2</i>

Digital skills

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