Emanuele Francazi

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linkedin.com/in/emanuele-francazi-a71717238 | Emanuele Francazi

Machine learning PhD candidate with a theoretical physics background, graduating in September 2025. Researching the impact of unfair conditions on learning dynamics in supervised learning and advancing generative diffusion models, with a focus on both theoretical insights and practical applications. Collaboration with peers from diverse backgrounds has enriched the relevance and scope of my work.

Research Experience

Machine Learning - Diffusion Models | *Research stay at ENS (in collaboration with Prof.* **G. Biroli***)* Oct 2024 - Mar 2025

- Secured SNSF Mobility grant for an ongoing research project on Generative Diffusion Models at ENS.

Machine Learning - Initial Guessing Bias (IGB) | *PhD Student at EPFL & Eawag (ETH)* Feb 2023 - present

- Developed a novel theory on biased initial class predictions in untrained (deep) neural networks (**ICML 2024**).
- Validated the theory through PyTorch experiments across architectures (ViT, ResNet, MLP-mixer, etc.) and datasets.
- Co-supervised a research project on the IGB effect in normalization layers, fostering collaboration.
- Launched a project linking the IGB effect with established phenomena, enhancing understanding of both.

Machine Learning - Class Imbalance | *PhD Student at EPFL & Eawag (ETH)* Sep 2021 - Dec 2022

- Investigated algorithmic optimization under class imbalance in (S)GD and formulated variants, identifying conditions that improve peak recall (+0.7%to +6%) and accelerate convergence (4x to 100x) (**ICML 2023**).
- Provided PyTorch code linking theory to practice (e.g., computer vision) across various networks and datasets.

Statistical Physics | *BS/MS Student at Sapienza University of Rome* Sep 2018 - May 2021

- Analyzed phase transitions in highly heterogeneous graphs for my MS thesis, employing message passing algorithms.
- Explored spin glasses and low-temperature states under Prof. **G. Parisi** for my BS thesis.

Leadership Experience

Member of PhD Committee (Coordinator) of Eawag (ETH) Jan 2023 - present
Mentoring: Co-Supervised Master's thesis on "Impact of Normalization Layers on IGB" Oct 2023 - Mar 2024
Teaching Assistant at Environmental Systems Analysis, Eawag (ETH) June 2022 - June 2023

Education

- École Polytechnique Fédérale de Lausanne (EPFL), *PhD in Physics* | Lausanne/Zurich, Switzerland — July 2021 - July 2025
  PI : **F. Krzakala, M. Baity-Jesi**
- Sapienza University of Rome, *MS in Theoretical Physics* | Rome, Italy — Sep 2018 - May 2021
  PI : **F. Ricci Tersenghi** *Final Grade : 110/110 cum laude*
- Sapienza University of Rome, *BS in Physics* | Rome, Italy — Sep 2015 - Sep 2018
  PI : **G. Parisi** *Final Grade : 110/110 cum laude*

Skills

Programming **Advanced:** Python, PyTorch, C, Git **Intermediate:** Bash script, pandas **Familiar:** Matlab, R, Julia
Techniques **Advanced:** Statistical analysis, Coding, Parallel computing, Supercomputing/Cluster Experience
Languages **Native:** Italian **Fluent:** English **Beginner:** French, German

Main Publications

- **E. Francazi**, M. Baity Jesi, A. Lucchi - A Theoretical Analysis of the Learning Dynamics under Class Imbalance ICML 2023 [**Conference paper**] [**arXiv:2207.00391**]
- **E. Francazi**, A. Lucchi, M. Baity Jesi - Initial Guessing Bias: How Untrained Networks Favor Some Classes ICML 2024 [**Conference paper**] [**arXiv:2306.00809**]
- **E. Francazi**, M. Mezard, J.P. Bouchaud, G. Biroli - Impact of noise choice in Diffusion Models - (in preparation)
- **E. Francazi***, F. Pinto*, A. Lucchi, M. Baity Jesi - The effect of normalization in neural network initialization (in preparation)
- A. Bassi, M. Baity Jesi, C. Albert, A. Lucchi, **E. Francazi** - Connecting Initial Guessing Bias to Order Phase in Deep Neural Network - (in preparation)

Awards, Scholarships and Research Grants

SNSF Mobility grants in projects: For doctoral research abroad to enhance scientific profile. Oct 2024 - Mar 2025
Magna cum laude BS Degree & **Magna cum laude MS Degree** Sep 2018 & May 2021
Merit-Based Tuition Exemption: Awarded for exceptional academic achievements. Sep 2015 - Sep 2017