

CV RAFFAELE MARINO

PERSONAL INFORMATION

Name: Raffaele;
Family Name: Marino;

EDUCATION

- 01/10/2013 - 15/06/2017:** **Ph.D. in Theoretical Physics,**
Royal Institute of Technology (KTH), Stockholm, Sweden.
Thesis: “*Dynamics and Thermodynamics of Translational and Rotational Diffusion Processes Driven out of equilibrium*”
Supervisor: Prof. Dr. Erik Aurell
- 01/09/2010 - 18/04/2013:** **M.Sc. in Theoretical Physics, 110/110**
Sapienza Università di Roma, Rome, Italy.
Thesis: “*Algoritmi di Ottimizzazione per il K-SAT problem*”
(Optimization Algorithms for solving K-SAT problem)
Supervisor: Prof. Dr. Giorgio Parisi
- 01/09/2006 - 27/05/2010:** **B.Sc. in Theoretical Physics, 101/110**
Sapienza Università di Roma, Rome, Italy.
Thesis: “*L' Evoluzione della Cooperazione nel Dilemma del Prigioniero*” (The Evolution of Cooperation in Prisoners' Dilemma)
Supervisor: Prof. Dr. M. A. Virasoro and Prof. Dr. I. Giardina

RESEARCH EXPERIENCES

01/03/ 2019-21/03/2021 Senior Researcher (post-doc) at EPFL, School of Computer and Communication Science, Lausanne, Switzerland.

Research project: an investigation of high dimensional statistics, modern inference, and machine learning. This interdisciplinary project aims to benefit from recent learning theory developments to solve high-dimensional partial differential equations using deep learning methodology. In this project, we built deep neural networks for approximating high-dimensional Kolmogorov equation solutions in polynomial time, avoiding, therefore, the curse of dimensionality. Moreover, a comparison of the performance of variants of the deep neural network, derived by using different discretization schemes of the stochastic differential equations, has been investigated. *Supervisor:* Prof. Dr. Nicolas Macris

01/09/2017-28/02/2019: Postdoctoral Fellow at HUJI, School of Computer Science and Engineering, Jerusalem, Israel.

Research project: an investigation of stochastic optimization, computational complexity, and graph theory. The project aimed to develop new greedy and message passing algorithms for overcoming the limits of existing algorithms for graphical models. Empirical comparisons of the developed algorithms with the existing ones showed strong evidence that an exhaustive search over a small number of variables of the problem improves greedy algorithms' performance without presenting the curse of dimensionality. The algorithms developed in this project, e.g., the hidden clique problem, are the best practical methods at the moment.

Supervisor: Prof. Dr. Scott Kirkpatrick

01/10/2013-31/07/2017: Ph.D. student at NORDITA (KTH and SU), Stockholm, Sweden.

Research project: an investigation of stochastic thermodynamics and statistical mechanics out of equilibrium. The project was centered around the theory of transport processes in non-equilibrium systems, where thermal noise typically plays a dominant role. Apart from studying idealized stochastic models, the research focused on developing concrete realizations of such transport phenomena and developing thermodynamics analysis.

Supervisor: Prof. Dr. Erik Aurell

SUPERVISING AND MENTORING ACTIVITIES

- 2020 – I supervised two bachelor students at EPFL for a semester project.
- 2016 – I supervised a master student at KTH for a three months project.

FUNDING AWARDED AND SCHOLARSHIPS

- Member of the Advisory Board AI Transparency Institute (Switzerland)
- IOP trusted reviewer (recognition of the exceptionally high level of peer review competency).
- Winner of International calling for Research Fellowships at Leonardo Labs (2021-2026) (not accepted)
- Winner of a PIML 2020 travel grant.
- 2-year post-doc contract at Sapienza Università di Roma (2021-2023)
- Winner of International calling for programs at NORDITA (2020), (400K SEK up to 600K SEK).
- 2-year post-doc contract at EPFL (2019-2021).
- 2-year post-doc fellowship at the Hebrew University of Jerusalem (2017-2019).
- 4-year Ph.D. student contract at NORDITA and KTH (2013-2017).
- Winner of national competition for admission to Military School "Nunziatella" in Naples, Italian Ministry of Defence (2003).

ORGANISATION OF CONFERENCES

- Nordita Program "Hard Problems: Beyond Equilibrium Methods" (Summer 2021, delayed to Summer 2022 cause Covid-19), NORDITA, Stockholm, Sweden.

SKILLS

Professional skills: solid knowledge of physics, math, algorithms, and hard combinatorial problems.

Technical skills: advanced C++ programming for scientific computation, Python programming, TensorFlow, Deep Learning, Machine Learning, Linux, IOS, Windows, Mathematica.

Personal skills: Leadership, Team building, Problem-solving oriented.

Languages: Italian (mother tongue), English (fluent-C1), French (beginner-A1/A2)

PUBLICATION LIST

Number of papers: 10

Number of papers in preparation: 1

Number of Ph.D. thesis: 1

Number of talks: 12

Number of posters: 2

h-index Google Scholar: 4

Overall citations according to Google Scholar: 61

Overall citations according to Scopus:

PEER-REVIEWED PUBLICATIONS IN INTERNATIONAL SCIENTIFIC JOURNALS:

1. **R. M.**, G. Parisi, F. Ricci-Tersenghi. The backtracking survey propagation algorithm for solving K-SAT problems. *Nature Communications* 7, 12996 2016.
2. **R. M.**, R. Eichhorn, E. Aurell. Entropy production of a Brownian ellipsoid in the overdamped limit. *Phys. Rev. E* 93, 012132 2016.
3. E. Aurell, S. Bo, M. Dias, R. Eichhorn, **R. M.** Diffusion of Brownian ellipsoid in a force field. *EPL (Europhysics Letters)* 114 (3), 30005 2016
4. **R. M.**, E. Aurell. Advective-diffusive motion on large scale from small scale dynamics with an internal symmetry. *Phys. Rev. E* 93, 062147 2016.

PEER-REVIEWED BOOKS/MONOGRAPHS:

5. **R.M.** Dynamics and Thermodynamics of Translational and Rotational Diffusion Processes Driven out of equilibrium. *KTH, School of Computer Science and Communications*, 2017.

PUBLICATIONS UNDER REVIEW IN INTERNATIONAL SCIENTIFIC JOURNALS:

6. **R. M.**, S. Kirkpatrick. Revisiting the Challenges of MaxClique. [arxiv:1807.09091] 2018, submitted to *Phys. Rev. E* (peer-reviewed - under revision).
7. **R. M.**, S. Kirkpatrick. Large independent set on random d-regular graphs with d small. [arxiv:2003.12293] 2020, submitted to *Journal of Combinatorial Optimization* (peer-reviewed - under revision)
8. **R. M.** Learning from Survey Propagation: a Neural Network for MAX-E-3-SAT. [arxiv:2012.06344] 2020, submitted to *Machine Learning: Science and Technology 2020* (under review)
9. **R. M.**, N. Macris. Solving non-linear Kolmogorov equations by using deep learning: a numerical comparison of discretization schemes. [arxiv:2012.07747] 2020, submitted to *Journal of Nonlinear Science* (under review).
10. S. Caracciolo, R. Fabbriatore, **R. M.**, G. Parisi, G. Sicuro. Criticality and conformality in the random dimer problem. [arxiv:2012.13956] 2020, submitted to *PRL* (under review).

PRE-PRINT:

11. **R. M.**, R. Eichhorn, Brownian motion of an ellipsoidal particle in a tilted periodic potential: long term velocity and diffusion. 2017, DOI:10.13140/RG.2.2. 29995.05926.

PAPERS READY FOR SUBMISSION:

12. Jérémy Vachier, **R. M.** Deep learning in Active Matter. 2021, [in preparation]

ORAL CONTRIBUTIONS, POSTERS, TO INTERNATIONAL CONFERENCES:

1. **Contributed talk:** *Solving non-linear Kolmogorov equations by using deep learning: a numerical comparison of discretization schemes.* **Santa Fe 3rd Physics Informed Machine Learning.** 13/01/2020, Santa Fe, USA (NM)
2. **Contributed talk:** *A greedy story of Max-Clique.* **Mathematical and computational aspects of machine learning.** 9/10/2019, Scuola Normale di Pisa, Pisa, Italy.
3. **Invited talk:** *Message passing algorithms & greedy algorithms: two different approaches for solving constraint satisfaction problems.* **PostDoc Mini-Symposium.** 13/12/2018 The Hebrew University of Jerusalem, Faculty of Science, Jerusalem, Israel
4. **Invited talk:** *Entropy production of a Brownian ellipsoid in the overdamped limit.* **NORDITA Day-Winter 2015.** 20/11/2015 NORDITA, Stockholm, Sweden.

5. **Poster:** *Revisiting the challenges of MaxClique. Statistical physics and machine learning back together.* 24/8/2018 Cargese, France.
6. **Poster:** *Diffusion of a Brownian ellipsoid in a force field. Statistical mechanics of quantum dynamics.* 5/2016 Mariehamn, Sweden.

ORAL CONTRIBUTIONS TO INTERNATIONAL SEMINARS:

1. **Invited talk:** *Solving non-linear Kolmogorov equations by using deep learning: a numerical comparison of discretization schemes. Complex systems and Biological physics seminar.* 08/10/2020 NORDITA, Stockholm, Sweden.
2. **Invited talk:** *Solving non-linear Kolmogorov equations by using deep learning: a numerical comparison of discretization schemes. Los Alamos National Laboratories Seminar.* 23/01/2020 Los Alamos National Laboratories, USA (NM)
3. **Invited talk:** *Revisiting the challenges of MaxClique. IPG Seminar.* 17/10/2018 EPFL, School of Computer and Comm. Science, Lausanne, Switzerland.
4. **Invited talk:** *Dynamics and thermodynamics of translational and rotational diffusion processes driven out of equilibrium. Ph.D. Thesis public defence.* 15/6/2017 Royal Institute of Technology (KTH), Stockholm, Sweden.
5. **Invited talk:** *The Backtracking Survey Propagation algorithm for solving random K-SAT problems. Complex systems and Biological physics seminar.* 20/9/2016 NORDITA, Stockholm, Sweden.
6. **Invited talk:** *Diffusion of a Brownian ellipsoid in a force field. Complex systems and Biological physics seminar.* 23/8/2016 NORDITA, Stockholm, Sweden.
7. **Invited talk:** *Anomalous entropy production of a Brownian particle: the general case. Complex systems and Biological physics seminar.* 09/12/2014 NORDITA, Stockholm, Sweden.
8. **Invited talk:** *Optimization algorithms for K-SAT problems. Complex systems and Biological physics seminar.* 23/10/2013 NORDITA, Stockholm, Sweden.

SOURCE CODES (<https://github.com/RaffaeleMarino>):

1. *The backtracking survey propagation algorithm (C++)*
2. *Survey inspired decimation algorithm (C++)*
3. *Greedy algorithm SM₁-ES (C++)*
4. *Greedy algorithm SM₂-ES (C++)*
5. *A greedy algorithm for finding a large independent set on random regular graphs (C++)*
6. *Message passing algorithm for Hidden Clique (C++)*
7. *Class Quaternion (C++)*
8. *E-R graph builder (C++)*
9. *Well Random Number Generator (C++)*
10. *Effective Diffusion Simulations (C/C++)*
11. *Deep learning neural networks for different PDEs (Python and TensorFlow)*
12. *Deep learning neural networks for MAX-E-3-SAT (C++, mlpack libraries)*