MARIO DE FLORIO

Postdoctoral Research Associate at the Division of Applied Mathematics, Brown University

📍 Division of Applied Mathematics, 170 Hope St, Providence, RI 02906   ✉ mario_de_florio@brown.edu   📞 +1 (520) 273-9437
🆔 0000-0003-2285-3074   🔗 https://www.linkedin.com/in/mariodeflorio/   🌐 https://mariodeflorio.github.io/
🔖 https://scholar.google.com/citations?user=d7AxeFoAAAAJ&hl=en&oi=ao   Ｒ https://www.researchgate.net/profile/Mario-De-Florio

About

Research engineer with expertise in mathematical modeling of differential equations and complex systems, collaborating with subject matter experts in a variety of fields, such as nuclear dynamics, astrodynamics, fluid dynamics, chemical kinetics, epidemiological models, and systems biology, to help them understand the underlying phenomena using first principles and experimental data. Multidisciplinary researcher with background in nuclear engineering, applied mathematics, AI/ML, focused on the development of Physics-Informed Machine Learning algorithms for solving real-world multiscale systems.

EXPERIENCE

Postdoctoral Research Associate

Brown University
Division of Applied Mathematics

📅 January 2023 – Present   📍 Providence, RI

- Developing Physics-Informed Machine Learning algorithms for differential equations
- Chaotic systems

Graduate Research Assistant

The University of Arizona
Department of Systems & Industrial Engineering
Space Systems Engineering Laboratory
Lunar & Planetary Laboratory

📅 January 2020 – December 2022   📍 Tucson, AZ

- Developed a new Physics-Informed Neural Networks framework called **X-TFC**
- Applied Physics-Informed algorithms to Orbit Propagation, Radiative Transfer, Rarefied Gas Dynamics, Nuclear Reactor Dynamics, Numerical Integration, Chemical Kinetics, Epidemiological Models, Biological Systems, and Power Systems
- Remote Sensing for Earth Systems characterization and Space Exploration
- Meteorites parameters estimation via Hapke model inversion in collaboration with **Lunar & Planetary Laboratory**
- Supervised MS and PhD visiting students.

Visiting Researcher

The University of Arizona
Department of Systems & Industrial Engineering

📅 January 2019 – May 2019   📍 Tucson, AZ

- Applied Physics-Informed Neural Networks to Radiative Transfer and Rarefied-Gas Dynamics
- Developed a software for Binary Asteroid Systems characterization via light-curves inversion, in collaboration with the **Planetary Science Institute**

Intern

Alma Mater Studiorum - Università di Bologna
Laboratorio di Ingegneria Nucleare di Montecuccolino

📅 November 2017 – January 2018   📍 Bologna, ITA

- Centered learning of Plasma Physics and FORTRAN 90 programming language
- FORTRAN 90 for simulations of a fusion plasma.

Intern

Futura S.p.A.

📅 August 2015 – September 2015   📍 Lucera, ITA

- Control of the ordinary operation of Photovoltaics and Wind power plants
- Detection of production data, drafting technical reports, drafting requests for new plant connections

EDUCATION

Ph.D. in **Systems & Industrial Engineering**
The University of Arizona

📅 January 2020 – December 2022 📍 Tucson, AZ

- Dissertation Title: Physics-Informed Neural Networks and Functional Interpolation for Initial Value Problems with Applications to Integro-Differential and Stiff Differential Equations
- Advisor: Prof. **Roberto Furfaro**
- Grade Point Average: 3.9 out of 4
- Major in Systems Engineering, Minor in Statistics & Machine Learning
- Elected peer representative of Ph.D. students to the SIE Graduate Studies Committee.
- Courses: Stochastic Modeling I, Engineering Statistics, Fundamentals of Optimization, Systems Theory, Introduction to Machine Learning, Advanced Statistical Regression Analysis, Design & Analysis of Experiments, Statistical Machine Learning & Data Mining, Meteorites

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M.S. in **Energy & Nuclear Engineering**
Alma Mater Studiorum - Università di Bologna

📅 September 2016 – July 2019 📍 Bologna, ITA

- Dissertation Topic: **Numerical Solutions of Radiative Transfer Problem**
- Advisor: Prof. **Domiziano Mostacci**
- Grade Point Average: 3.9 out of 4
- Courses: Heat Transmission & Applied Thermo-Fluid Dynamics, Management & Environmental Impact of Energy Systems, Mathematical & Numerical Methods for Energetics, Sustainable Technologies for Energy Resources, Modern Physics, Plasma Industrial Applications, Modeling & Simulation Techniques for Energy, Neutronics & Plasma, Radioprotection.

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Erasmus+ **European Master of Science in Nuclear Fusion and Engineering Physics**
Universidad Complutense de Madrid
Universidad Carlos III de Madrid

📅 January 2018 – June 2018 📍 Madrid, ESP

- Courses: Computational Physics, Statistical Physics, Electric Power Stations II

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B.S. in **Energy & Nuclear Engineering**
Alma Mater Studiorum - Università di Bologna

📅 September 2012 – July 2016 📍 Bologna, ITA

- Dissertation Topic: **Description of the ITER Tokamak Cooling Water System**
- Advisor: Prof. **Emanuele Ghedini**
- Grade Point Average: 3.1 out of 4
- Laboratories: general technologies of materials and industrial applications of plasma, Testing of Machines and Power Systems, Radioprotection, Thermo-Fluid Dynamics Computational Laboratory

PUBLICATIONS

📄 Journal Articles (h-index = 8)

[1] Laghi, L., Schiassi, E., De Florio, M., Furfaro, R., and Mostacci, D. 2023. Physics-Informed Neural Networks for 1-D Steady-State Diffusion-Advection-Reaction Equations, *Nuclear Science and Engineering.* **https://doi.org/10.1080/00295639.2022.2160604**

[2] De Florio, M., Schiassi, E., and Furfaro, R., Physics-informed neural networks and functional interpolation for stiff chemical kinetics, *Chaos* 32, 063107 (2022). **https://doi.org/10.1063/5.0086649**

[3] De Florio, M., Schiassi, E., Ganapol, B.D., and Furfaro, R., 2022. Physics-Informed Neural Networks for rarefied-gas dynamics: Poiseuille flow in the BGK approximation. *Z. Angew. Math. Phys.* 73, 126.
https://doi.org/10.1007/s00033-022-01767-z

[4] Schiassi, E., De Florio, M., Ganapol, B.D., Picca, P. and Furfaro, R., 2022. Physics-informed neural networks for the point kinetics equations for nuclear reactor dynamics. *Annals of Nuclear Energy*, 167, p.108833.
https://doi.org/10.1016/j.anucene.2021.108833

[5] De Florio, M., Schiassi, E., D'Ambrosio, A., Mortari, D. and Furfaro, R., 2021. Theory of Functional Connections Applied to Linear ODEs Subject to Integral Constraints and Linear Ordinary Integro-Differential Equations. *Mathematical and Computational Applications*, 26(3), p.65.
https://doi.org/10.3390/mca26030065

[6] Schiassi, E., De Florio, M., D'Ambrosio, A., Mortari, D. and Furfaro, R., 2021. Physics-informed neural networks and functional interpolation for data-driven parameters discovery of epidemiological compartmental models. *Mathematics*, 9(17), p.2069.
https://doi.org/10.3390/math9172069

[7] Schiassi, E., Furfaro, R., Leake, C., De Florio, M., Johnston, H. and Mortari, D., 2021. Extreme theory of functional connections: A fast physics-informed neural network method for solving ordinary and partial differential equations. *Neurocomputing*, 457, pp.334-356.
https://doi.org/10.1016/j.neucom.2021.06.015

[8] De Florio, M., Schiassi, E., Ganapol, B.D. and Furfaro, R., 2021. Physics-informed neural networks for rarefied-gas dynamics: Thermal creep flow in the Bhatnagar–Gross–Krook approximation. *Physics of Fluids*, 33(4), p.047110.
https://doi.org/10.1063/5.0046181

[9] De Florio, M., Schiassi, E., Furfaro, R., Ganapol, B.D. and Mostacci, D., 2021. Solutions of Chandrasekhar's basic problem in radiative transfer via theory of functional connections. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 259, p.107384.
https://doi.org/10.1016/j.jqsrt.2020.107384

📄 Preprints

[1] Schiassi, E., D'Ambrosio, A., De Florio, M., Furfaro, R. and Curti, F., 2020. Physics-informed extreme theory of functional connections applied to data-driven parameters discovery of epidemiological compartmental models. *arXiv preprint arXiv:2008.05554*.
https://arxiv.org/abs/2008.05554v1

[2] Schiassi, E., Leake, C., De Florio, M., Johnston, H., Furfaro, R. and Mortari, D., 2020. Extreme theory of functional connections: A physics-informed neural network method for solving parametric differential equations. *arXiv preprint arXiv:2005.10632*.
https://arxiv.org/abs/2005.10632v1

👥 Conference Proceedings

[1] Schiassi, E., D'Ambrosio, A., Johnston, H., De Florio, M., Drozd, K., Furfaro, R., Curti, F. and Mortari, D., 2020, August. Physics-informed extreme theory of functional connections applied to optimal orbit transfer. In *Proceedings of the AAS/AIAA Astrodynamics Specialist Conference, Lake Tahoe, CA, USA* (pp. 9-13).

[2] Sonnett, S., Grav, T., Williamson, B., Witry, J., Reddy, V., Furfaro, R., De Florio, M., Schiassi, E., Chatelain, J., Lejoly, C. and Le Corre, L., 2019, September. Lightcurves, Shape Models, and HG Parameters of Trojan and Hilda Binary Candidates. In *EPSC-DPS Joint Meeting 2019* (Vol. 2019, pp. EPSC-DPS2019).

📑 Dissertations

[1] Mario De Florio, 2022. "Physics-Informed Neural Networks and Functional Interpolation for Initial Value Problems with Applications to Integro-Differential and Stiff Differential Equations". PhD dissertation. The University of Arizona.

[2] Mario De Florio, 2019. "Accurate Solutions of the Radiative Transfer Problem via Theory of Connections". MS thesis. Alma Mater Studiorum - Università di Bologna. **https://amslaurea.unibo.it/18553/**

[3] Mario De Florio, 2016. "Description of the ITER Tokamak Cooling Water System". BS thesis. Alma Mater Studiorum - Università di Bologna. **https://amslaurea.unibo.it/11098/**

CONFERENCE TALKS

- **32nd International Symposium on Rarefied Gas Dynamics (RGD32)**, Seoul, South Korea, 4-8 July 2022. *Physics-informed Neural Network and Functional Interpolation for Rarefied-Gas Dynamics in the BGK Approximation*.
- **19th U.S. National Congress on Theoretical and Applied Mechanics (USNC/TAM 2022)**, Austin, Texas, 19-24 June 2022. *Boltzmann Neural Networks and Theory of Functional Connections for Rarefied-Gas Dynamics problems in the BGK approximation*.
- **1st World Online Conference on Theory of Functional Connections**, 22 May 2020. *Physics-Informed Solutions for Rarefied Gas Dynamics Problems via Theory of Functional Connections*.
- **Los Alamos - Arizona days, Online Workshop,** 18-19 May 2020. *Physics-Informed Solutions of Radiative Transfer Problems*.
- **26th International Conference on Transport Theory (ICTT-26)**, Paris, France, 22-27 September 2019. *Accurate Solutions of the Radiative Transfer Problem via Theory of Connections*.

PEER REVIEW ACTIVITY

Active peer reviewer for the following journals:

- Journal of Computational Physics – Elsevier
- Physics of Fluids — AIP Publishing
- Scientific Reports — Springer Nature
- Computational Materials Science — Elsevier
- Journal of Computational Science — Elsevier
- Neural Networks — Elsevier
- Sustainable Computing: Informatics and Systems — Elsevier

RESEARCH INTERESTS

Within the field of engineering and applied mathematics, my research interests span the areas of probabilistic machine learning, Physics-Informed Neural Networks, data-driven scientific computing, nuclear reactor dynamics and control, thermofluid dynamics, transport theory, and chemical and biology systems.
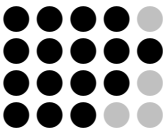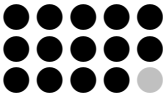
SKILLS

MATLAB ●●●●●
Python ●●●●○
Fortran ●●●○○
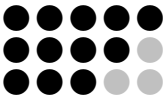
R ●●●○○
SAS ●●●○○

Microsoft Office ●●●●○
LaTeX ●●●●○
Solid Edge ●●●●○
Linux (Ubuntu) ●●●○○

LANGUAGES

Italian ●●●●●
English ●●●●●
Spanish ●●●●○

REFERENCES

George Karniadakis, Professor
@ george_karniadakis@brown.edu
▣ Division of Applied Mathematics, Brown University

Roberto Furfaro, Professor
@ robertof@arizona.edu
▣ Department of Systems & Industrial Engineering, The University of Arizona

Daniele Mortari, Professor
@ mortari@tamu.edu
▣ Department of Aerospace Engineering, Texas A&M University

Clayton Morrison, Associate Professor
@ claytonm@arizona.edu
▣ School of Information, The University of Arizona

Barry D. Ganapol, Professor
@ ganapol@cowboy.ame.arizona.edu
▣ Department of Aerospace & Mechanical Engineering, The University of Arizona

Domiziano Mostacci, Professor
@ domiziano.mostacci@unibo.it
▣ Department of Industrial Engineering, Università di Bologna

Byong Kwon, Senior Research Engineer
@ bykwon@arizona.edu
▣ Department of Systems & Industrial Engineering, The University of Arizona

Paolo Picca, Principal Nuclear Safety Inspector
@ ppicca@email.arizona.edu
▣ Office for Nuclear Regulation, Greater Liverpool Area