



Giuseppe Alessio D'Inverno

Curriculum Vitae

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Personal data

Birth Date: December 27, 1993

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Academic appointments

Current position

02/2024– **Postdoctoral Researcher**, *MathLab Group, Mathematics Area, SISSA, International School for Advanced Studies, Trieste, Italy*

Education

- 29/04/2024 **PhD in Information Engineering & Science (XXXVI cycle)**, *Department of Information Engineering and Mathematics, University of Siena, Italy*, Evaluation: "Excellent" cum laude
Thesis: "*Theoretical properties of Graph Neural Networks*", advisors: Maria Lucia Sampoli, Franco Scarselli, Monica Bianchini
- 17/04/2020 **MS in Applied Mathematics**, *University of Siena, Italy*, 110/110 cum laude
Thesis: "*Towards the determination of threshold in neural networks*", advisor: Luca Chiantini
- 22/02/2018 **BS in Mathematics**, *University of Siena, Italy*, 110/110 cum laude
Thesis: "*Studio della decomposizione ai valori singolari applicata alla ricostruzione di modelli 3D (A study on singular value decomposition and its application on 3D Models Reconstruction)*", advisor: Maria Lucia Sampoli
- 26/11/2015 **BA in Violin**, *Conservatorio "R. Franci", Italy*, 106/110
Thesis: "*La seconda sonata per violino BWV 1003 di J. S. Bach: Isotropia polifonica e sintassi tonale. (J.S.Bach Second Violin Sonata BWV 1003: Polyphonical isotropy and tonal syntax)*", advisor: Antonio Anichini
- 04/07/2012 **Upper secondary school diploma**, *Liceo Scientifico "P. Aldi" of Grosseto, Italy*, 100/100 cum laude

Grants and Fellowships

Grants and Fellowships

- 01/02/2024– **Postdoc Fellowship (CUP G93C22000610007)**, *SISSA, Trieste, Italy*
- 18-22/10/2023 **Grant “Organizzazione Convegni Scuole e Workshop” (CUP E53C22001930001)**, **Gruppo Nazionale Calcolo Scientifico, INdAM** (contribution for **Third Young Applied Mathematicians Conference**, September 18-22, 2023, *Siena*), *Italy*
- 11/2020–10/2023 **Ph.D. Full Scholarship in Information Engineering & Science (XXXVI cycle)**, **“Theoretical foundations of Graph Neural Networks”**, *Department of Information Engineering and Mathematics, University of Siena, Italy*

Research interests

Mathematical Foundations of Deep Learning - Graph Representation Learning - Numerical modeling for PDEs - Physics Informed Neural Networks - Neural Operators

Publications

Peer-reviewed Journals

1. **G. A. D’Inverno**, S. Brugiapaglia, M. Ravanelli (2024). “Generalization Limits of Graph Neural Networks in Identity Effects Learning” , *Neural Networks, Special Issue: Graph Representation Learning*, 106793, <https://doi.org/10.1016/j.neunet.2024.106793>
2. **G. A. D’Inverno**, J. Dong, (2024). “Comparison of Reservoir Computing topologies using the Recurrent Kernel approach”, *Neurocomputing*, 128679, <https://doi.org/10.1016/j.neucom.2024.128679>
3. **G. A. D’Inverno**, M. Bianchini, M. L. Sampoli, F. Scarselli (2024). “On the approximation capability of GNNs in node classification/regression tasks”, *Soft Computing*, 28, 8527–8547, <https://doi.org/10.1007/s00500-024-09676-1>
4. M. S. Bucarelli, **G. A. D’Inverno**, M. Bianchini, F. Scarselli, F. Silvestri (2024). “A topological description of loss surfaces based on Betti Numbers”, *Neural Networks*, 106465, <https://doi.org/10.1016/j.neunet.2024.106465>
5. S. Beddar-Wiesing, **G. A. D’Inverno**, C. Graziani, V. Lachi, A. Moallem-Oureh, F. Scarselli, J. M. Thomas (2024). “Weisfeiler–Lehman goes dynamic: An analysis of the expressive power of graph neural networks for attributed and dynamic graphs”, *Neural Networks*, 106213, <https://doi.org/10.1016/j.neunet.2024.106213>
6. A. Falini, **G. A. D’Inverno**, M. L. Sampoli, F. Mazzia (2022). “Splines Parameterization of Planar Domains by Physics-Informed Neural Networks”, *Mathematics*, 11(10), 2406, <https://doi.org/10.3390/math11102406>
7. **G. A. D’Inverno**, S. Brunetti, M. L. Sampoli, D. F. Muresanu, A. Rufa, M. Bianchini (2021). “Visual Sequential Search Test Analysis: An Algorithmic Approach”, *Mathematics*, 9(22), 2952, <https://doi.org/10.3390/math9222952>

Conference Papers

1. C. Fontana, **G. A. D’Inverno**, N. Cappetti (2024). Diagnostic Enface Imaging of Retinal Vascularization: Topological Reconstruction and Intersection Identification. In: Carfagni, M., Furferi, R., Di Stefano, P., Governi, L., Gherardini, F. (eds) Design Tools and Methods in Industrial Engineering III. ADM 2023. Lecture Notes in Mechanical Engineering. Springer, Cham. https://doi.org/10.1007/978-3-031-58094-9_5

Submitted

1. A. Varbella, D. Briens, B. Gjorgiev, **G. A. D’Inverno**, G. Sansavini. “Physics-Informed GNN for non-linear constrained optimization: PINCO a solver for the AC-optimal power flow” (2024). arXiv:2410.04818. *Under review*, ICLR 2025.
2. **G. A. D’Inverno**, S. Moradizadeh, S. Salavatidezfouli, P. C. Africa, G. Rozza. “Mesh-Informed Reduced Order Models for Aneurysm Rupture Risk Prediction” (2024). arXiv:2410.03802. *Under review*, Biomechanics and Modeling in Mechanobiology
3. **G. A. D’Inverno**, M. Bianchini, F. Scarselli. “VC dimension of Graph Neural Networks with Pfaffian activation functions” (2024). arXiv:2401.12362. *First Revision*, Neural Networks.
4. L. Chiantini, **G. A. D’Inverno**, S. Marziali. “Product Of Tensors and Description of Networks” (2024). arXiv:2402.06768. *Submitted*, SIAM Journal of Applied Algebra and Geometry.

Teaching and supervision

Teaching: Bachelor and master level

- 10/2024–12/2024 **Teaching Assistant for the course “Advanced Programming” (Fall 2024)**, *Università degli Studi di Trieste & SISSA*, Trieste (TS)
- 09/2023–12/2023 **Lecturer for the course “Discrete Mathematics & Theory 2” (Fall 2023)**, *CET Academic Programs for Virginia University*, Siena, Italy
- 03/2021–07/2022 **Teaching Assistant for the Mathematical Analysis 2 undergraduate course (Spring 2021, 2022)**, *Department of Information Engineering and Mathematics, University of Siena*, Siena, Italy
- 10/2021–02/2022 **Teaching Assistant for the Numerical Calculus undergraduate course (Fall 2021, 2022)**, *Department of Information Engineering and Mathematics, University of Siena*, Siena, Italy
- 10/2020–02/2022 **Teaching Assistant for the Linear Algebra undergraduate course (Fall 2020, 2021, 2022)**, *Department of Information Engineering and Mathematics, University of Siena*, Siena, Italy
- 16/04/2019 **Invited lesson for the course of “Numerical Analysis” for the Master in Applied Mathematics**, *University of Siena*, Siena, Italy

Supervision: Bachelor and Master level

- 2024 **Co-supervision for Master’s degree thesis in Mathematics**, “*Surrogate Models for diffusion on graphs: a high-dimensional polynomial approach*”, *Candidate: Kylian Avalon*, Department of Mathematics and Statistics, Concordia University, Montréal (CA)

- 2022 **Co-supervision for Master's degree thesis in Applied Mathematics**, "*One Dimensional Model of Navier-Stokes Equations for the Arterial Blood Flow*", Candidate: *Hasel Cicek Konan*, Department of Information Engineering and Mathematics, University of Siena
- 2020 **Co-supervision for Master's degree thesis in Applied Mathematics**, "*Different classes of tensors for modeling rater agreement data*", Candidate: *Federica Cenni*, Department of Information Engineering and Mathematics, University of Siena
- 2023 **Co-supervision for Bachelor's degree thesis in Mathematics**, "*Studio di formule di quadratura per l'approssimazione numerica di integrali singolari ed ipersingolari*", Candidate: *Sofia Corsi*, Department of Information Engineering and Mathematics, University of Siena
- 2023 **Co-supervision for Bachelor's degree thesis in Mathematics**, "*Analisi di sopravvivenza su dati clinici tramite il metodo di Kaplan-Meier*", Candidate: *Daniela Bagno*, Department of Information Engineering and Mathematics, University of Siena

Research Stays

- 02/2023–05/2023 **Visiting scholar**, *Montréal Institute for Learning Algorithms (MILA) & Université de Montréal*, Montréal, Canada, hosts Prof. Mirco Ravanelli & Prof. Simone Brugiapaglia
- 05/2022–09/2022 **Visiting scholar**, *Biomedical Imaging Group, École Polytechnique Fédérale de Lausanne (EPFL)*, Lausanne, Switzerland, host Prof. Michael Unser

Conferences, workshops and seminars

Invited talks

- 20/06/2024 **Contributed talk "Mesh-Informed reduced order models for aneurysm rupture risk prediction"**, *Scientific Machine Learning: Emerging Topics*, Trieste, Italy
- 06/06/2024 **Invited talk at minisymposium "DeepONet for inverse operator approximation in matrix-free contexts"**, *ECCOMAS 2024 Conference*, Lisbon, Portugal
- 29/02/2024 **Invited talk at minisymposium "VC dimension of Graph Neural Networks with Pfaffian Activation Functions"**, *SIAM UQ24 Conference*, Trieste, Italy
- 22/02/2024 **Contributed talk "Physics Informed Graph Neural Networks for Optimal Power Flow"**, *Workshop "PINN-PAD"*, Padova, Italy
- 19/01/2024 **Contributed talk "VC dimension of Graph Neural Networks with Pfaffian Activation Functions"**, *Workshop "Mathematics for Artificial Intelligence and Machine Learning"*, Milano, Italy
- 08/09/2023 **Contributed talk "Distress prediction based on Pennes' Bioheat Equation: a Physics Informed Neural Network approach"**, *Bioinformatiha 10*, Siena, Italy

- 30/09/2023 **Invited talk at minisymposium “Bounds and limitations on generalization capabilities of Graph Neural Networks”**, *SIMAI23 Conference*, Matera, Italy
- 29/09/2023 **Invited talk at minisymposium “An H-matrix based acceleration of Iga-BEM for 3D Helmholtz problems”**, *SIMAI23 Conference*, Matera, Italy
- 26/11/2022 **Contributed talk “Splines parameterization of planar domains by Physics Informed Neural Networks”**, *Workshop “Matematica per l’Intelligenza Artificiale ed il Machine Learning – Giovani Ricercatori”*, Torino (TO)
- 29/09/2022 **Contributed talk “Hierarchical matrices techniques for Helmholtz problem in IgaBEM setting”**, *GIMC-SIMAI Young 2022*, Pavia (PV)
- 22/09/2022 **Contributed talk “Hierarchical matrices techniques for Helmholtz problem in IgaBEM setting”**, *SMART 2022*, Rimini(RI)
- 19/09/2022 **Contributed talk “Hierarchical matrices techniques for Helmholtz problem in IgaBEM setting”**, *2nd Young Applied Mathematicians Conference (YAMC)*, Arenzano(GE)
- 29/10/2021 **Contributed talk “The expressive power of Graph Neural Networks – A unifying point of view”**, *20th International Conference of the Italian Association for Artificial Intelligence*, online
- 22/07/2021 **Contributed talk “The expressive power of Graph Neural Networks – A unifying point of view”**, *ACDL 2021*, Certosa di Pontignano (SI)

Organizer

- 16–20/09/2024 **Fourth Young Applied Mathematicians Conference**, *University of Rome “La Sapienza”*, Italy, with G. Auricchio, C. Carrara, C. Graziani, A. Kushova, G. Loli, S. Marziali, A. Marchetti, M. Menci, E. Onofri
- 24–28/06/2024 **Summer School ‘Artificial Intelligence for Biomedical Applications’**, *Monasterino della Conoscenza, Siena*, Italy, with P. Bongini, C. Graziani, V. Lachi, N. Pancino
- 13–14/05/2024 **Minisymposium “Deep Learning Methods for Numerical Linear Algebra”**, **SIAM LA24 Conference**, *Sorbonne Université*, Paris (FR), with C. Millevoi
- 18–22/09/2023 **Third Young Applied Mathematicians Conference**, *University of Siena*, Italy, with G. Auricchio, C. Graziani, V. Lachi, F. Locatelli, G. Loli, L. Zambon

Journal activities

Referee work

IEEE Transaction on Neural Network and Learning Systems, Neural Networks, Neurocomputing, Applied Numerical Mathematics, Soft Computing, Opuscula Mathematica, International Journal of Knowledge-Based and Intelligent Engineering Systems

Research projects

- 2022 **INdAM-GNCS Project 2022: “Verso nuove frontiere dell’analisi isogeometrica” (Coordinator: Prof. Francesca Pelosi, Duration 12 Months)**, *Gruppo Nazionale di Calcolo Scientifico, INdAM*, Italy

Educational activities

- 18–30/07/2023 **Summer School on Physics Informed Neural Networks and Applications**, *KTH*, Stockholm, Sweden
- 29/06–01/07/2022 **Summer Research Institute 2022 - Learning: Optimization and Stochastics**, *EPFL*, Lausanne, Switzerland
- 28/02–04/03/2022 **Lectures on Mathematics of Deep Learning**, *Isaac Newton Institute for Mathematical Sciences*, Cambridge, United Kingdom
- 26–30/07/2021 **DeepLearn 2021**, Las Palmas di Gran Canaria, Spain
- 19–23/07/2021 **Advanced Course on Data science & Machine Learning (ACDL) 2021**, Certosa di Pontignano (SI), Italy
- 21–25/06/2021 **Regularization Methods for Machine Learning (RegML) 2021**, *MaIGA*, University of Genova, online

Further information

Scientific Associations

- *Società Italiana di Matematica Applicata e Industriale (SIMAI)*, Young Member (2022-)
- *“AI&ML&MATH Group”*, *Unione Matematica Italiana (UMI)* (2021-)
- *Gruppo Nazionale di Calcolo Scientifico (GNCS)*, *Istituto Nazionale di Alta Matematica (INdAM)*, Young Member (2020-)

Professional Experience

- 01/09/2021 – **Maths & Physics Teacher**, *Liceo Statale “A. Rosmini”*, Grosseto, Italy
- 07/01–06/02/2020 **Violin Teacher**, *Istituto di Istruzione Superiore Polo “Luciano Bianciardi”*, Grosseto, Italy
- 11/2019–06/2020 **Violin Teacher**, *Fondazione Grosseto Cultura*, Grosseto, Italy
- 2021 – 2023 **Second Section violin player**, *Ensemble Symphony Orchestra*, Massa, Italy
- 2020 – 2023 **First Section violin player**, *Orchestra AMAT*, Firenze, Italy
- 2018 – 2023 **First Section violin player**, *Filharmonie Orchestra*, Campi Bisenzio (FI), Italy
- 2016 – 2023 **External adjoint violin player**, *Conservatorio “R. Franci”*, Siena, Italy
- 2012 – 2023 **First Section violin player**, *Orchestra Filarmonica di Lucca*, Lucca, Italy
- 2010 – 2023 **First Section violin player**, *Orchestra Città di Grosseto*, Grosseto, Italy

Professional activities and projects

- 10/2024 **AI Forum Hackathon – Mentorship**, Tavagnacco (UD)
- 10/2021 **Hackaton 4 Rare Diseases – Winner (Team “Power rAIngers”)**, Firenze, Italy
- 2016 – 2023 **“Pint of Science”, Local Team Collaborator(2016–2019, Siena; 2024, Trieste), Local Team Leader (2020–2023, Siena)**
- 2011 – 2014 **Youth National Lead Collaborator Società “Dante Alighieri”**, Roma, Italy

2009-2011 **Olimpiadi della Matematica, National Round, Group Category (2009-2011), Individual Category (2011)** , Cesenatico (RI), Italy

Computer skills and competencies

- R, HTML, Javascript, C : basic knowledge
- C++, Python, Matlab: proficient knowledge
- Java: Experis Back-End developer course (06-07/2020)
- ECDL certification

Language competences

Italian (Mother tongue), English (Proficient: C1 Cambridge Certificate, Grade: 198/210), French (Diplôme DELF B1, Grade: 83.5/100)

References

Prof. Dr. **Maria Lucia Sampoli**

Associate Professor in Numerical Analysis

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Prof. Dr. **Simone Brugiapaglia**

Associate Professor in Numerical Analysis

Interim Director of the Applied Math Laboratory of the Centre de Recherches Mathématiques

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Prof. Dr. **Gianluigi Rozza**

Full Professor in Numerical Analysis

Head of SISSA Mathematics Area, SISSA mathLab coordinator

PI of European Research Council project AROMA-CFD

SISSA, Mathematics Area, mathLab

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