Postdoctoral researcher in machine learning applied to radio astronomy at the University of Geneva. Member of the Department of Computer Science. Member of the Euclid Consortium.

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Work

University of Geneva (Switzerland) since 2023
Postdoctoral Assistant in machine learning applied to radio astronomy.
PI: Slava Volonshynovskiy.

University of Geneva (Switzerland) 2022-2023
Postdoctoral Assistant in machine learning applied to cosmology.
PI: Lucas Lombriser.

UCL – University College London (UK) 2021-2022
Research Fellow in explainable AI applied to cosmology.
PIs: Hiranya Peiris and Andrew Pontzen.

Education

UCL – University College London (UK) 2017-2021
Doctor of Philosophy (PhD) in Data Intensive Science, 4-year programme. Perren PhD Prize winner.
Advisors: Benjamin Joachimi and John Shawe-Taylor.
Thesis: Accelerating inference in cosmology and seismology with machine learning.

University of Padova (Italy) 2015-2017
2-year master course in Physics. Final grade: 110/110 *cum laude*.
Advisor: Sabino Matarrese.
Final project (published) on analysing the intrinsic alignment of bright structures in dark matter haloes using simulation and real data.

University of Padova (Italy) 2012-2015
Undergraduate course in Physics. Final grade: 110/110 *cum laude*.
Advisor: Denis Bastieri.
Final project on testing various phenomenological dark matter models using Fermi LAT data.

Industry

Faculty AI (UK) 2020
8-month internship in the R&D team working on privacy, fairness, explainability and robustness in the context of artificial intelligence (AI). I collaborated with data scientists and software engineers to develop AI solutions for other companies and organisations. My work led to a scientific publication on data privacy submitted to a major machine learning journal.

Selected Publications (full publication list available at this link; 11 publications, 6 as first author)

MNRAS: Monthly Notices of the Royal Astronomical Society
MLST: Machine Learning: Science and Technology
PRD: Physical Review D
OJAp: The Open Journal of Astrophysics
NeurIPS: Neural Information Processing Systems

1. A representation learning approach to probe for dynamical dark energy in matter power spectra
   D. Piras, L. Lombriser. 2023. Submitted to PRD.
   We proposed a representation learning architecture to compress multiple cosmological models, and showed its remarkable results when applied to a particular extension. I led the code implementation, data analysis, experiments and paper writing.

2. CosmoPower-JAX: high-dimensional Bayesian inference with differentiable cosmological emulators
   D. Piras, A. Spurio Mancini. 2023. OJAp, Vol. 6. Code available here.
   We developed differentiable neural emulators of cosmological power spectra within the JAX framework, demonstrating a speed-up of up to 4 orders of magnitude in high-dimensional Bayesian inference using Hamiltonian Monte Carlo sampling. I led the algorithm implementation, data analysis, experiments and paper writing.

3. A robust estimator of mutual information for deep learning interpretability
   D. Piras, H. V. Peiris, A. Pontzen, L. Lucie-Smith, N. Guo, B. Nord. 2023. MLST, 4, 025006. Code available here.
   Shorter version accepted at the Machine Learning and the Physical Sciences workshop at NeurIPS 2022.
   We developed GMM-MI, an estimator of mutual information based on Gaussian mixture models, and applied it to interpret deep representation learning models. I led the analysis, implemented and validated the algorithm, and wrote the paper.

4. Fast and realistic large-scale structure from machine-learning-augmented random field simulations
   D. Piras, B. Joachimi, F. Villaescusa-Navarro. 2023. MNRAS, 520 (1), 668-683.
   We produced a dataset of highly-correlated cheap and expensive dark matter fields, and trained a machine-learning model to learn the mapping between the two. I devised the idea, produced the dataset, ran the experiments and wrote the paper.

5. CosmoPower: emulating cosmological power spectra for accelerated Bayesian inference from next-generation surveys
   A. Spurio Mancini, **D. Piras**, J. Alsing, B. Joachimi, M. P. Hobson. 2022. MNRAS, 511 (2), 1771-1788.
   We developed neural emulators of cosmological power spectra to significantly accelerate cosmological Bayesian inference. I led part of the analysis, helped with the development of the remainder and wrote the corresponding parts of the paper.

6. The mass dependence of dark matter halo alignments with large-scale structure
   D. Piras, B. Joachimi, B. M. Schäfer, S. Hilbert, M. Bonamigo, E. van Uitert. 2018. MNRAS, 474 (1), 1165-1175.
   We developed a theoretical framework to characterise the intrinsic alignment of galaxies as a function of the mass of the hosting dark matter haloes. I led the data analysis and the model verification, and wrote the paper.

Grants & Awards (£10k+ in personal awards, £100k+ in scholarships)

Doctoral Research Award (2022, finalist and honourable mention)
For best PhD thesis and research in the field of natural and life sciences.
Top 1% in the UK. Awarded annually by the Association of British Turkish Academics, London.

ATI Post-Doctoral Enrichment Award (2022, £2k)
To facilitate post-doctoral activity throughout the UK on topics related to data science and AI.
12 awards across the entire university, 1st cohort. Awarded by the Alan Turing Institute, London.

Perren PhD Prize in Data Intensive Science 2020-2021 (2021, £300)
In recognition of an exceptional PhD thesis submitted to the UCL Centre for Doctoral Training in Data Intensive Science.
Awarded annually to 1 student out of the entire cohort (~10 students) by the UCL CDT in DIS, London.

UCL CDT in DIS studentship (2017-2021, £120k)
To pursue a PhD in Data Intensive Science at University College London. Includes £10k/year for travel and equipment.

Valentino Baccin Prize (2017, €5k)
For the excellent work done in preparing and publishing a master's degree thesis in the field of physics.
One prize per year among about thirty thousand students. Awarded by the City of Bassano del Grappa, Vicenza.

Sergio Gambi Prize (2017, €2.5k)
For the best 2nd year performance among all 2-year scientific master's degrees.
Two prizes per year among about ten thousand students. Awarded by the University of Padova, Padova.

Erasmus+ at University College London (2017, €2.5k)
6-month traineeship in the department of Physics & Astronomy. I led a scientific publication and received a PhD offer (accepted).
Awarded by the European Union.

Fermi High School Prize (2012, €1k)
For obtaining the highest marks in high school, which I completed one year in advance.
Awarded by the Enrico Fermi High School, Padova.

Invited & Contributed Talks (a selection; 20+ talks, 10+ invited)

Nov 2023, Debating the potential of machine learning in astronomical surveys, IAP/CCA, Paris, France, contributed

Nov 2023, Cosmo/ExGal seminar, UCL, London, UK, invited

Apr 2023, CosmoClub, ETH, Zurich, Switzerland, invited

Dec 2022, Mullard Space Science Laboratory, Surrey, UK, invited

Jul 2022, ML Summer School, UCL, London, UK, invited

Mar 2022, AI UK 2022, London, UK, invited

Oct 2021, Debating the potential of machine learning in astronomical surveys, IAP, Paris, France, contributed, video

May 2021, Data Science Department, SISSA, Trieste, Italy, invited

Feb 2021, CDT seminar, UCL, London, UK, invited

Nov 2020, Geophysics Group Meeting, UCL, London, UK, invited

Dec 2019, Data Science for Physics and Astronomy, Alan Turing Institute, London, UK, contributed

Jun 2019, Artificial Intelligence methods in Cosmology, ETH, Ascona, Switzerland, contributed

Jul 2018, STFC's Summer School in Artificial Intelligence and Machine Learning, UCL, London, UK, invited

Refereeing & Examination Panels

Panel member to select undergraduate students for a paid Research Experience Placement 2022
"From galaxies to the earth: studying earthquakes with astronomical machine learning", funded by the London NERC DTP.

Supervisor to summer student (Liam Staras, undergraduate, University of Cambridge) 2023

Referee for MNRAS since 2023

Software Skills

Advanced: Python (including TensorFlow, JAX and PyTorch), C++. *Basic*: FORTRAN, IDL, HTML, CSS

Teaching

UCL – University College London (UK) 2017-2021
Teaching assistant, demonstrator, marker and invigilator for the following courses:
Practical Physics and Computing 1
Classical Mechanics
Practical Astrophysics and Computing
Electromagnetic Theory
Electricity and Magnetism
Machine Learning with Big Data

London Business School (UK) 2018-2021
Teaching assistant and demonstrator for the following courses:
Python Programming – Master in Management
Python Programming – Master of Business Administration
Applied Programming Course: Basic Python
Applied Programming Course: Intermediate Python
Introduction to Python for Data Science
Machine Learning for Big Data
Decision Analytics and Modelling
Python for Finance

University of Geneva (Switzerland) 2023
Teaching assistant for Labo 4 (General Relativity).

Outreach & Public Engagement

– Bath AI Society 2023
Invited speaker to discuss applications of machine learning to physical sciences with undergraduate students.

– Alan Turing Institute Roundtable: How to thrive in your PhD 2022
Panel member for a discussion with 30+ UK PhD students about best practices during postgraduate studies.
– SkillsGap panel member
Took part in a panel discussion for 15–19 year olds discussing AI in astrophysics and providing career guidance.
– Postgraduate outreach talk in the Department of Physics, UCL, London
Title: *Leap of lognormal (LOL): accelerating cosmological simulations with machine learning*.

– UCL-Jordan Machine Learning workshops 2021
Prepared and delivered a series of 4 hands-on workshops in machine learning topics.
– UCL Data Science MSc
Helped MSc students by providing guidance and support through workshops and Q&A sessions.
– UCL-Jordan DIS
Tutored for the machine learning course held between UCL and the University of Jordan.

– ML Journal Club 2020
Set up and co-hosted a machine learning journal club in the Centre for Doctoral Training in Data Intensive Science at UCL.

– MSc Open Day talk at UCL, London 2019
Title: *Generating virtual universes using machine learning.*
– For Inquisitive Minds
Presented and discussed my PhD topic during a podcast with experts from different fields.

– PhD peer mentoring 2018
Provided friendly support to 1st year PhD students in the Department of Physics and Astronomy at UCL.
– UCL Certificate of Higher Education in Astronomy
Helped mature students by marking and providing feedback to their final dissertations.

– DataKind UK – Data Dive 2017
Collaborated to explore applications of data science to help charities during a 2-day hackathon.