Postdoctoral researcher in machine learning applied to cosmology at the University of Geneva.
Member of the Department of Theoretical Physics.

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Work

University of Geneva (Switzerland) since 2022
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.
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 conference.

Selected Publications (full publication list available at this link)

MNRAS: Monthly Notices of the Royal Astronomical Society GJI: Geophysics Journal International MLST: Machine Learning: Science and Technology
NeurIPS: Neural Information Processing Systems

1. A robust estimator of mutual information for deep learning interpretability
   D. Piras, H. V. Peiris, A. Pontzen, L. Lucie-Smith, N. Guo, B. Nord. Submitted to MLST. 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.

2. Fast and realistic large-scale structure from machine-learning-augmented random field simulations
   D. Piras, B. Joachimi, F. Villaescusa-Navarro. Submitted to MNRAS.
   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.

3. 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.

4. Towards fast machine-learning-assisted Bayesian posterior inference of microseismic event location and source mechanism
   D. Piras, A. Spurio Mancini, A. M. G. Ferreira, B. Joachimi, M. P. Hobson. 2022. GJI, 232 (2), 1219-1235.
   We used machine learning techniques to speed up the Bayesian inference of any type of microseismic event and identify the source type. I devised the algorithms, implemented the experiments, validated the results and wrote the paper.

5. 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

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.
From: Association of British Turkish Academics, London.

ATI Post-Doctoral Enrichment Award (2022, £2.0k)
To facilitate post-doctoral activity throughout the UK on topics related to data science and AI.
12 awards across the entire university, 1st cohort.
From: Alan Turing Institute, London.

Valentino Baccin Prize (2017, €5.0k)
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.
From: 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.
From: 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.
From: European Union.

Fermi High School Prize (2012, €1.0k)
For obtaining the highest marks in high school, which was completed one year in advance.
From: Enrico Fermi High School, Padova.

Invited & Contributed Talks (a selection)

Dec 2022, Mullard Space Science Laboratory, Surrey, UK
(Interpretable) deep learning for the large-scale structure, invited.

Jul 2022, Crash Course in ML, UCL, London, UK
Generative models, lecture and hands-on session with customised material, invited.

Mar 2022, AI UK 2022, London, UK
Simulations of the Universe from random fields, invited.

Oct 2021, Debating the potential of machine learning in astronomical surveys, IAP, Paris, France
From lognormal fields to realistic simulations, contributed, video available at this https link.

May 2021, Data Science Department, SISSA, Trieste, Italy
What can data science do for cosmology?, invited.

Feb 2021, CDT seminar, UCL, London, UK
Differential privacy for high-dimensional data, invited.

Nov 2020, Geophysics Group Meeting, UCL, London, UK
Accelerated Bayesian inference of microseismic events using deep learning, invited.

Dec 2019, Data Science for Physics and Astronomy, Alan Turing Institute, London, UK
Using machine learning to generate virtual universes, contributed.

Sep 2019, CDT in DIS Annual Meeting, UCL, London, UK
Using machine learning to generate virtual universes, contributed.

Jun 2019, Artificial Intelligence methods in Cosmology, ETH, Ascona, Switzerland
Generating virtual uniVAErses, contributed..

May 2019, PhysAstroData Round Table, UCL, London, UK
Introduction to TensorFlow, invited.

Jul 2018, STFC's Summer School in Artificial Intelligence and Machine Learning, UCL, London, UK
A semi-supervised approach to topic modelling, invited.

Examination & Evaluation 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.

Software Skills

Advanced: Python (including TensorFlow 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	Electromagnetic Theory
Classical Mechanics	Electricity and Magnetism
Practical Astrophysics and Computing	Machine Learning with Big Data

London Business School (UK) 2018-2021
Teaching assistant and demonstrator for the following courses:

Python Programming – Master in Management	Introduction to Python for Data Science
Python Programming – Master of Business Administration	Machine Learning for Big Data
Applied Programming Course: Basic Python	Decision Analytics and Modelling
Applied Programming Course: Intermediate Python	Python for Finance

Outreach & Public Engagement

– 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
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.