Postdoctoral researcher in machine learning applied to cosmology at the University of Geneva.

Member of the Department of Theoretical Physics.

Contact**:** [dr.davide.piras@gmail.com](mailto:dr.davide.piras@gmail.com) Website: [dpiras.github.io](https://dpiras.github.io/)

**Work \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

[University of Geneva](https://www.unige.ch/) (Switzerland) since 2022

Postdoctoral assistant in machine learning applied to cosmology.

PI: Lucas Lombriser.

[UCL – University College London](https://www.ucl.ac.uk/) (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](https://discovery.ucl.ac.uk/id/eprint/10141578/).

[University of Padova](https://www.unipd.it/en/) (Italy) 2015-2017

2-year master course in Physics. Final grade: 110/110 *cum laude*.

Advisor: Sabino Matarrese.

[Final project](https://thesis.unipd.it/handle/20.500.12608/27863) (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](https://thesis.unipd.it/handle/20.500.12608/19825) on testing various phenomenological dark matter models using Fermi LAT data.

**Industry \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

[Faculty AI (UK)](https://faculty.ai/) 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**](https://dpiras.github.io/publications/)**)** **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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](https://ui.adsabs.harvard.edu/abs/2022arXiv221100024P/abstract)

**D. Piras**, H. V. Peiris, A. Pontzen, L. Lucie-Smith, N. Guo, B. Nord. Submitted to MLST. [Code available here](https://github.com/dpiras/GMM-MI).  
Shorter version accepted at the [Machine Learning and the Physical Sciences workshop at NeurIPS 2022](https://ml4physicalsciences.github.io/2022/files/NeurIPS_ML4PS_2022_11.pdf).  
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.

1. [Fast and realistic large-scale structure from machine-learning-augmented random field simulations](https://ui.adsabs.harvard.edu/abs/2022arXiv220507898P/abstract)

**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.

1. [CosmoPower: emulating cosmological power spectra for accelerated Bayesian inference from next-generation surveys](https://academic.oup.com/mnras/article/511/2/1771/6505144)

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.

1. [Towards fast machine-learning-assisted Bayesian posterior inference of microseismic event location and source mechanism](https://academic.oup.com/gji/article/232/2/1219/6750231?guestAccessKey=38557bf5-8861-44df-b566-691dde295a12&utm_source=authortollfreelink&utm_campaign=gji&utm_medium=email)

**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.

1. [The mass dependence of dark matter halo alignments with large-scale structure](https://academic.oup.com/mnras/article-abstract/474/1/1165/4590050?redirectedFrom=fulltext)

**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](http://drawards.org.uk/) (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](https://www.turing.ac.uk/work-turing/alan-turing-institute-post-doctoral-enrichment-awards-2021) (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](https://www.youtube.com/watch?v=jhp1bvc6p08).

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](https://london-nerc-dtp.org/).

**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

Classical Mechanics

Practical Astrophysics and Computing

Electromagnetic Theory

Electricity and Magnetism

Machine Learning with Big Data

[London Business School](https://www.london.edu/) (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

**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](https://www.skillsgap.tech/) 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](https://www.ucl.ac.uk/prospective-students/graduate/taught-degrees/data-science-msc)

Helped MSc students by providing guidance and support through workshops and Q&A sessions.

— [UCL-Jordan DIS](https://www.ucl.ac.uk/global/news/2020/may/ucls-collaboration-global-partners-continues-virtually)

Tutored for the machine learning course held between UCL and the [University of Jordan](http://ju.edu.jo/home.aspx).

— 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](https://www.listennotes.com/podcasts/for-inquisitive/09-simulating-our-universe-Yg9exQP07tV/)

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](https://www.ucl.ac.uk/physics-astronomy/certificate-higher-education-astronomy)

Helped mature students by marking and providing feedback to their final dissertations.

— [DataKind UK – Data Dive](https://datakind.org.uk/) 2017

Collaborated to explore applications of data science to help charities during a 2-day hackathon.