Research Fellow in explainable artificial intelligence and cosmology at University College London
Member of the Physics & Astronomy group and the Cosmoparticle Initiative

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Work

UCL – University College London (UK) since 2021
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.

ASI Data Science (UK) 2018
4-month group project in natural language processing applied to topic modelling. We developed and built an interactive web interface for fast topic modelling of large corpora of text.

Selected Publications

MNRAS: Monthly Notices of the Royal Astronomical Society GJI: Geophysics Journal International

1. 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 pairs 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.

2. 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 that can speed up cosmological Bayesian inference by many orders of magnitude. I led part of the analysis, helped with the development of the remainder and wrote the corresponding parts of the paper.

3. Towards fast machine-learning-assisted Bayesian posterior inference of realistic microseismic events
   D. Piras, A. Spurio Mancini, B. Joachimi, M. P. Hobson. 2021. Submitted to GJI.
   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.

4. 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.

The full publication list is available at this link.

Grants & Awards

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.
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)

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, 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

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

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

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

Dec 2018, CDT in DIS – Upgrade talks, UCL London, UK
Generating virtual universes

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

Python (including advanced TensorFlow and PyTorch)
C++
FORTRAN (basic)
IDL (basic)
HTML (basic)
CSS (basic)

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

Outreach & Public Engagement

SkillsGap panel member 2022
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 2022
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 2020-2021
Helped MSc students by providing guidance and support through workshops and Q&A sessions.

UCL-Jordan DIS 2020-2021
Tutored for the machine learning course held between UCL and the University of Jordan.

ML Journal Club 2019-2021
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 2019
Presented and discussed my PhD topic with experts from different fields.

PhD peer mentoring 2018-2020
Provided friendly support to 1st year PhD students in the Department of Physics and Astronomy at UCL.

UCL Certificate of Higher Education in Astronomy 2018
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.