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.
Working with 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 on the application of machine learning generative models to cosmology.

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

UCL – University College London (UK) 2017-2017
6-month traineeship funded by the Erasmus+ programme.

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

INDUSTRY

Faculty AI (UK) 2020
8-month internship in the most experienced Artificial Intelligence (AI) company in Europe. Worked in the R&D team dealing with AI privacy, fairness, explainability and robustness. Collaborated with data scientists, computer scientists and software engineers to develop AI solutions for companies and organisations.

ASI Data Science (UK) 2018
4-month group project in Natural Language Processing applied to topic modelling. Developed and built a web interface for fast topic modelling of large corpora of text.

PUBLICATIONS

MNRAS: Monthly Notices of the Royal Astronomical Society
NeurIPS: Neural Information Processing Systems
GJI: Geophysics Journal International
* indicates joint effort

1. 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. 2021. Submitted to MNRAS.
   We developed neural emulators of cosmological power spectra that can speed up cosmological Bayesian inference by many orders of magnitude. I ran part of the analysis, helped with the development of the remainder and wrote the corresponding parts of the paper.

2. Towards Machine Learning-Based Meta-Studies: Applications to Cosmological Parameters
   T. Crossland, P. Stenetorp, D. Kawata, T. Kitching, **D. Piras**, et al. 2021. Submitted to MNRAS.
   We developed a machine learning method to extract measurements of cosmological parameters from scientific abstracts for historical trend analysis. I helped creating the annotation dataset and reviewed 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 algorithm, implemented the experiments, validated the results and wrote the paper.

4. Learning to Noise: Application-Agnostic Data Sharing with Local Differential Privacy
   A. Mansbridge*, G. Barbour*, **D. Piras***, C. Frye, I. Feige, D. Barber. 2020. Submitted to NeurIPS 2021.
   We developed a machine learning variational approach to guarantee the privacy of high-dimensional data. I co-lead the implementation and the experimental validation of the method, and helped with its theoretical design and paper writing.

5. Accelerating Bayesian microseismic event location with deep learning
   A. Spurio Mancini, **D. Piras**, A. M. G. Ferreira, M. P. Hobson, B. Joachimi. 2021. Solid Earth, 12, 1683–1705.
   We applied 7 different machine learning models to seismic traces to obtain a huge speed-up in the Bayesian inference of their locations. I helped devise the algorithms, lead their validation 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 lead the data analysis and the model verification, and wrote the paper.

Awards

Valentino Baccin Prize (2017)
Prize for the excellent work done in preparing and publishing a master's degree thesis in the field of Physics (€5.0k).
From: City of Bassano del Grappa, Vicenza.

Sergio Gambi Study Prize (2017)
Prize for the best 2nd year performance amongst all 2-year scientific master's degrees (€2.5k).
From: University of Padova, Padova.

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

Talks, Seminars and Conference Presentations

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

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

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

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

Mar 2019, MSc Open Day, UCL, London, UK
Generating virtual universes using machine learning

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 (poster session)

Software Skills

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

Teaching

UCL – University College London (UK) since 2017
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) since 2018
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 and Other Activities

UCL-Jordan Machine Learning workshops 2021
Prepared and delivered a series of 4 hands-on workshops in machine learning topics.

UCL Data Science MSc since 2020
Helping the MSc students by providing guidance and support through workshops and Q&A sessions.

UCL-Jordan DIS since 2020
Tutor for the Machine Learning course held between UCL and the University of Jordan.

ML Journal Club since 2019
Set up and co-hosting a journal club in machine learning in the Centre for Doctoral Training in Data Intensive Science at UCL.

For Inquisitive Minds 2019
An outreach podcast where I discussed my PhD topic with non-experts.

PhD peer mentoring since 2018
Providing 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
A 2-day hackathon to explore applications of data science to help charities.