Chris Pedersen

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RESEARCH INTERESTS

I am a researcher in the deep learning space, working on a range of projects applying ML methods to problems across science.

EXPERIENCE

Courant Institute for Mathematical Sciences, New York University September 2022 - present
Postdoctoral Associate
Topics: Working on using ML techniques to improve the accuracy and robustness of climate models

Centre for Cosmology and Particle Physics, New York University September 2021 - August 2022
Postdoctoral Associate
Topics: Applications of statistical techniques and deep learning to challenges in astrophysics, working with Prof. Shirley Ho

Centre for Computational Astrophysics, Flatiron Institute September 2021 - present
Guest Researcher

EDUCATION

University College London September 2017 - August 2021
Ph.D. in Astrophysics

- Extensive use of HPC resources, including being primarily responsible for a 4.5M CPU hour allocation on a Tier 1 machine (code performance evaluation, running simulations, data management, postprocessing and final analysis.)
- Development of simulation code in C/C++, construction of Bayesian inference pipelines in Python.

Cardiff University September 2012 - July 2017
MPhys in Physics with Astronomy, First class honours

- Bayesian inference using Markov chain Monte Carlo simulations, in the context of gravitational wave astronomy.
- Construction of data processing pipelines in Python.

ML PROJECTS LED

Cancer-net (2022):

- Using graph neural networks to model the progression of prostate and brain cancer based on the genetic mutations within the tumor.
- My repsonsibilities are model building in PyTorch, model optimisation, and performance validation.
- Project ongoing, will lead to a publication by end of 2022.

Wavelet scattering for cosmological inference (2022):

- Applying wavelet scattering networks to perform parameter inference from cosmological density fields.
- I developed the model in PyTorch and built a model optimisation pipeline.
- This project led to a workshop paper at ICML 2022.

Cosmology emulator (2020-2021):

- Built a surrogate model (or *emulator*) using Gaussian processes to emulate the output of computationally expensive cosmological simulations.
- Led to a publication and publicly available code.

TECHNICAL SKILLS

Computational skills	Python, Linux/Bash, C/C++, git, LaTeX, High Performance Computing (OpenMP, MPI, cuda), PyTorch, SciPy, scikit-learn
Statistical & ML techniques	Bayesian inference, Markov chain Monte Carlo simulations, linear regression, logistic regression, SVM, PCA, Gaussian processes, convolutional neural networks, graph neural networks, autoencoders, wavelet scattering networks
Software development	LaCE (Developer), cup1d (Developer), MP-Gadget (Contributor), fake_spectra (Contributor)

PUBLICATIONS

Excluding collaboration papers - full list available at available here

- **C. Pedersen**, M. Eickenberg, S. Ho
  Learnable wavelet neural networks for cosmological inference,
  ICML 2022 Machine Learning for Astrophysics Workshop
- J. J. Givans, A. Font-Ribera, A. Slosar, L. Seeyave, **C. Pedersen**, K. K. Rogers, M. Garny, D. Blas, V. Iršič
  Non-linearities in the Lyman-α forest and in its cross-correlation with dark matter halos,
  https://arxiv.org/abs/2205.00962
- T. Crossland, P. Stenetorp, D. Kawata, S. Riedel, T. D. Kitching, A. Deshpande, T. Kimpson, C. L. Liew-Cain, **C. Pedersen**, D. Piras, M. Sharma
  Towards Machine Learning-Based Meta-Studies: Applications to Cosmological Parameters,
  https://arxiv.org/abs/2107.00665
- **C. Pedersen**, A. Font-Ribera, K. K. Rogers, P. McDonald, H. V. Peiris, A. Pontzen, A. Slosar
  An emulator for the Lyman-α forest in beyond-ΛCDM cosmologies, JCAP 2021 (2021) 033
- S. Bird, Y. Feng, **C. Pedersen**, A. Font-Ribera
  More accurate simulations with separate initial conditions for baryons and dark matter, JCAP 2020 (2020) 002
- **C. Pedersen**, A. Font-Ribera, T. D. Kitching, P. McDonald, S. Bird, A. Slosar, K. K. Rogers, A. Pontzen
  Massive neutrinos and degeneracies in Lyman-alpha forest simulations, JCAP 2020 (2020) 025
- M. P. Rey, A. Pontzen, O. Agertz, M. D. A. Orkney, J. I. Read, A. Saintonge, **C. Pedersen**
  EDGE: The origin of scatter in ultra-faint dwarf stellar masses and surface brightnesses, ApJL 886 L3 (2019)

REFERENCES

Prof. Shirley Ho, *Flatiron Institute & New York University, New York* - shirleyho@flatironinstitute.org
Dr. Andreu Font-Ribera, *Institut de Fisica d'Altes Energies, Barcelona* - afont@ifae.es
Prof. Nickolay Gnedin, *Fermilab, Illinois* - gnedin@fnal.gov
Dr Michael Eickenberg, *Flatiron Institute, New York* - meickenberg@flatironinstitute.org