

AI-based super-resolution for improving dust extinction correction



SUMMARY.

The era of Big Data is transforming the way scientists approach their research, and ultimately how science progresses and discoveries are made. Current space missions have highlighted a critical need for the development of new tools capable of processing and analysing Big Data from space. In parallel, recent missions, benefiting from technological progresses, have raised the level of collected data to unprecedented levels. Advances in observation systems and instruments require equal advances in data management and analysis. In this framework, Artificial Intelligence (AI) is a powerful tool that is becoming more common across a wide range of fields, including astronomy and Earth observations. In this module, the student will use AI techniques to enhance the resolution of existing 3D dust datasets to improve estimates of interstellar extinction. This module is provided by ACRI-ST, an SME of the space sector that provides engineering data services for space missions.

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OBJECTIVES

The module will provide practical algorithmic knowledge. The student will become familiar with different AI techniques, including deep learning using neural networks.

Understanding of the problematic, and how to tackle it, will enable the student to understand the advantages and limitations of AI techniques.

PREREQUISITES

Some knowledge of the programming language Python and general computing skills are required. Having followed courses on Maths/Stat, Signal/image processing and General Astrophysics are encouraged.

THEORY

by NICK COX

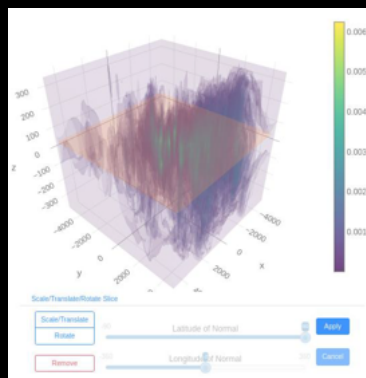
The module will cover:

- Supervised, semi-supervised and unsupervised learning
- Machine learning (e.g. Random Forests) and Deep learning (e.g. Convolutional Neural Networks, Auto-Encoders)

APPLICATIONS

by JERONIMO BERNARD-SALAS

Determining the interstellar extinction is essential for the interpretation of astronomical observations. The student will apply transformer-based networks to improve the 3D spatial resolution of a dust extinction cube based on a high-resolution cube that covers a smaller area. The project covers different steps in data science, from data preparation, model fitting (train/test), hyperparameters optimisation, data analysis and scientific interpretation.



MAIN PROGRESSION STEPS

- First half-week: theoretical courses (a series of talks with exercises in between).

- Practical period (6 weeks): Applied AI astrophysics project.
- Last week: Preparation of final project presentation and report.

ACRI-ST EVALUATION

- Theoretical understanding of applied AI techniques (weight 35%)
- Practical evaluation of written report, research quality and professional development (weight 65%)

BIBLIOGRAPHY & RESOURCES

Machine Learning in Python
 Machine Learning and Data Mining for Astronomy
 3D extinction maps: Inverting intercalibrated extinction catalogues.
 Image credits: S106 (NASA, ESA, Hubble Legacy Archive, Utkarsh Mishra).
 3D dust cube: EXPLORE project (Horizon 2020 101004114).

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