Artificial Intelligence

AI for the Interstellar Medium

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 astronomical data. This module is provided by ACRI-ST, an SME of the space sector that provides engineering data services for space missions.

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 develop critical thinking and a creative mindset.

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 is encouraged.

THEORY

by Jeronimo Bernard-Salas

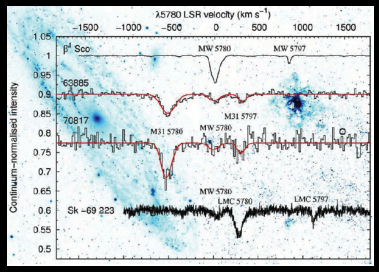
The module will cover:

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

APPLICATIONS

by Nick Cox

The student will apply AI techniques to tackle the nature of the diffuse interstellar bands. The project is a novel study merging the observed spectral data (VLT and other) with quantitative line-of-sight measurements available from the literature (structured data). The goal is to apply ML/DL algorithms to predict the diffuse interstellar band spectra (e.g. absolute and relative band strengths) based on input physical parameters, and vice versa, predict physical parameters based on input spectra. The project will cover different steps in data science, from data preparation, pre-processing, and feature extraction to 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.

EVALUATION

ACRI-ST grading:

- Theoretical understanding of applied AI techniques (weight 50%)
- Practical evalution of written report, research quality and professional development (weight 50%)

BIBLIOGRAPHY & RESOURCES

Machine Learning in Python
Machine Learning and Data Mining for Astronomy
Variational Auto-Encorders
Image credits: S106 (NASA, ESA, Hubble Legacy Archive, Utkarsh Mishra). DIBs (Cox 2011).

CONTACT

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