Stage M2, 2019/2020

Measurement of galaxy redshifts from multi-band photometric data with machine learning

Context

Cosmology is entering an era of big data, with telescopes from the ground and in space providing images of hundreds of millions of galaxies, to study the distribution of matter on very large scales. The matter distribution is mapped on the one hand using weak gravitational lensing, the distortion of the images of high-redshift galaxies induced by foreground matter structures according to the Theory of General Relativity. On the other hand, galaxy clustering is used to trace the underlying dark-matter structures. In both cases, the redshift of galaxies needs to be estimated, using information from multiple broad bands in ultra-violet, visible, and infra-red wavelengths. The computation of precise *photometric redshifts* is of great importance for any modern cosmological experiment.

The goal of this M2 stage is to estimate photometric redshifts from the state-of-the-art UNIONS survey. This survey is comprised of imaging data from CFIS[1] (Canada-France Imaging Survey), Pan-STARRS[2], and HSC[3]. This ongoing multi-telescope survey will cover $4,800$ deg^2 in the Northern sky when completed. Around one third of that data will be available by the start of this internship.

The student will apply machine-learning techniques, including deep learning, to obtain precise photometric redshifts and error estimates.

Outline of the project

The tasks and objectives of the internship are as follows.

1. Get familiar with multi-band galaxy surveys, and available UNIONS data in particular.
2. Get familiar with photometric redshift estimation techniques, with focus on machine-learning approaches.
3. Apply machine-learning to UNIONS images to estimate photometric redshifts. Compare to existing measurements from previous, smaller, surveys, and analyse the performance and biases of the estimated redshifts.

Methods

During the stage, the student will work on multi-band imaging data. They will apply machine-learning methods, and analyse their performance.

[1] http://www.cfht.hawaii.edu/Science/CFIS/
[2] https://panstarrs.stsci.edu/
[3] https://www.naoj.org/Projects/HSC/

Scientific environment
The stage will be carried out in the CosmoStat[4] laboratory at the Département d'Astrophysique[5] (DAp) at CEA Saclay, under the joint supervision of Martin Kilbinger and Joana Frontera-Pons. CosmoStat hosts a multidisciplinary team whose research includes statistics, signal processing, machine learning, and cosmology. CosmoStat members are working on the weak-lensing analysis of CFIS.

Requirements
The candidate should be a Master 2 (or equivalent) student with background in either physics/astrophysics or applied mathematics/signal processing/data science. Experience with python is not required, but would be advantageous.

The application deadline is 15/01/2020. The duration of the internship is 4 – 6 months.

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