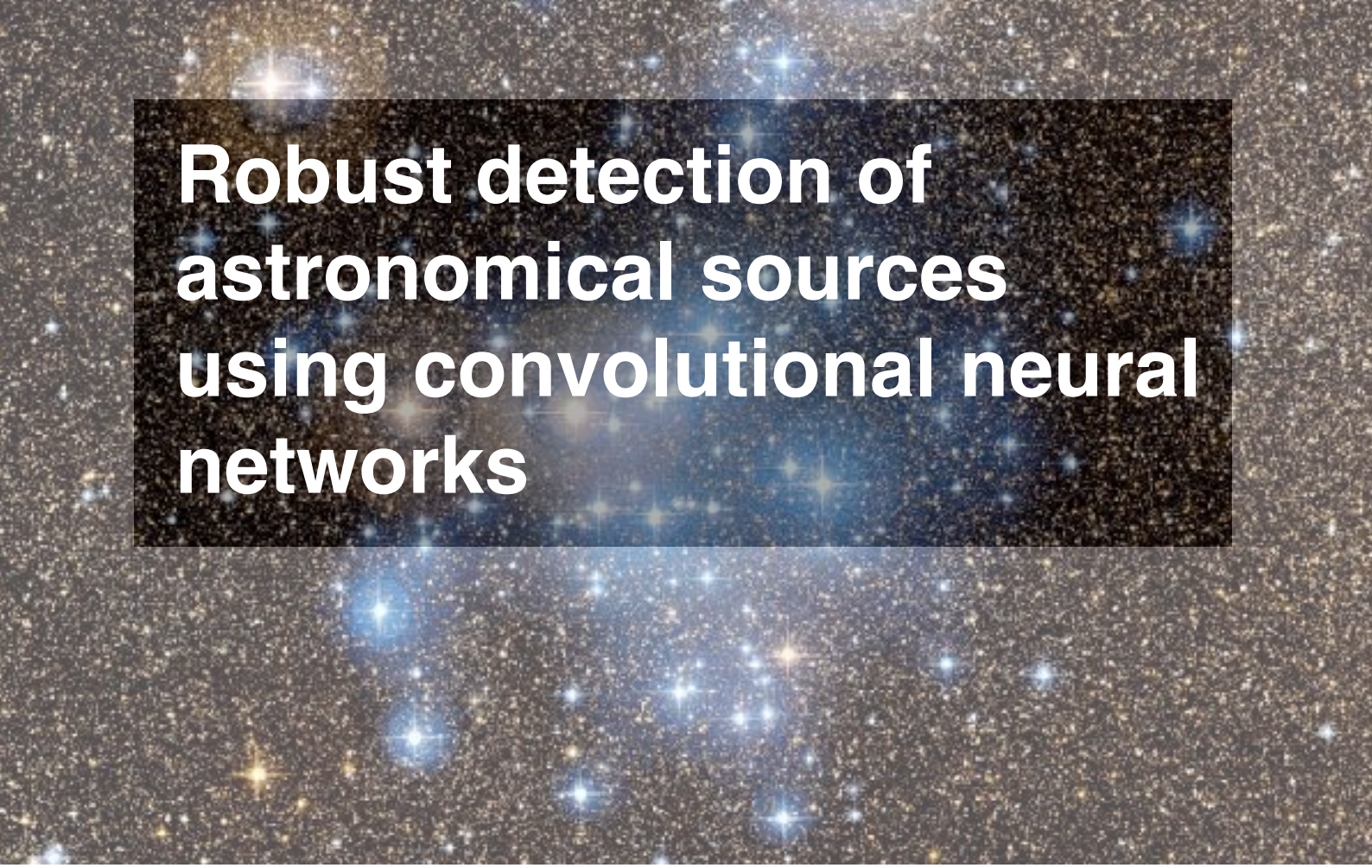

Robust detection of astronomical sources using convolutional neural networks

PhD Thesis

Contact

Emmanuel Bertin	bertin@iap.fr	Institut d'Astrophysique de Paris
Hervé Bouy	herve.bouy@u-bordeaux.fr	Laboratoire d'Astrophysique de Bordeaux

Location

University of Bordeaux

Important dates

- Application deadline: 31/03/2017
- PhD Start: early/mid September 2017

Keywords

Astronomy - Image/ Signal processing - Machine Learning - Deep learning - Joint PhD

Description

Most scientific results derived from astronomical images are obtained by analyzing catalogues of objects (essentially point sources and galaxies) that are extracted from those images. Automated and reasonably efficient algorithms are now capable of detecting and measuring billions of sources in large imaging surveys. These algorithms are largely empirical, and achieve a certain robustness towards the many contaminants that affect observations (neighboring sources, diffraction spikes, optical reflections, halos, cosmetic and charge transfer defects, cosmic ray hits, persistence, electronic patterns, ...).

However, their performance in terms of reliability and completeness is now insufficient with regard to the scientific requirements of current or forthcoming experiments (Cosmic-DANCe, Euclid mission, and the associated surveys). A qualitative leap is necessary, which must also satisfy the processing time constraints imposed by the large amount of data that must be processed.

The goal of this thesis is to address the problem of detecting and deblending sources by means of deep convolutional neural networks. This approach has proved its great potential during recent exploratory work by our team at IAP (Paillassa & Bertin 2016).

In contrast to machine learning techniques that have already been applied to astronomical data, the aim here will be to define and apply a multi-instance pixel labelling method directly from a heterogeneous set of multichannel images, relying on state-of-the-art techniques in the field. The sky background and the high dynamic range that characterize astronomical images will have to be taken into account.

This research work will require the development of a data augmentation procedure adapted to the problem (multi-epoch and multichannel content) and the manipulation of a large volume of image simulations and real observations in an intensive distributed computing environment, using the latest generation graphical computing (GPU) processors at LAB (Bordeaux) and IAP (Paris). The work on simulations and data will be done in close collaboration with the Euclid and CFIS teams at IAP (for low density fields), and Cosmic-DANCe in Bordeaux (high density fields).

The final aspect of this thesis will be the statistical validation of the models and algorithms on Euclid and ground image simulations as well as their application to actual Cosmic-DANCe and CFIS survey data.

It is a joint-PhD thesis between the Laboratoire d'Astrophysique de Bordeaux and the Institut d'Astrophysique de Paris. The student will be based at the University of Bordeaux, with regular visits at the IAP.

LAB and IAP offer very stimulating research environments with staff working in various areas of astrophysics and image processing. As a member state of ESO, ESA and CFHT, France has access to their first-class facilities. The beautiful city of Bordeaux offers one of the highest quality of living and a vibrant cultural life.

Funding is fully secured for the 3 years of the PhD, 50% by the CNES and 50% by an Idex grant at the University of Bordeaux.

Requirements, skills, qualifications

- **Degree**: Aspiring candidates must hold a degree equivalent to a European Master (5 years of Higher Education) or engineering degree in signal/image processing, or machine learning or astrophysics, or related fields.
- **Programming**: Experience with Python is welcome
- **Experience** in image processing is a plus, although all excellent applicants will be considered
- **Language**: Proficiency in either English or French is required
- **Nationality**: All nationalities are welcome to apply (subject to visa restrictions)

Creativeness and motivation are especially welcome.

Review of applications starts April 1, 2017, for a start early/mid September 2017.
The Doctoral studies require no more than three years.

Salary & Benefits

The gross monthly stipend is 1,680 euros the first year and a half, increasing to 1,945 euros the last year and a half.
The contract carries medical insurance and other social benefits in addition to a stipend. Contracts are awarded and administered by the CNES and university of Bordeaux doctoral department. Doctoral contracts are true employment contracts to the extent that they are enforceable by law and carry all of the benefits attached to such contracts under French law.

Application

Applications should include a CV, a letter of motivation and a brief description of past research and future plans, as well as 2 or 3 letters of reference. These documents must be submitted by email as a PDF file.