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Galaxy detection with deep learning in radio-astronomical datasets

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Large astronomical facilities generate an ever-increasing data volume, rapidly approaching the exascale, following the need for better resolution, better sensitivity, and larger wavelength coverage. Modern radio astronomy is strongly affected, especially regarding giant radio interferometers that produce large quantities of raw data. In particular, the forthcoming arrival of the SKA (Square Kilometer Array) will revolutionize the field of radio astronomy and the associated processing methods. This instrument is foreseen to have the necessary sensitivity to set constraints on the cosmic dawn and to trace the evolution of astronomical objects over cosmological times. SKA's projected raw data rate is about 1 TB/s, which should generate 700 PB/year of archived data.

In this context, the MINERVA team from the Paris Observatory has developed a new galaxy detection and characterization method for massive radio astronomical datasets by adapting modern deep-learning object detection techniques. These approaches have proved their efficiency on complex computer vision tasks, and we seek to identify their specific strengths and weaknesses when applied to astronomical data.

In this presentation, I will introduce YOLO-CIANNA, a highly customized deep-learning object detector designed for astronomical datasets. I will describe the method itself as well as several low-level adaptations that were required to address the specific challenges of radio-astronomical image analysis. I will then present how this method performs on simulated 2D continuum images and HI emission cubes from the first two editions of the SKA Observatory Science Data Challenges. Finally, I will discuss the difficulties that arise when applying this new approach to real observational data from SKA precursor instruments.

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