UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee PhD
information technology
electrical engineering

DIETI

UNINA

UDCNet a Deep Learning Architecture for detection and characterization of sources in radio data cubes

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Tutor: Vincenzo Moscato
Co Tutor: Giuseppe Longo

Cycle: 35th Year: second

My Background

- Msc Degree: Physics, University of Naples Federico II;
- Research Group: PICUS, DAME, COIN;
- PhD Start Date: November 2019;
- Scholarship type: Company founderd;
- Partner Company: EUSTEMA RND Lab Naples.

Research Field of Interest

- Deep Learning for detection and characterisation of sources in 3D Volumes, application to SKA (Astro), APERITIF (Astro), Breast-MRI (e-Health) and PRISMA (Geology);
- automatic preprocessing pipelines for Radio Telescopes such as SKA and APERITIF;
- Hybrid models, i.e. models which use clustering to enhance the performance of classification models. Application of HyCASTLE to problems of interest;
- Computer Vision;
- Data Science: several collaborations with Dermatologists, Oncologists, Dentists have been established in order to bring our know-how to their fields of interest;

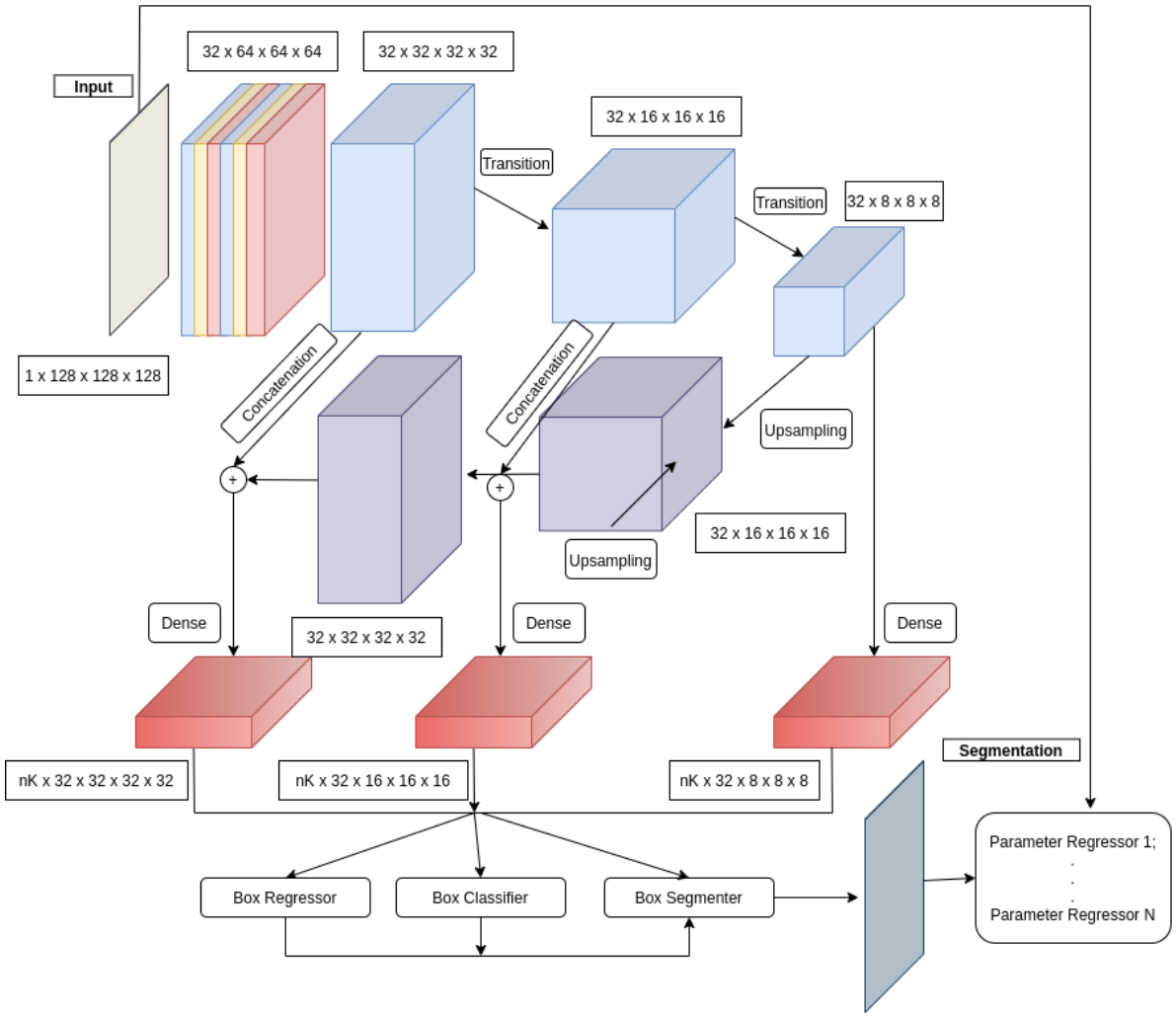
Study Activities

- MSc Courses: Information Theory, Elaborazione dei Segnali Digitali;
- Seminars: Picariello Lectures on Data Science, and specific seminars of interest for my research;
- Conferences:
  - IAU Challenges and Innovations in Computational Astrophysiscs - Presentation HyCASTLE
  - European Astronomical Sociaty Annual Meeting 2021 - Presentation UDCNet and SKA preliminary results;
  - Third national Workshop on the SKA Project
  - From Cells To Galaxies: Exploring the Synergies between Radio Astronomy and Medical Imaging

Research activity: Thesis

Problem: can Deep Learning can be applied to find and characterise sources inside data cubes produced by interferometric radio telescopes such as SKA?
Objective: there is a strong interest in the Radio Data community for Deep Learning detection pipelines (Big Data Regime Astrophysics).
Several have been developed for MRI Data, given the similarities between the data products, can we use the knowledge acquired in the e-Health field to develop our own architecture and obtain reliable performances on Astrophysical data while also retaining competitive performances on medical data?
Prospective: develop a custom architecture and test its performance on four datasets: SKA, APERITIF, Breast-MRI and PRISMA. On the first one there is a direct competition with other methods (SKA-Data Challenge 2), on the third one the collaboration with EUSTEMA.

UDCNet - UNet-like Detection and Characterization Network (a.k.a. we still have to find a name for it..!)



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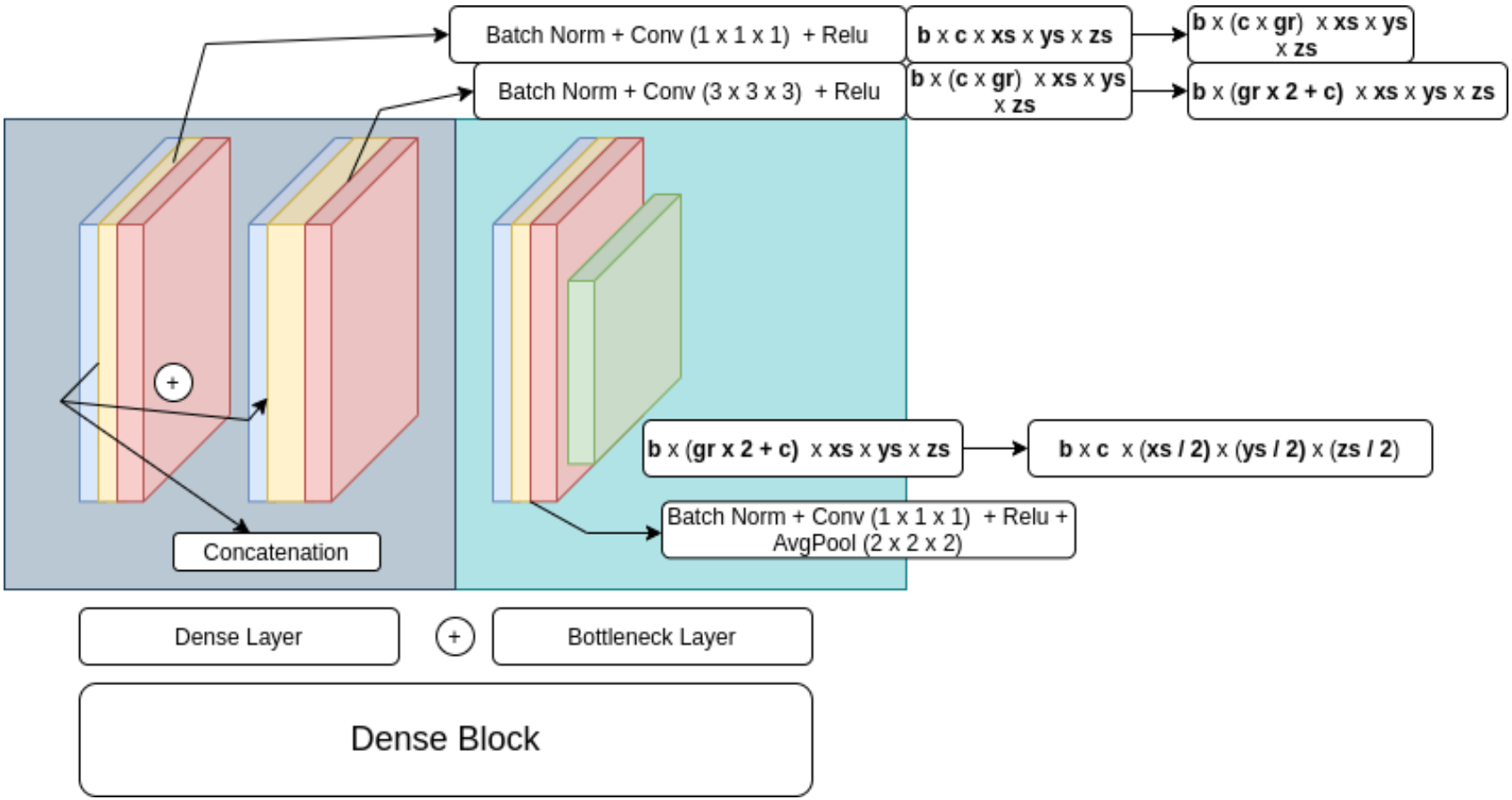
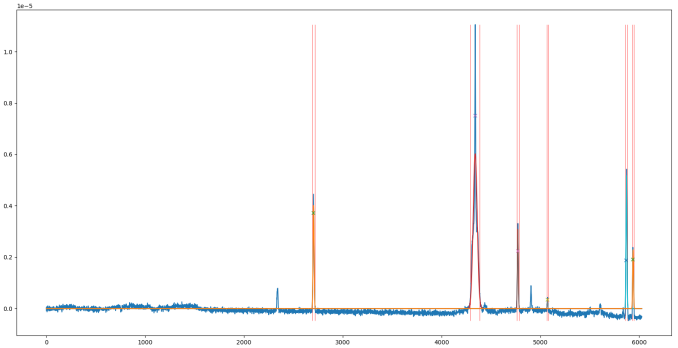
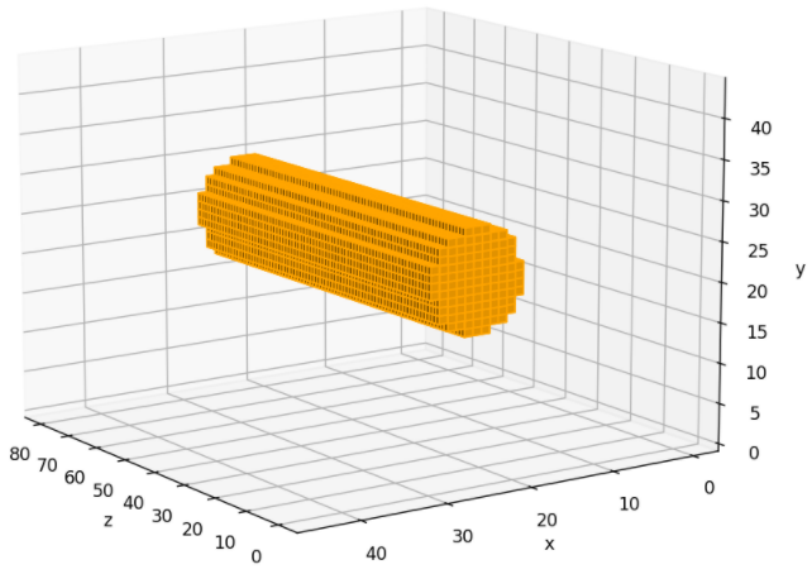


Applications

Progress on SKA Data

- Automatic bad channels flagging and elimination;
- Segmentation masks and bounding boxes are produced from sources morphological parameters - **source modelling**;
- Data augmentations and patch based batching.





Research Products

P1	A novel approach to the classification of terrestrial drainage networks based on deep learning and preliminary results on solar system bodies. 12 March 2021, Nature Sci Rep 11, 5875 (2021)
P2	Periodic Astrometric Signal Recovery Through Convolutional Autoencoders Part of the Emergence, Complexity and Computation book series (ECC, volume 39)
P3	Effectiveness and Safety of Long-Term Dupilumab Treatment in Elderly Patients with Atopic Dermatitis: A Multicenter Real-Life Observational Study, 22 July 2021 American Journal of Clinical Dermatology, doi: 10.1007/s40257-021-00597-5
P4	A new source detection and characterization pipeline for radio data-cubes: application to the SKA-DC2 EAS 2021 Conference 28/06/2021 – 02/07/2021
P5	HyCASTLE: a Hybrid Classification System based on Typicality, Labels and Entropy AU Challenges and Innovations In Computational Astrophysics – II Live Zoom Meeting 18 – 21 November 2020