

Status of Machine Learning in Astronomy

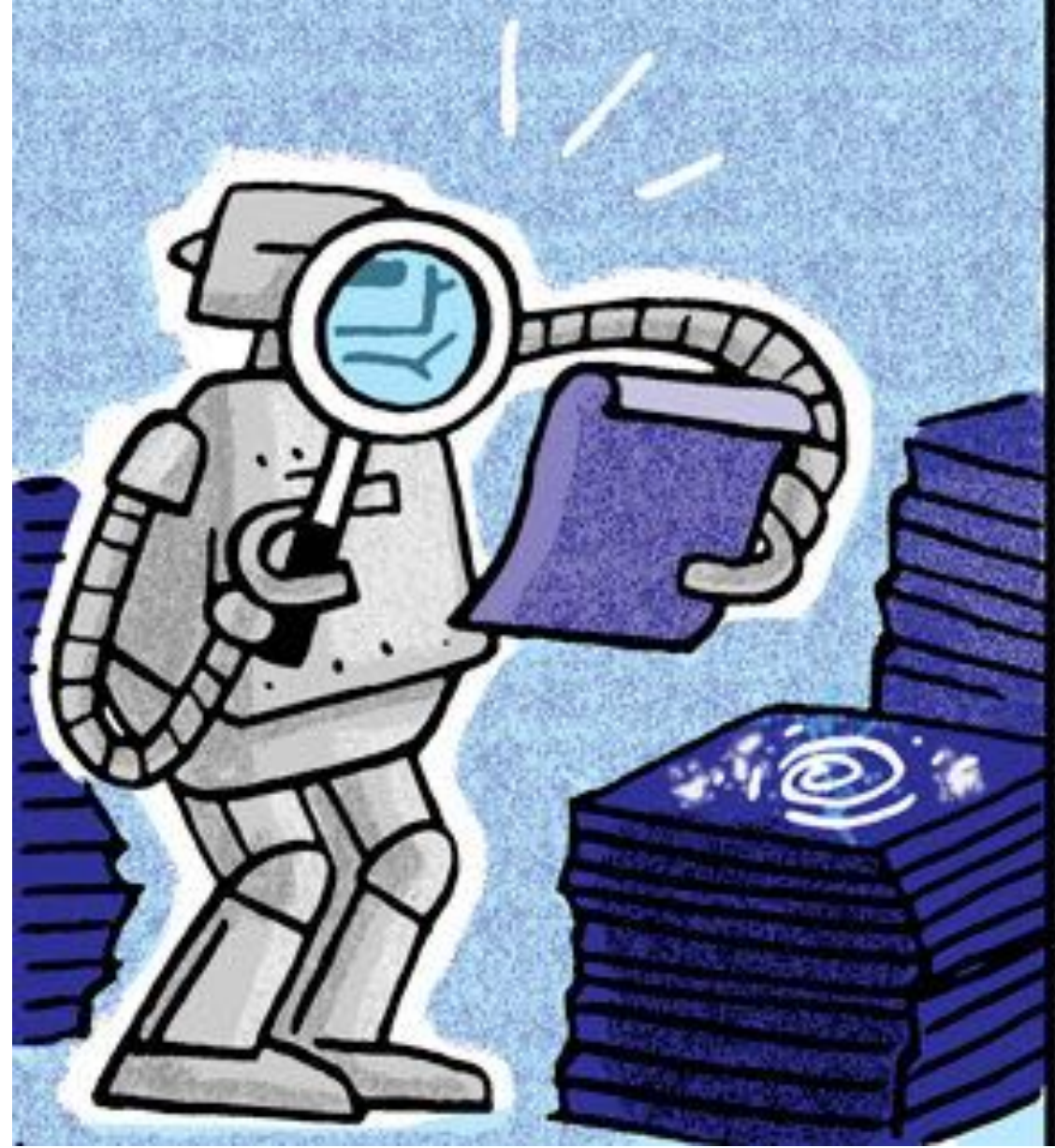
Nikhel Gupta

CSIRO Future Science Platform for MLAI
CSIRO Space & Astronomy

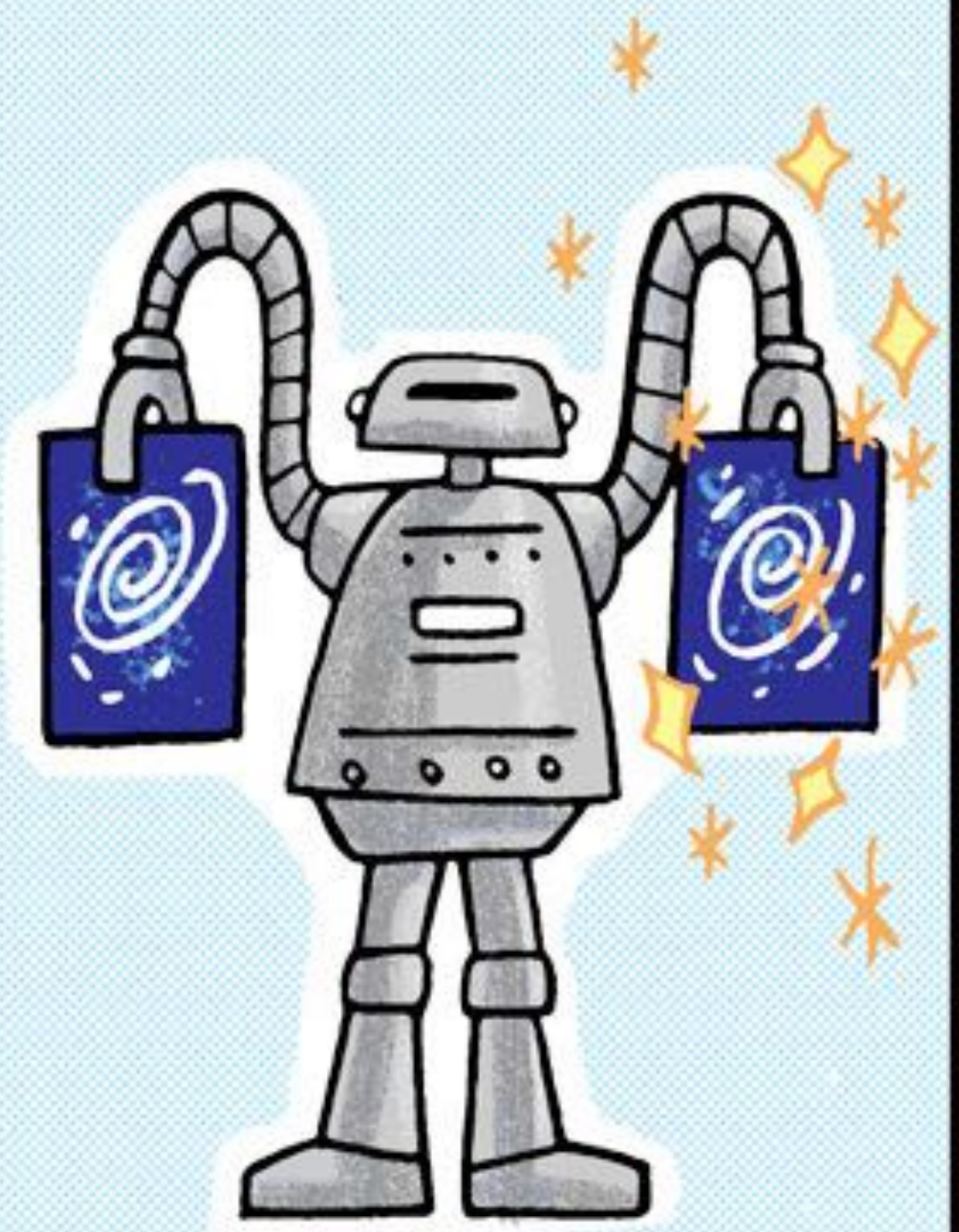


MACHINE LEARNING HELPS OUT

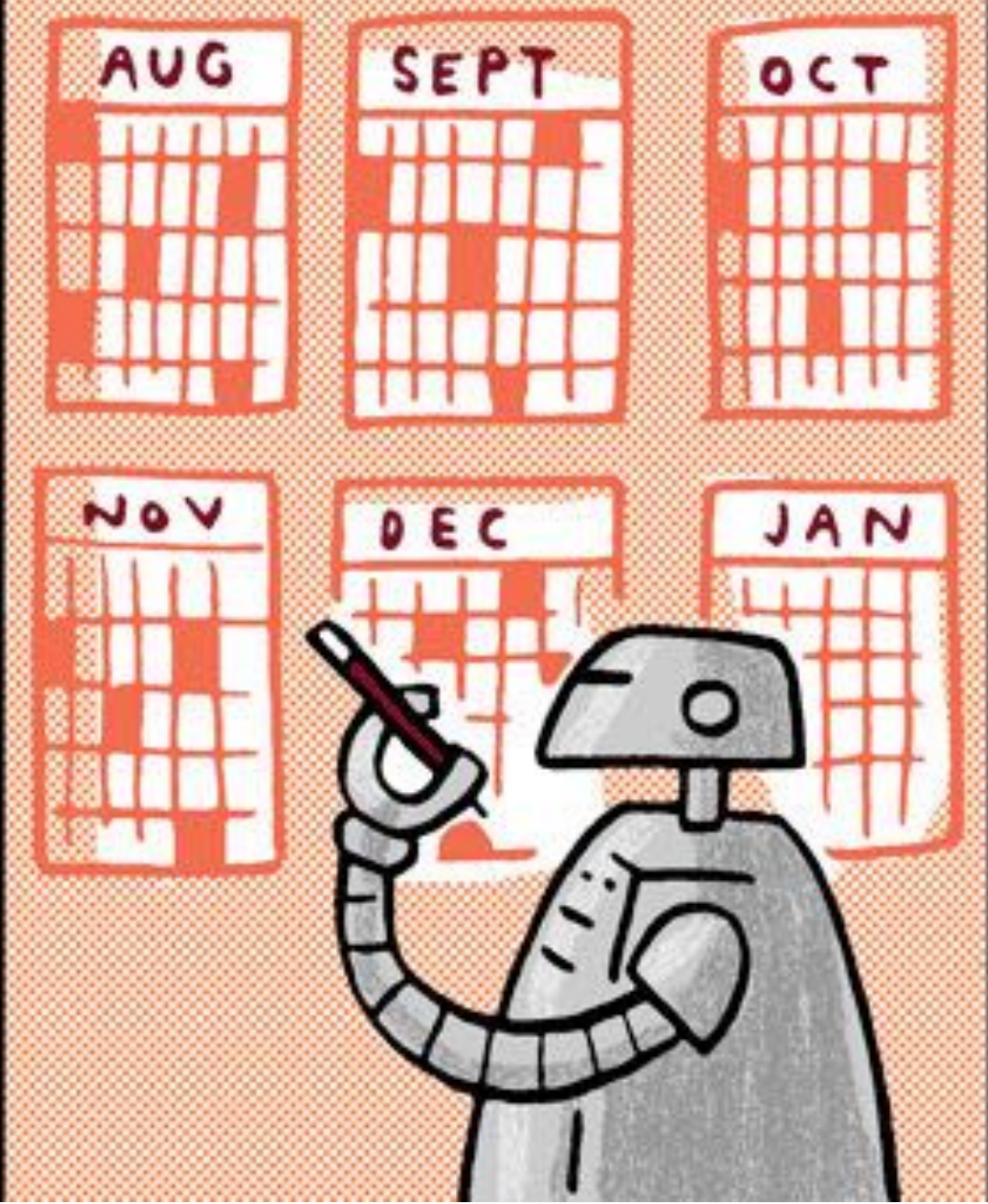
OBJECT
DETECTION/
CLASSIFICATION



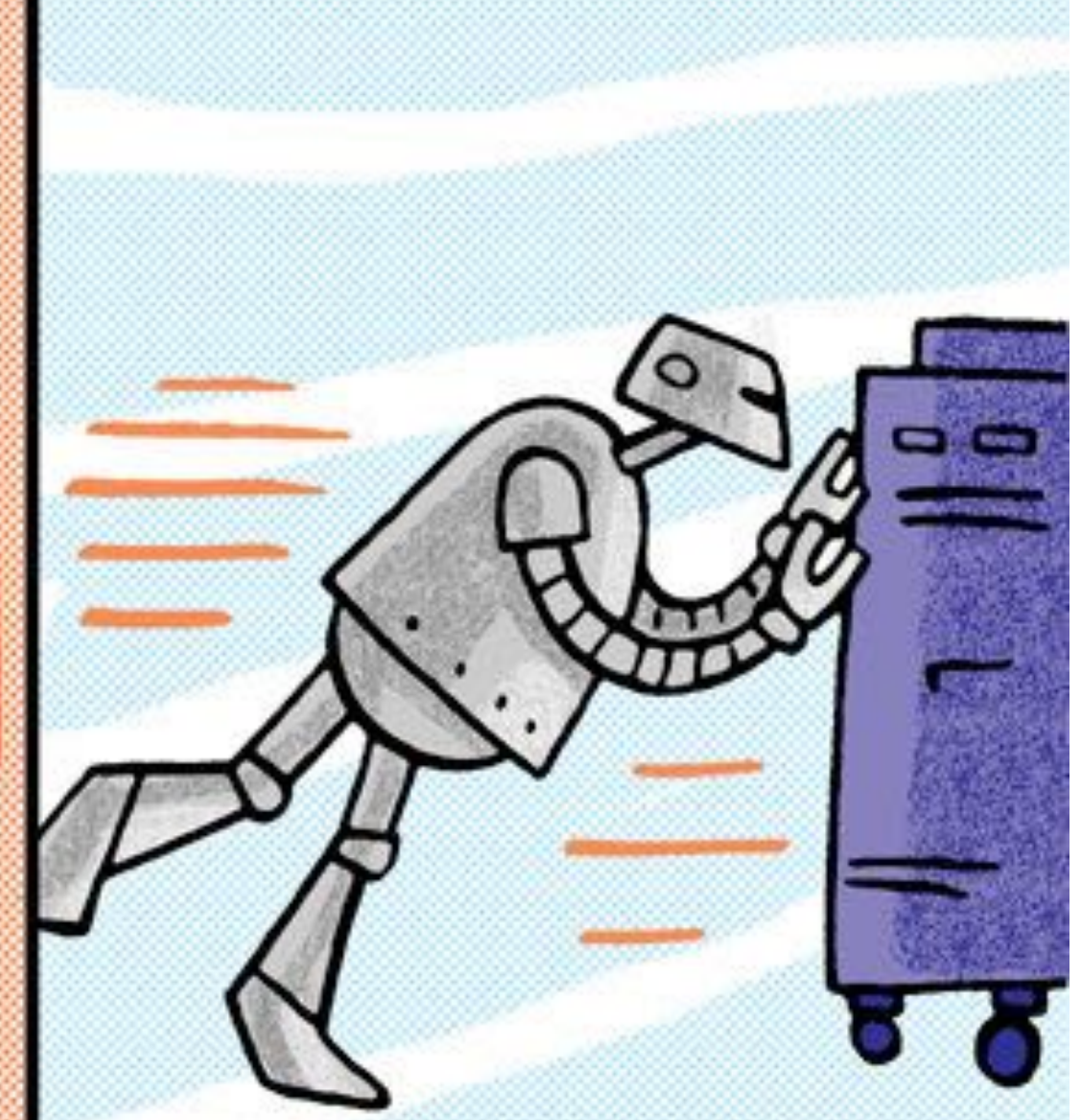
CLEANING
IMAGES

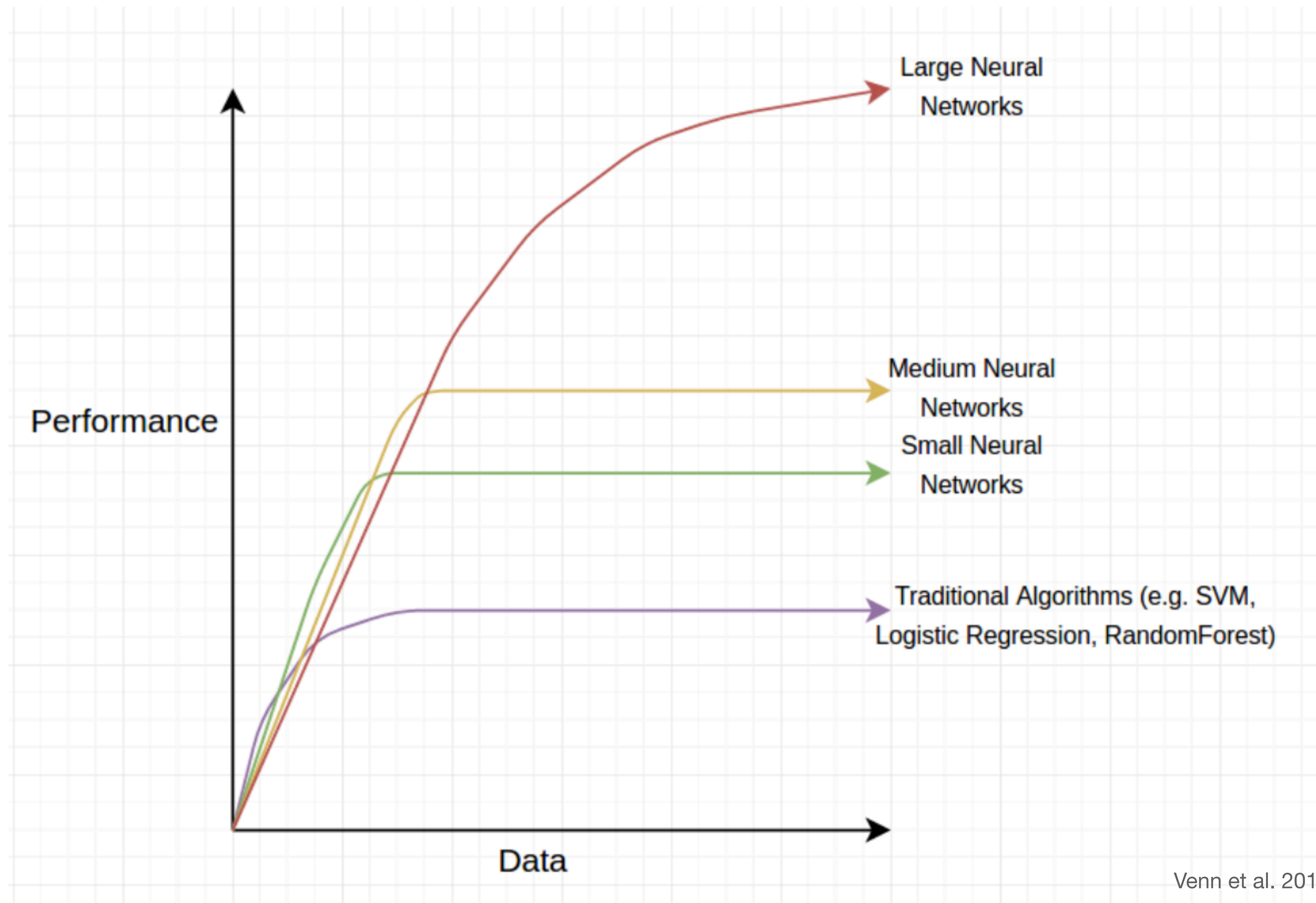


MAKING
SCHEDULES



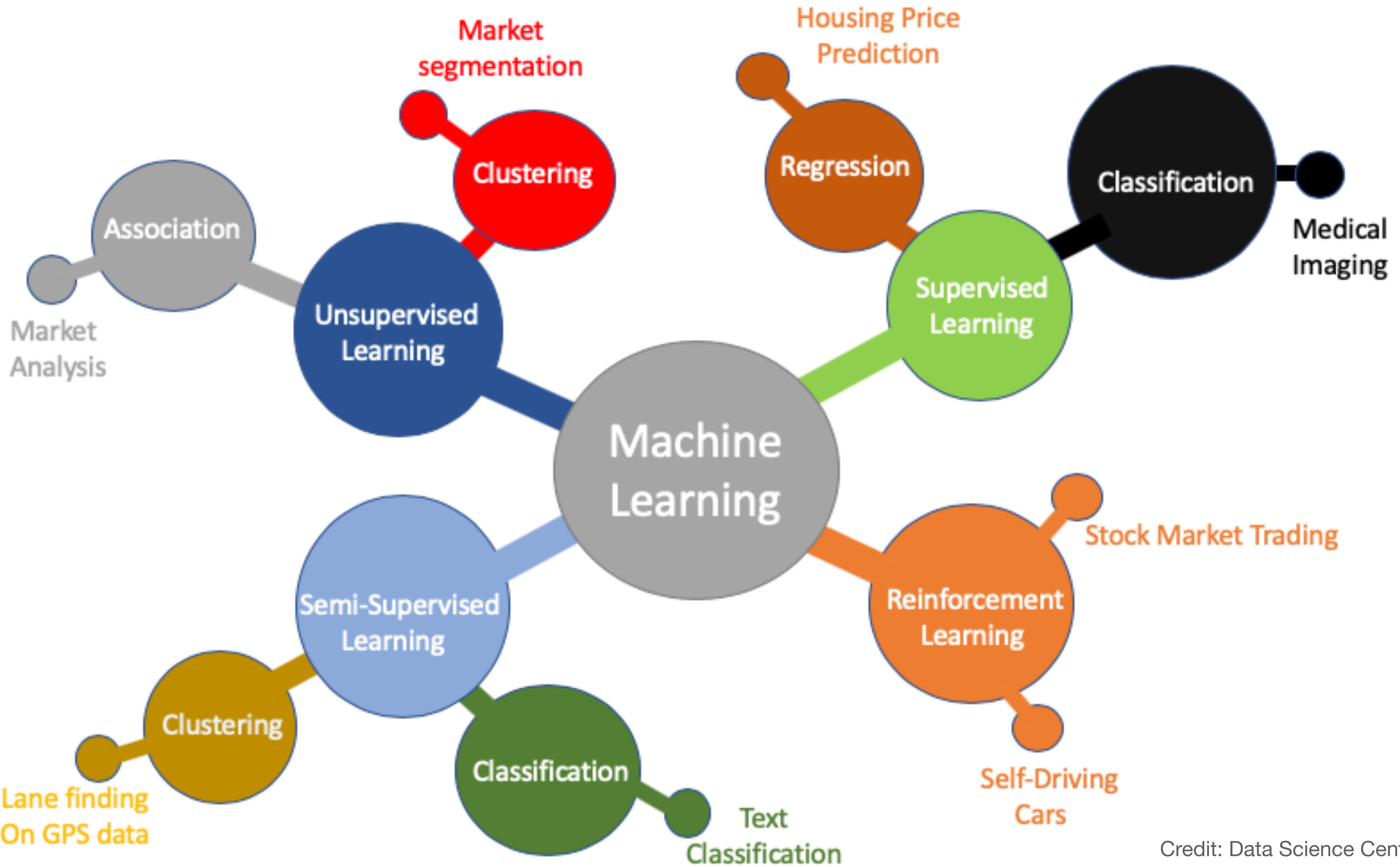
MAKING
SIMULATIONS
GO FASTER





Venn et al. 2019





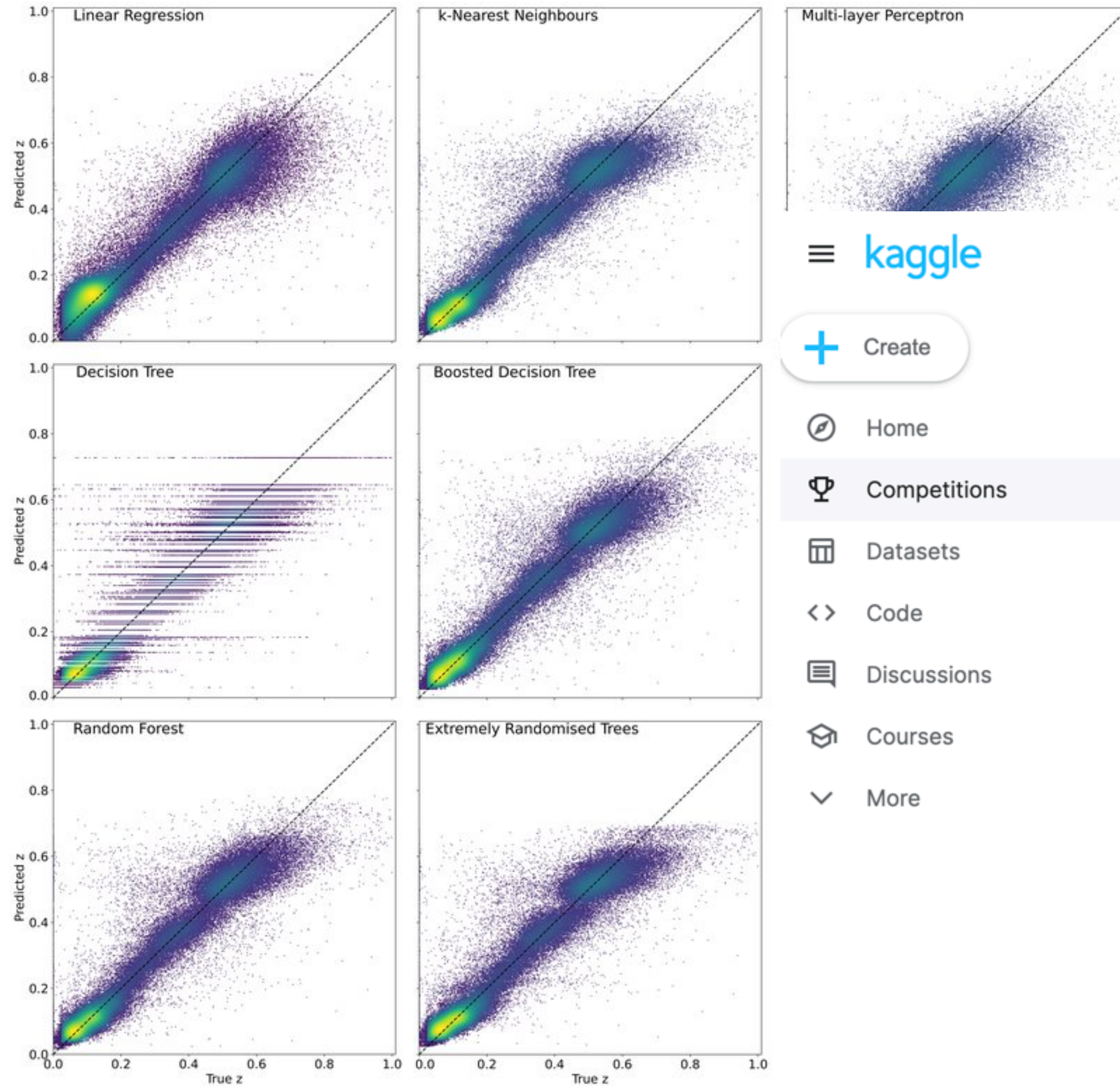
Credit: Data Science Central





Credit: Data Science Central

Supervised Learning in Astronomy Examples



Henghes et al. 2021

Redshift estimations Catalog space i.e. using tables

The screenshot shows the Kaggle interface for a competition titled "Machine Learning for photo-z estimation". The page includes a search bar, navigation links (Home, Competitions, Datasets, Code, Discussions, Courses, More), and a detailed description of the problem. The description states that galaxy redshift surveys are used to probe cosmological models, and that the baryonic acoustic oscillation (BAO) sound horizon can be used as a standard ruler to characterize the expansion rate of the Universe. A precise measurement of the redshifts of galaxies is fundamental to extract this information.

Machine Learning for photo-z estimation
Investigate the use of recent advances in machine learning to design a new photometric redshift estimation procedure.

11 teams · 2 years ago

[Overview](#) [Data](#) [Code](#) [Discussion](#) [Leaderboard](#) [Rules](#)

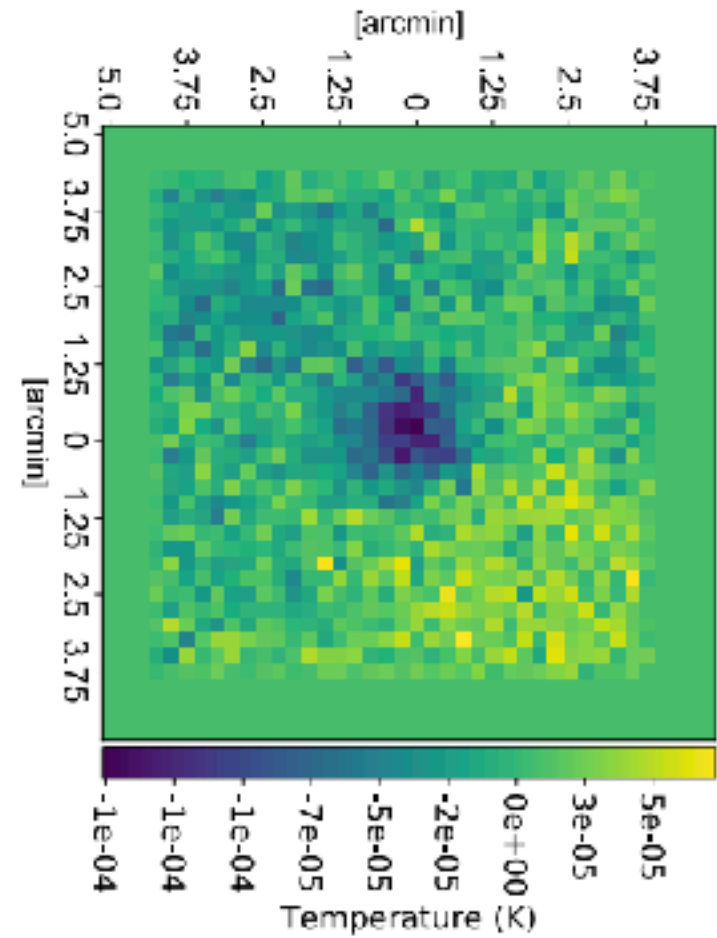
Problem description

Galaxy redshift surveys are among the main observational tools to probe cosmological models. The leading methods measure the distance scale imprinted in the large-scale distribution of galaxies by oscillations in the primordial baryon-photon plasma. This baryonic acoustic oscillation (BAO) sound horizon can be used as a standard ruler to characterize the expansion rate of the Universe at different times, thereby providing constraints on cosmological parameters such as the total matter and dark energy densities. A precise measurement of the redshifts of galaxies is fundamental to extract this

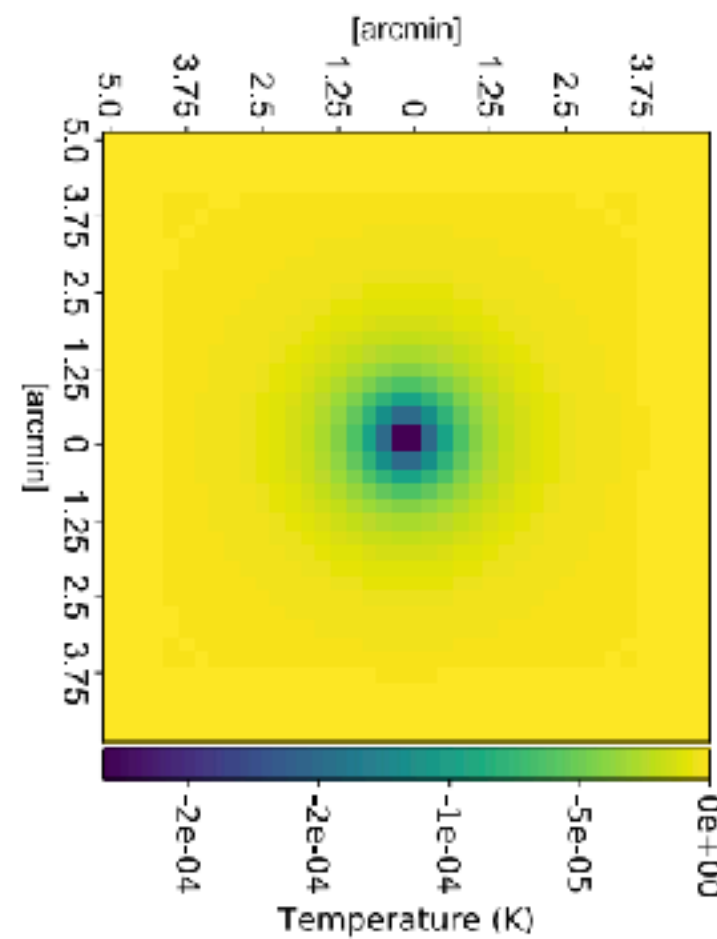
Supervised Learning in Astronomy Examples

Mass Estimation (Image Space)

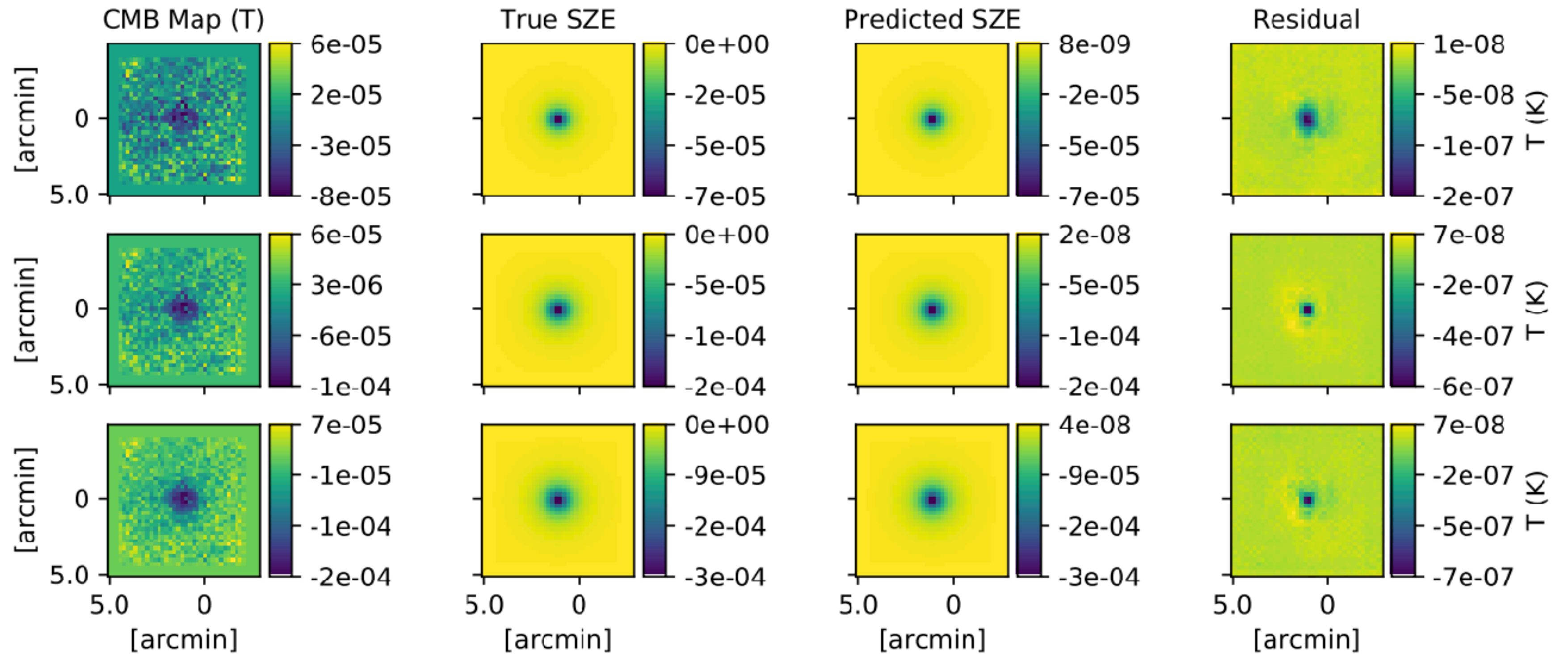
Gupta et al. 2020, 2021



mResUNet



+ M_{200c}



Supervised Learning in Astronomy Examples

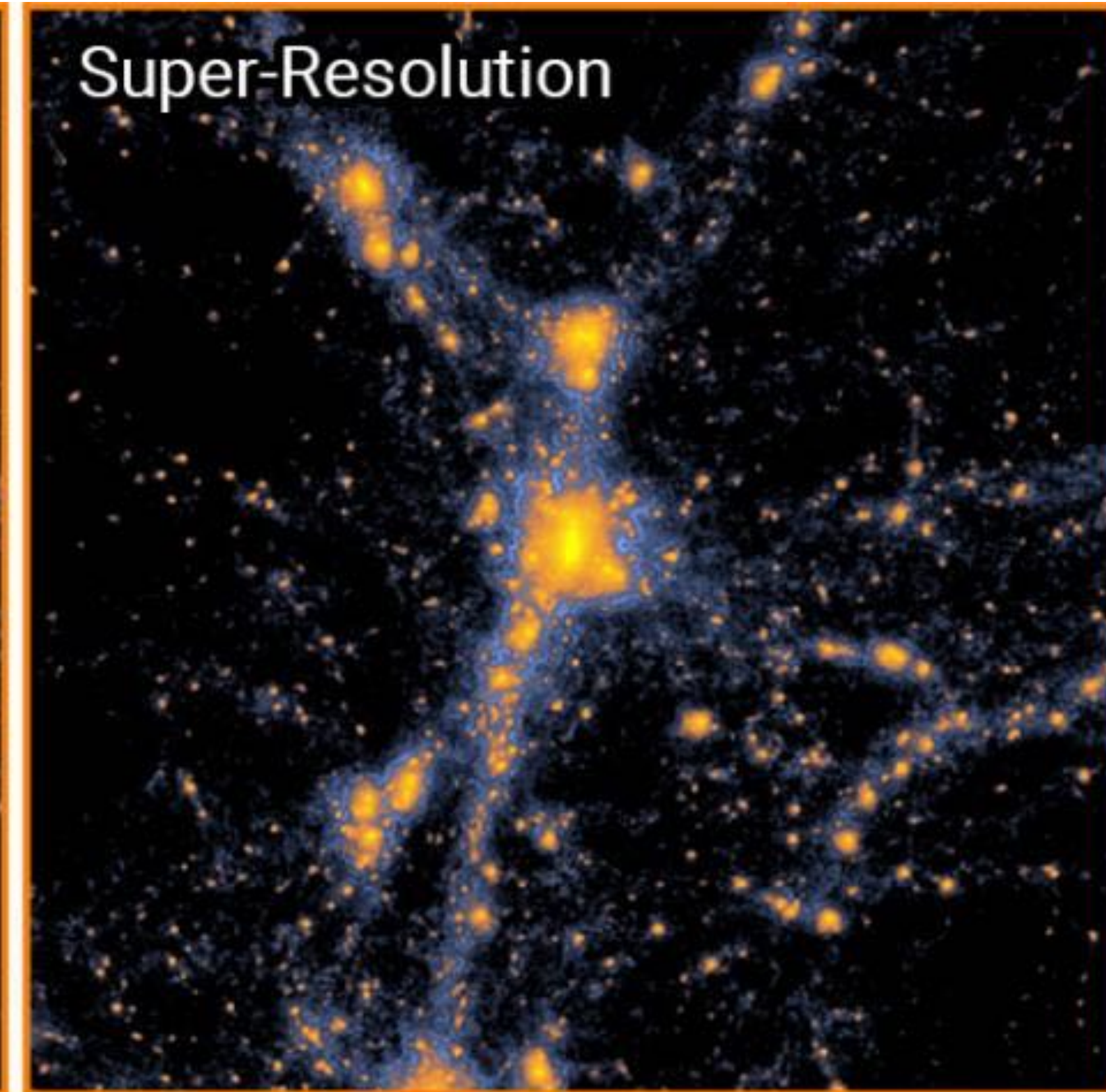
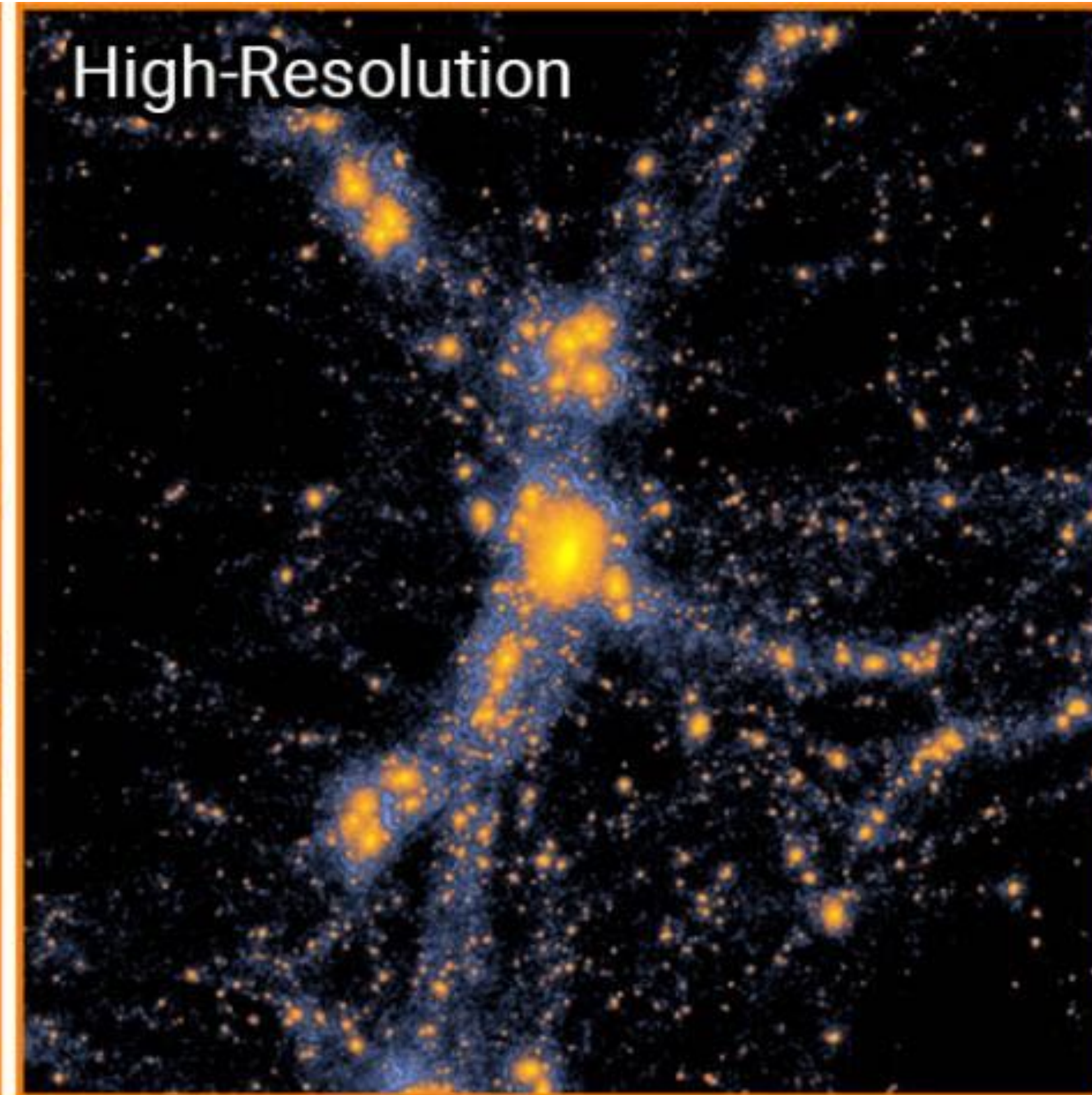
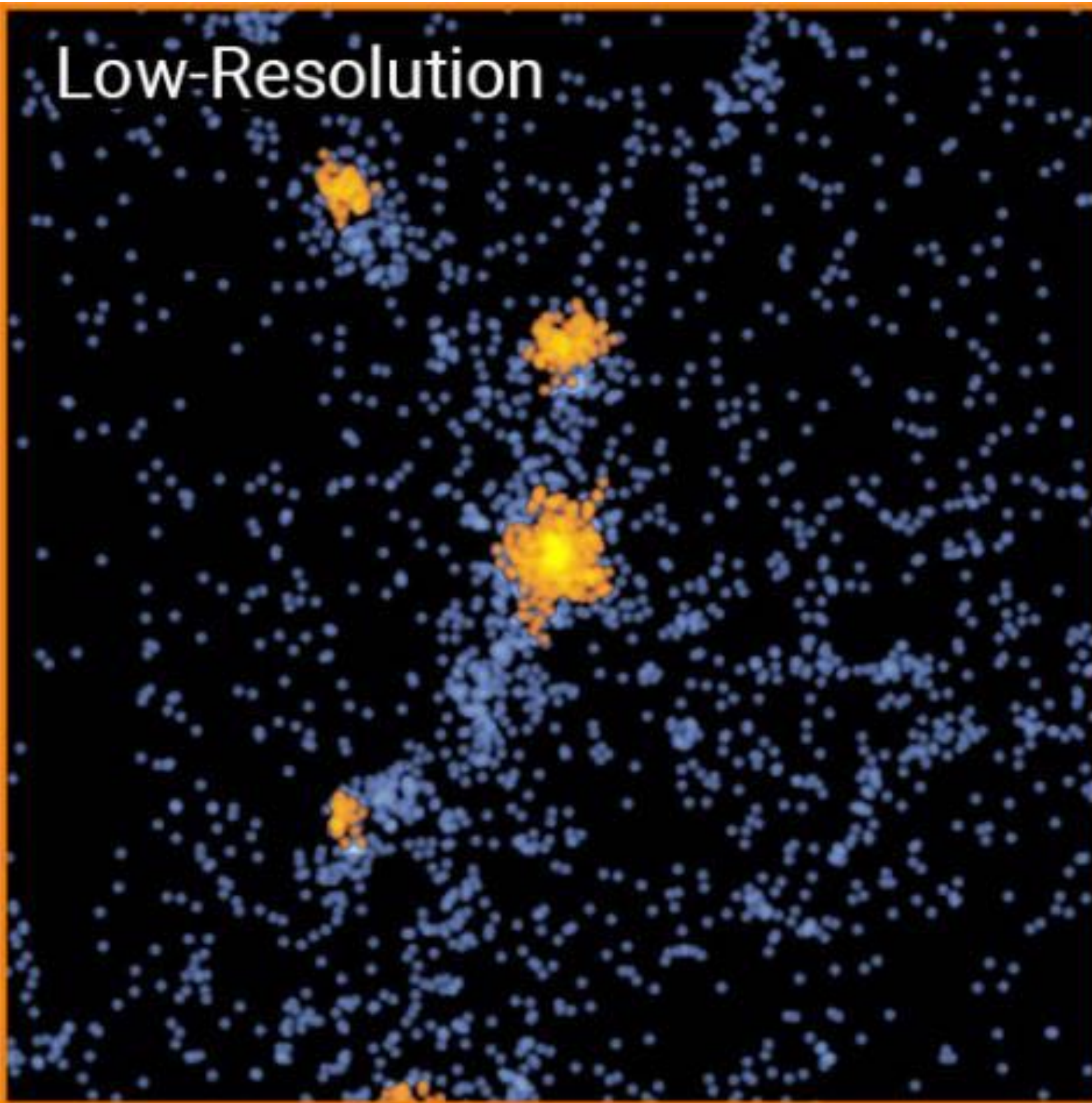
Making simulations fast (Image Space)

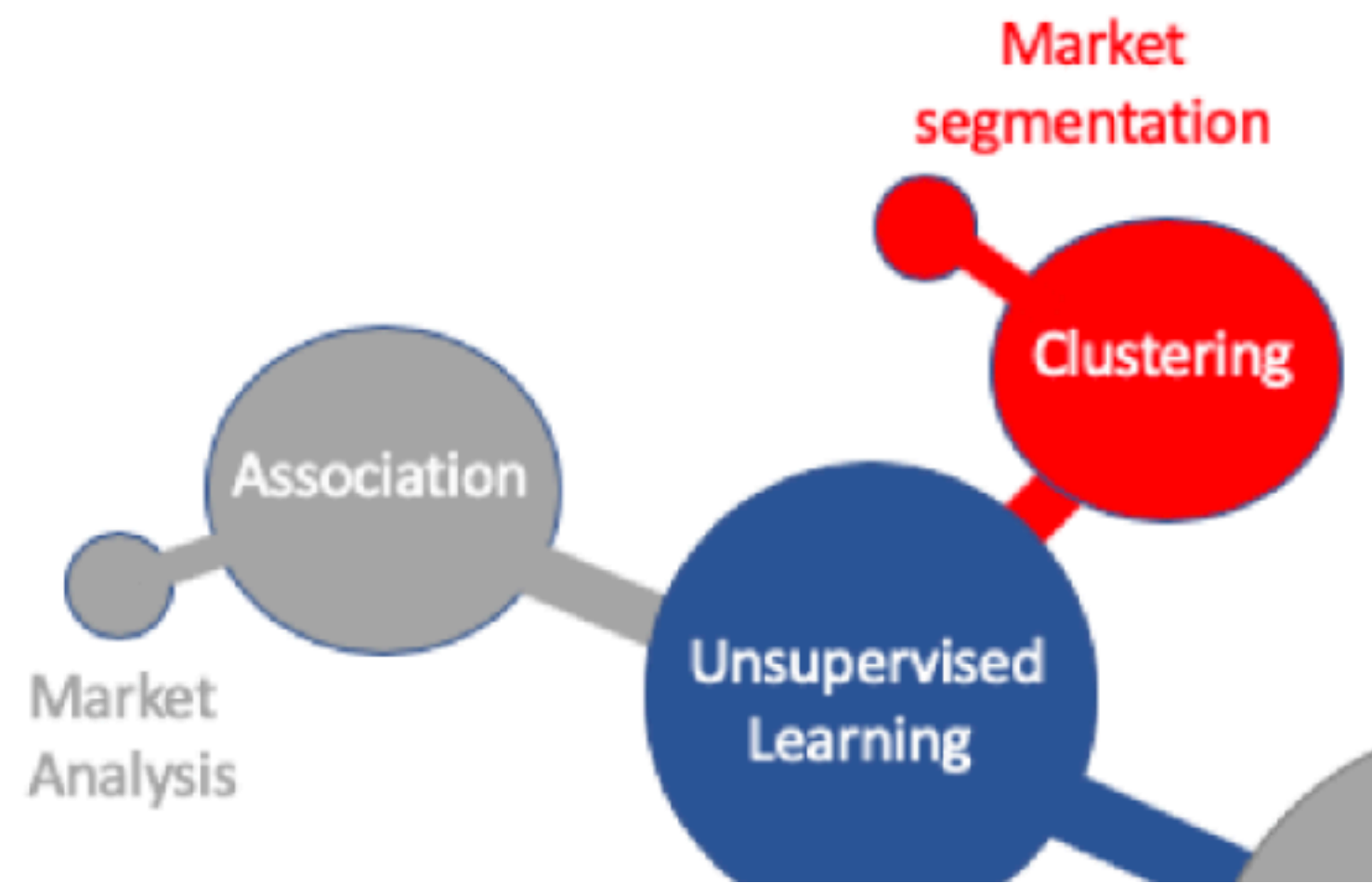
Y. Li et al. 2021

Low-Resolution

High-Resolution

Super-Resolution

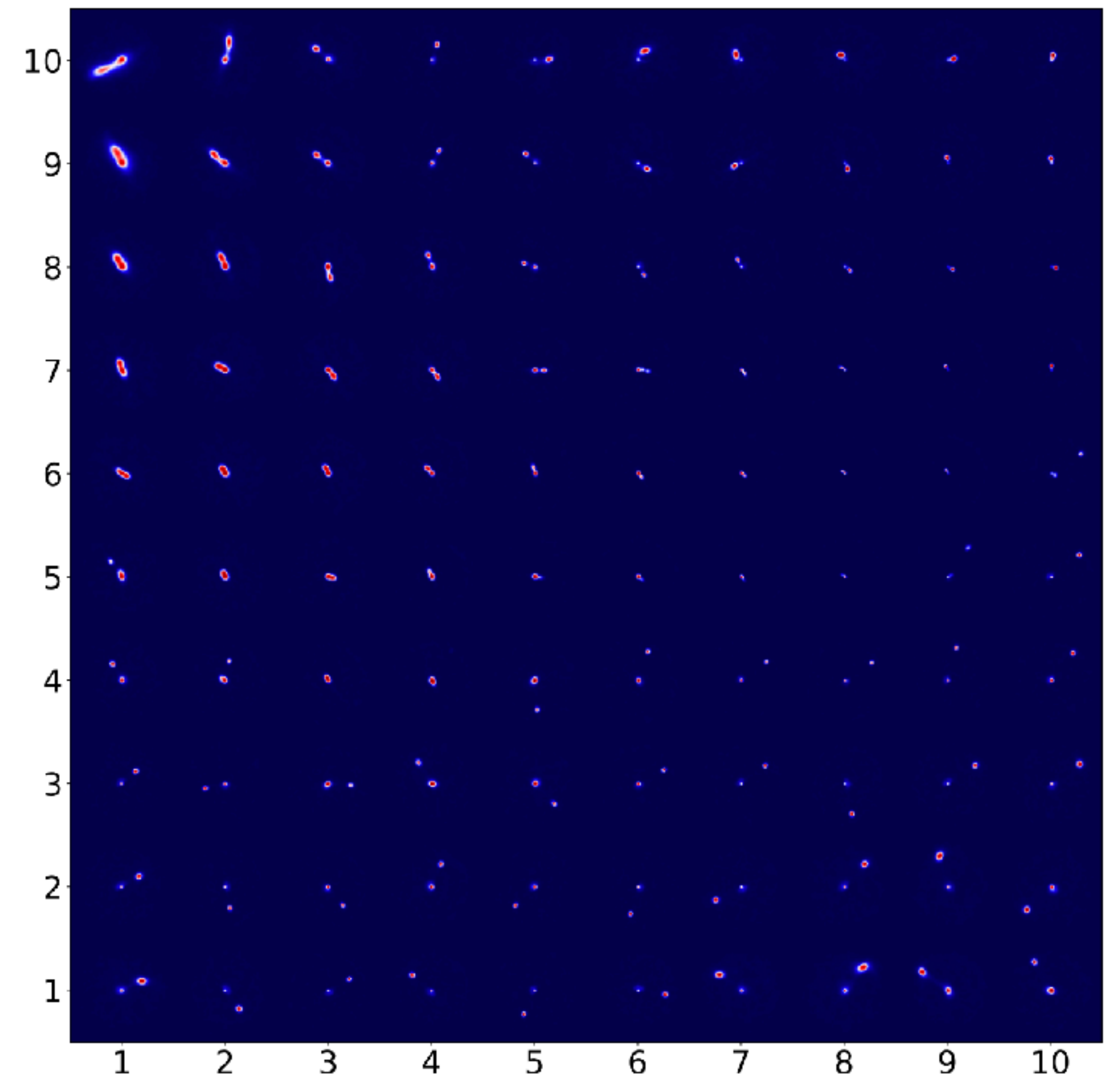
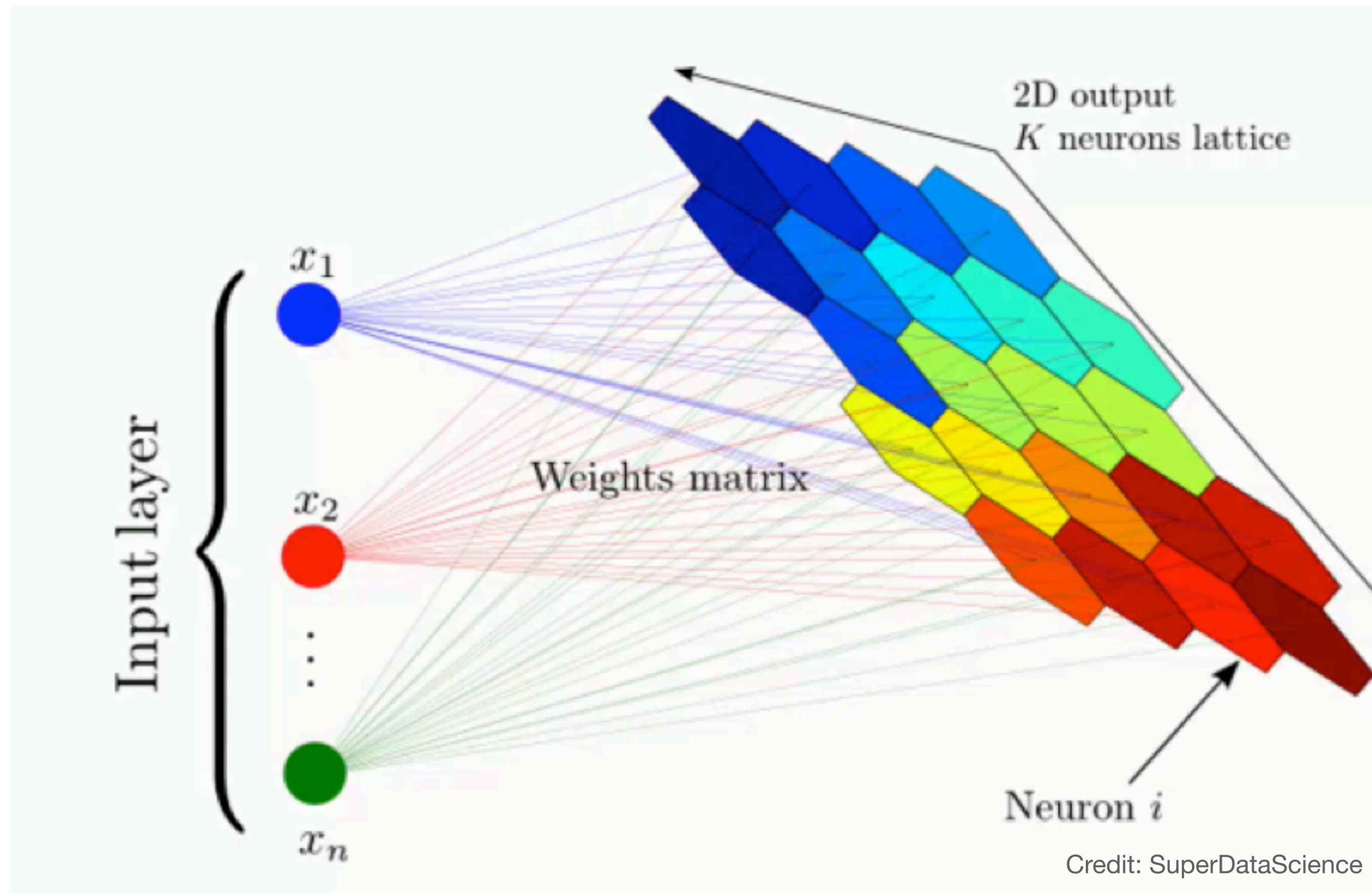




Credit: Data Science Central

Un-supervised Learning in Astronomy Examples

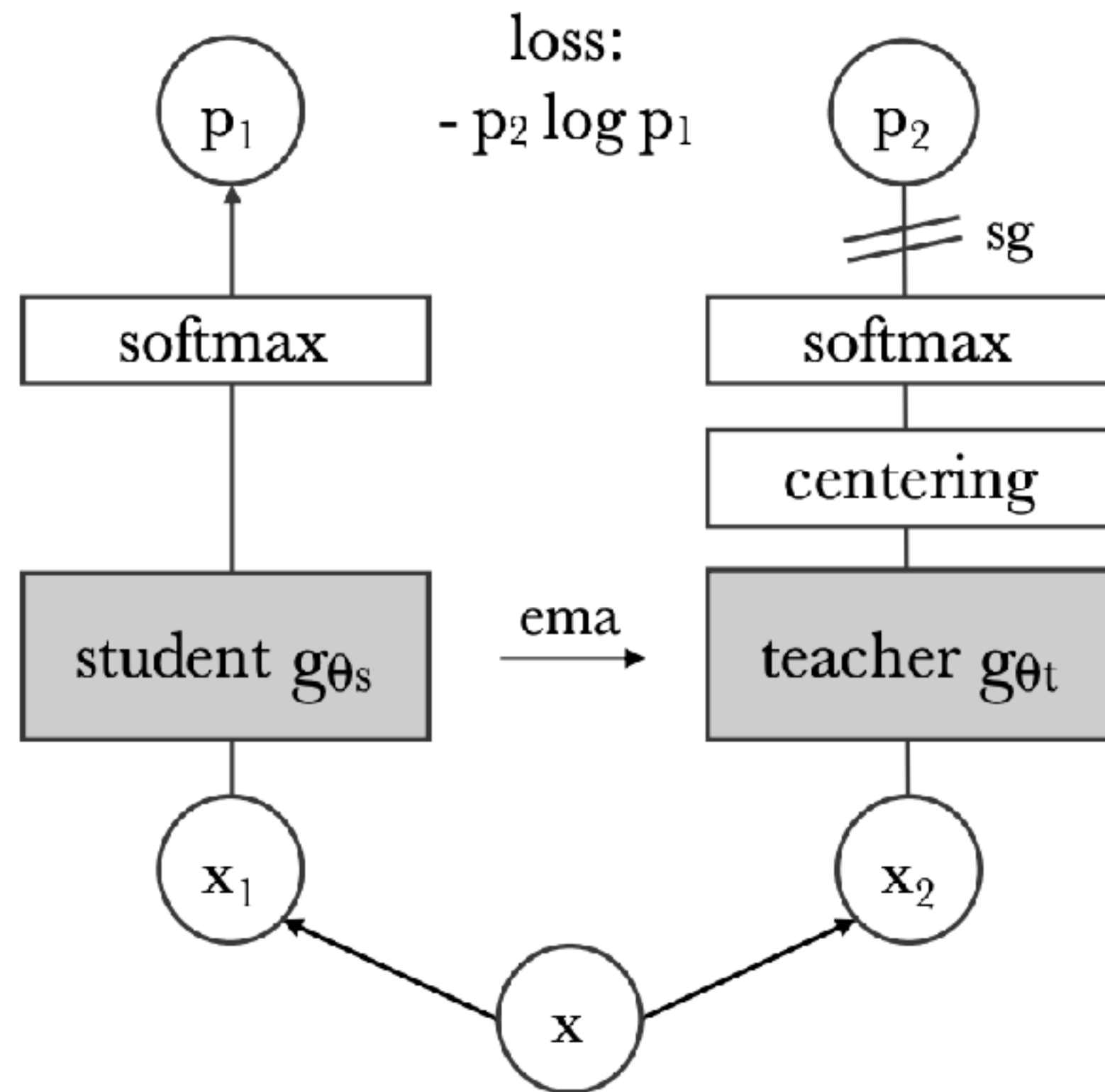
(1) feature extraction, (2) clustering, (3) visual representation



Self Organising Maps

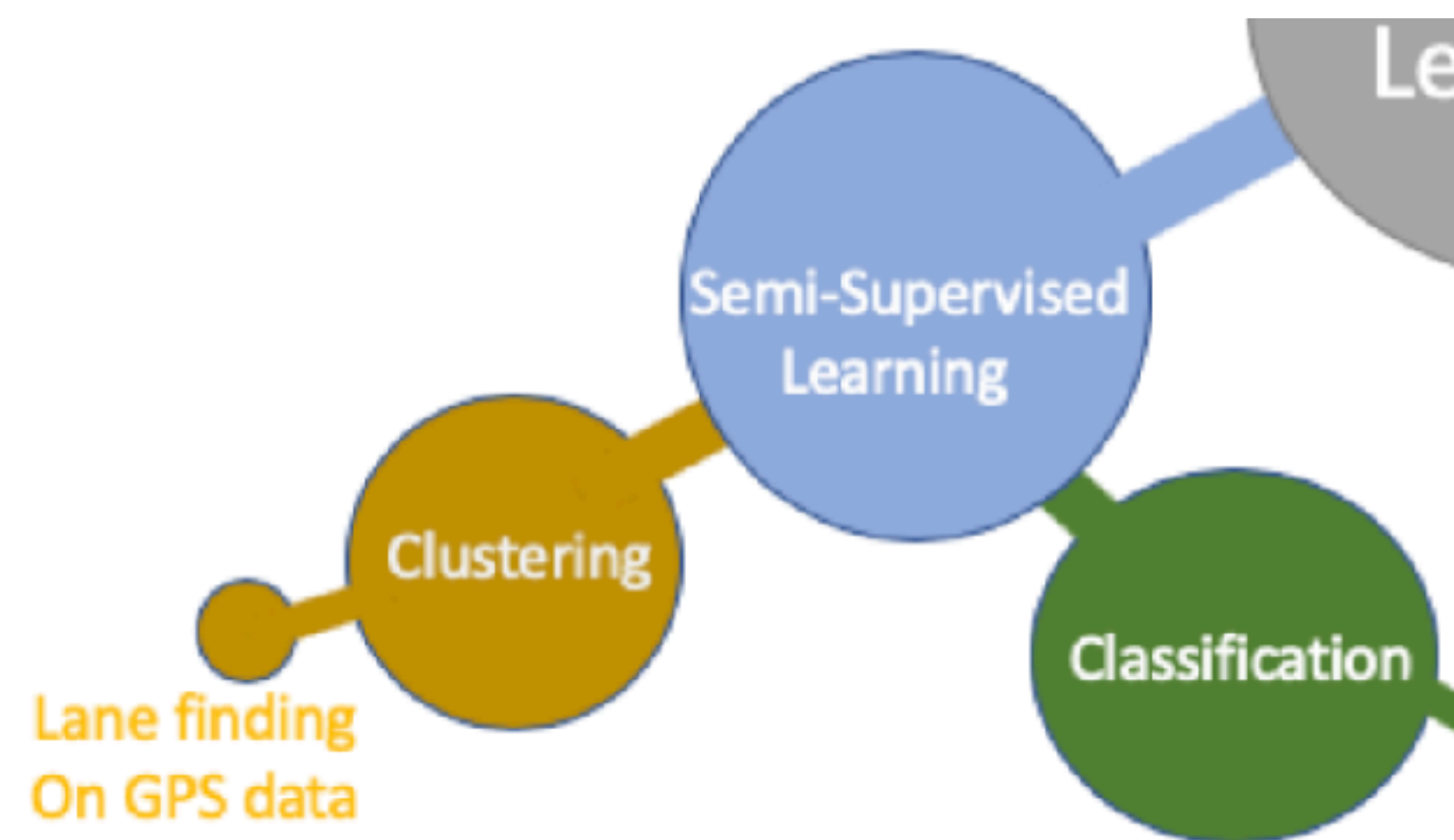
Un-supervised Learning in Astronomy Examples

(1) feature extraction, (2) clustering, (3) visual representation



Student Teacher self-supervised networks

Webb et al. 2020

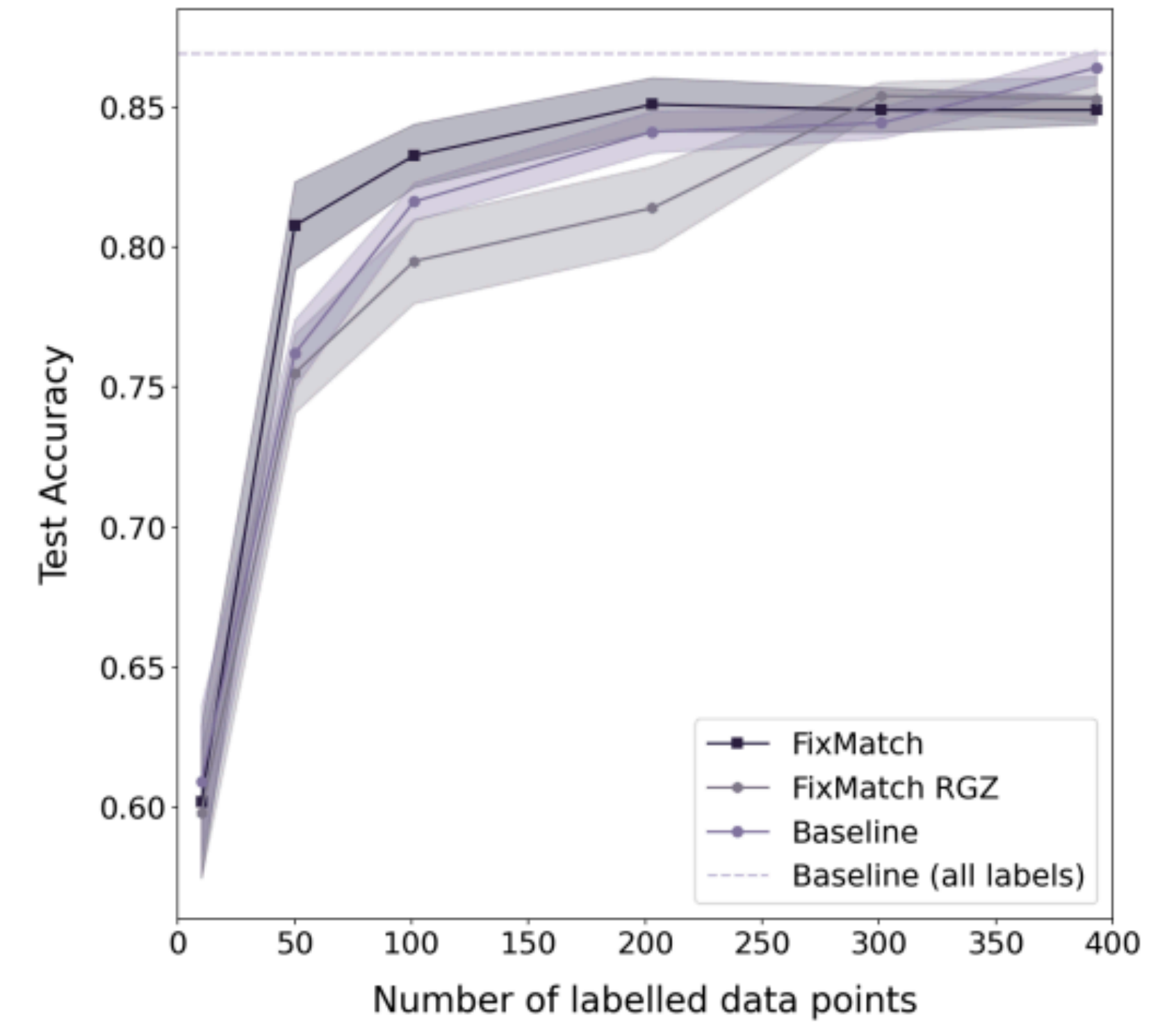
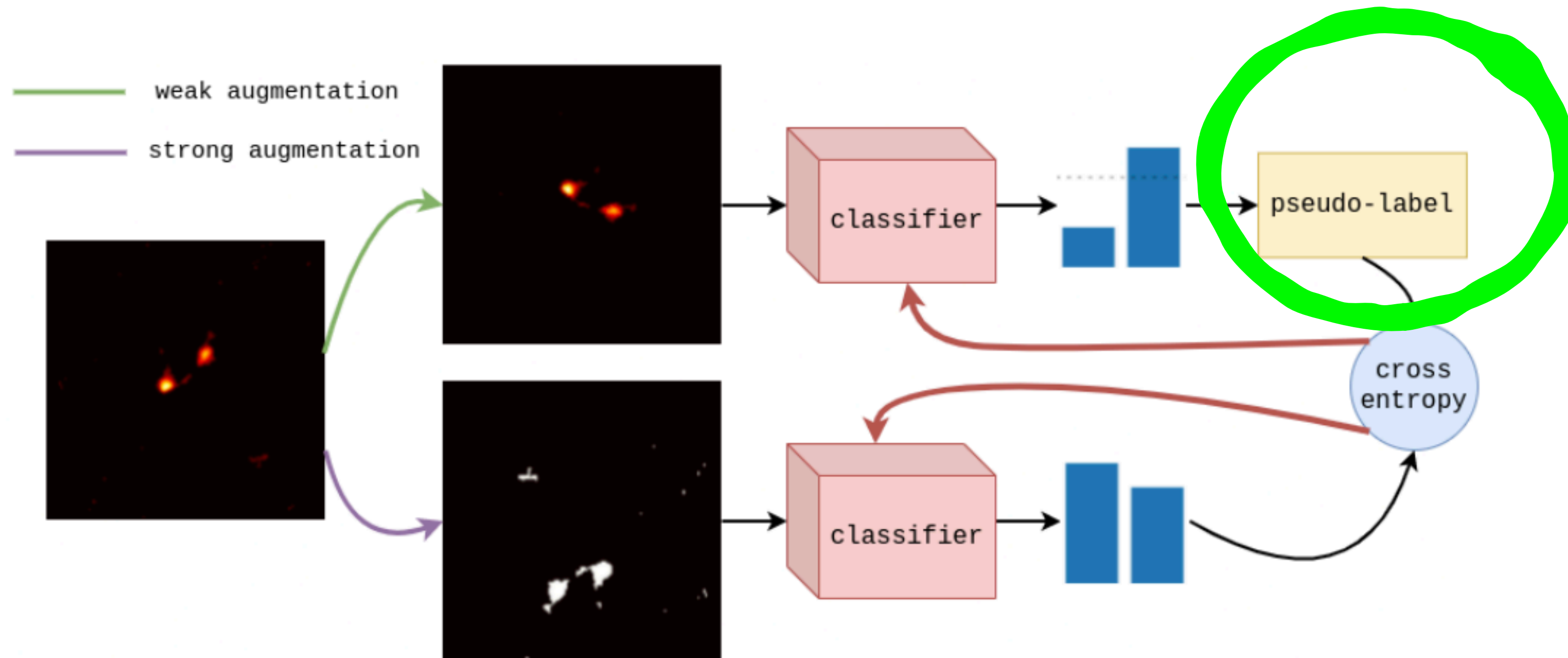


Credit: Data Science Central



Semi-supervised Learning in Astronomy Examples

(1) feature extraction, (2) clustering/**classification (few labels)**, (3) visual representation



Slijepcevic et al. 2021



Credit: Data Science Central



Reinforcement Learning in Astronomy Examples

Deep reinforcement learning for smart calibration of radio telescopes

Sarod Yatawatta¹★ and Ian M. Avruch†

¹ASTRON, Oude Hoogeveensedijk 4, 7991 PD Dwingeloo, The Netherlands

13 May 2021

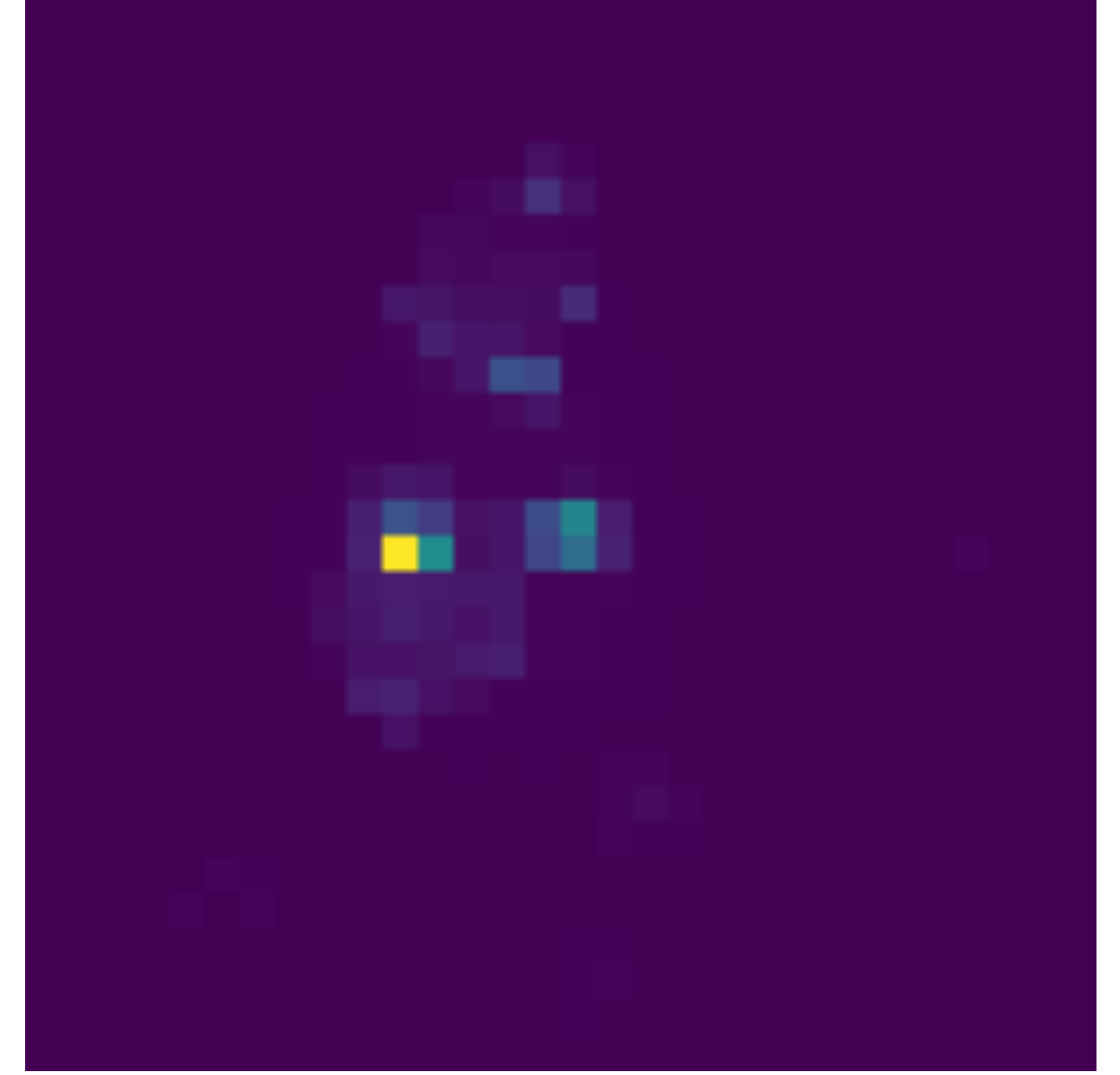
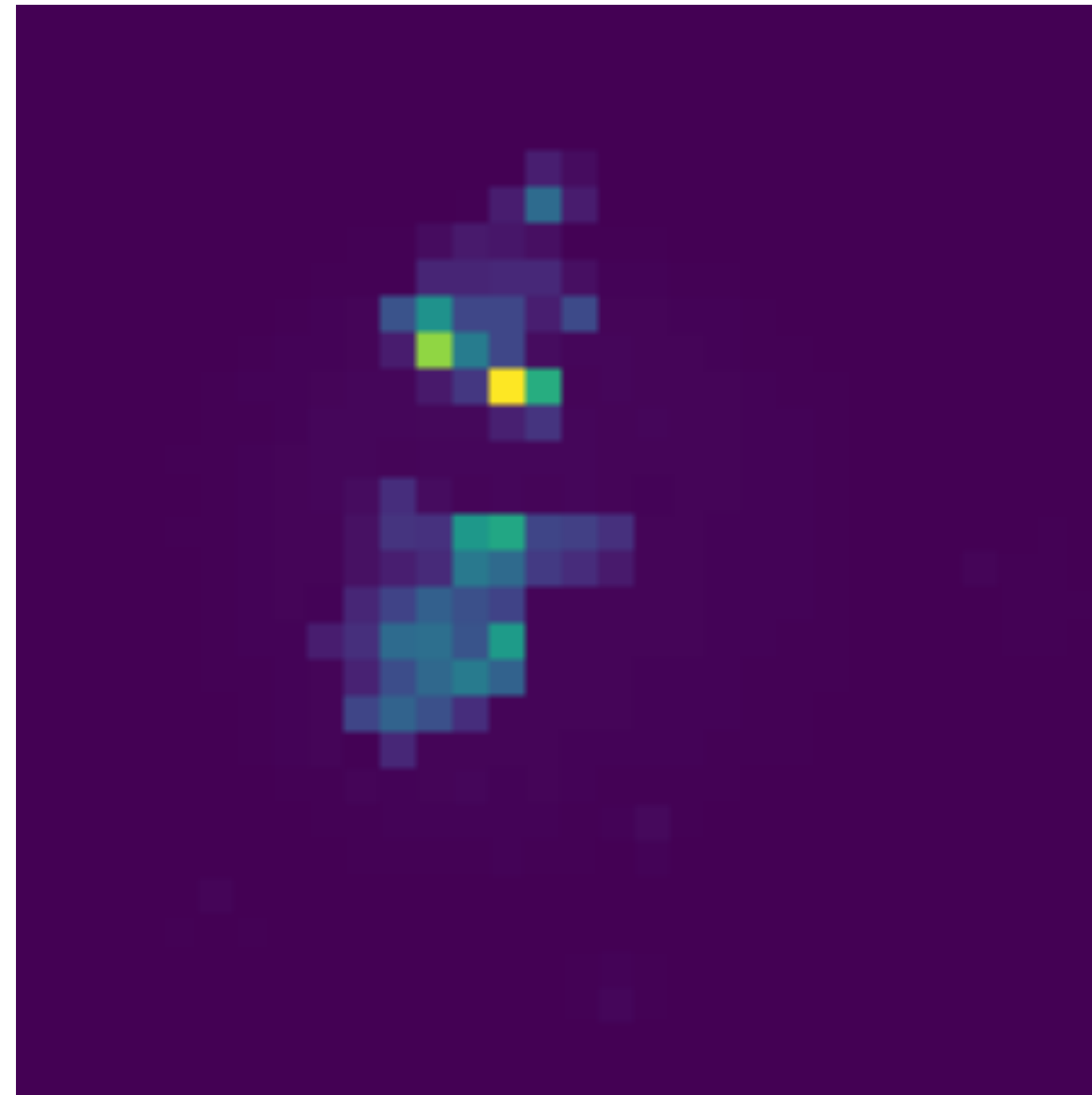
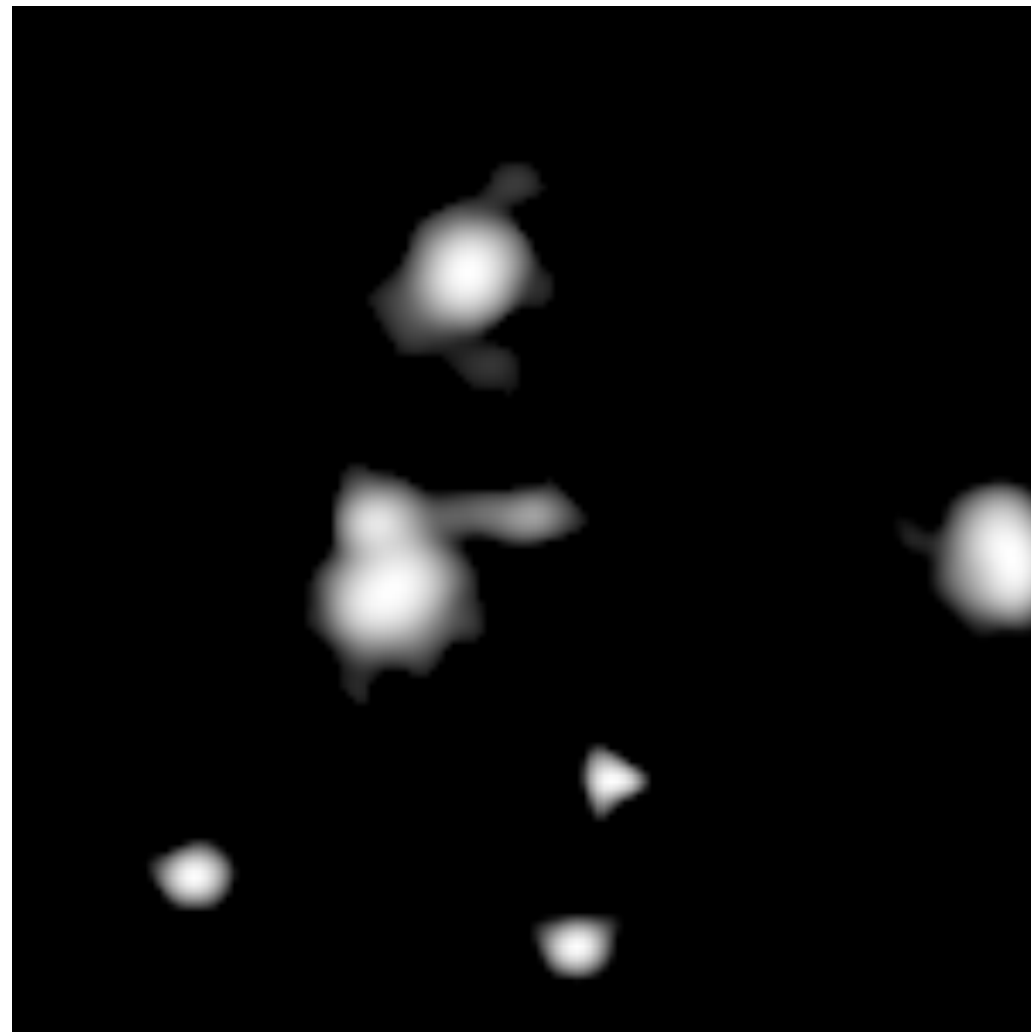
[astro-ph.IM] 12 May 2021

ABSTRACT

Modern radio telescopes produce **unprecedented** amounts of **data**, which are **passed through many processing pipelines** before the **delivery of scientific results**. **Hyperparameters of these pipelines need to be tuned by hand** to produce **optimal results**. Because **many thousands of observations are taken during a lifetime of a telescope** and because **each observation will have its unique settings**, the **fine tuning of pipelines is a tedious task**. In order to **automate this process of hyperparameter selection in data calibration pipelines**, we **introduce the use of reinforcement learning**. We test two reinforcement learning techniques, **twin delayed deep deterministic policy gradient (TD3)** and **soft actor-critic (SAC)**, to **train an autonomous agent to perform this fine tuning**. For the sake of **generalization**, we consider the pipeline to be a **black-box system** where the **summarized state of the performance of the pipeline is used by the autonomous agent**. The **autonomous agent trained in this manner is able to determine optimal settings for diverse observations** and is **therefore able to perform smart calibration, minimizing the need for human intervention**.

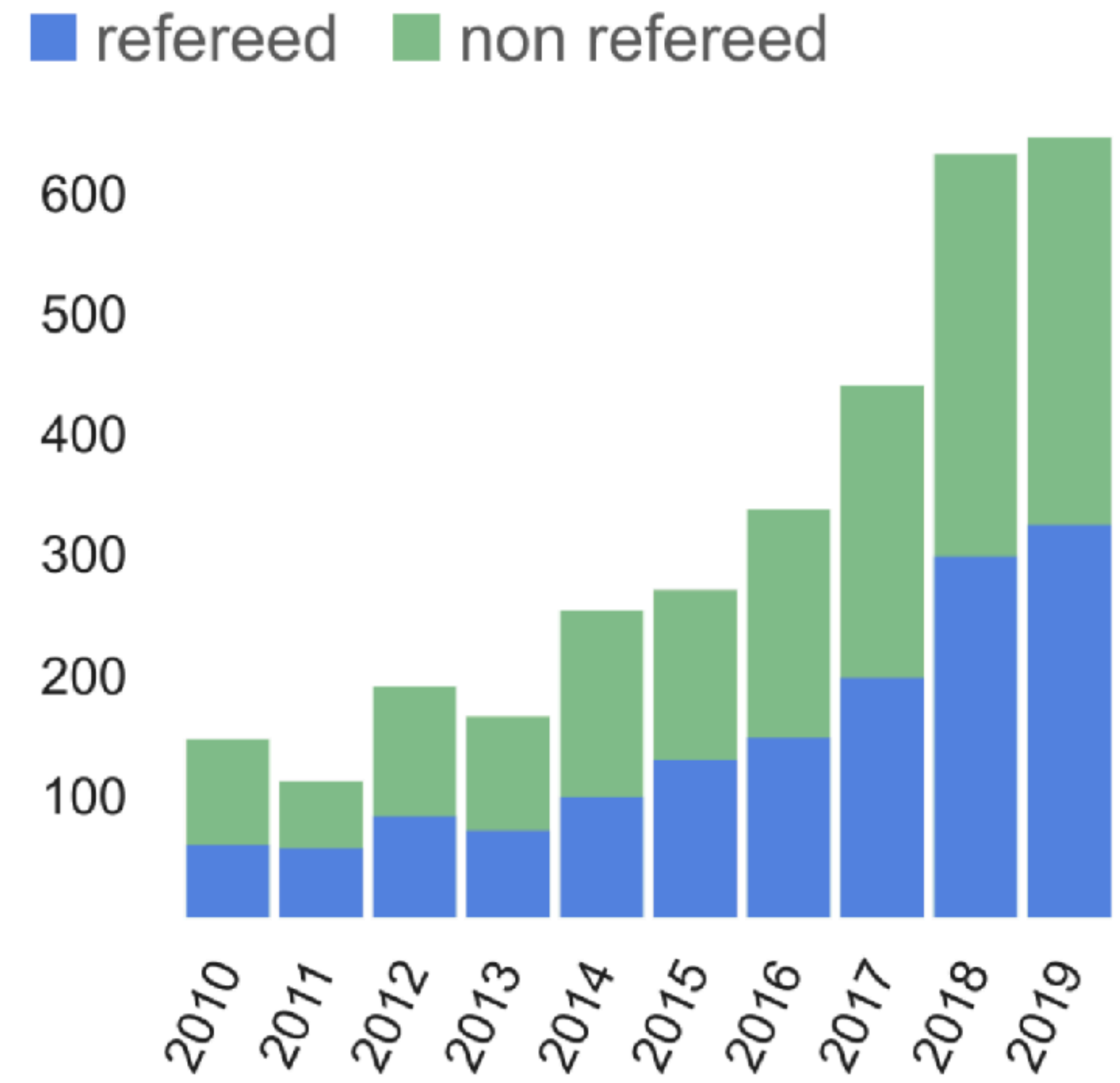
Key words: Instrumentation: interferometers; Methods: numerical; Techniques: interferometric

New Networks other than Convolutional Neural Network



Vision Transformers with Attention Layers instead of Convolutional Layers

Astronomy papers that include machine learning methods in the abstract or title!



Source ADS, Venn et al. 2019

