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A domain-adaptation approach to classify ionised nebulae in nearby galaxies

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The classification and the determination of physical parameters for astrophysical objects is often performed by comparing data with theoretical models. This comparison, however, can be biased by imperfect matching of the observational signatures in the data, and by simplifying assumptions and missing physics in the models. These factors limit the performance of classical machine learning tools and the reliability of uncertainty estimations.

In this talk I will introduce a domain-adversarial neural network (DANN) to bridge the gap between theoretical models (source domain) and observational data (target domain). A DANN is an example of domain-adaptation algorithms, whose goal is to maximise the performance of a model trained on labelled data in the source domain on an unlabelled target domain by extracting domain-invariant features.

I will showcase an application to the classification of ionized nebulae in large integral field spectroscopy datasets. Classifying ionised nebulae in nearby galaxies is crucial to study stellar feedback mechanisms and understand the physical conditions of the interstellar medium.

Our results indicate a significant improvement in classification performance in the target domain when employing the DANN framework compared to a classical neural network classifier. The combined use of domain adaptation and noise injection improves the classification accuracy in the target domain by 20%. This study highlights the potential of domain adaptation methods in tackling the domain shift challenge when using theoretical models to train ML pipelines in astronomy.

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