



MACHINE LEARNING FOR ASTROPHYSICS

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ULISSE: A tool for one-shot sky exploration and its application for detection of AGN and galaxy properties.

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We present ULISSE (aUtomatic Lightweight Intelligent System for Sky Exploration), a deep learning tool capable of identifying objects that share morphological and photometric properties with a query prototype based on a single image, effectively creating a list of lookalikes. ULISSE performs a similarity search directly using features extracted from the ImageNet dataset and identifies a list of candidates without the need for any time-consuming neural network training, complex analysis of real photometric and spectroscopic data, or deep understanding of the physics of underlying processes. As a result, it can be readily applied to any new dataset.

We applied ULISSE to two tasks: (i) the detection of active galactic nuclei (AGN) and (ii) the identification of galaxies sharing similar star-formation rates (SFR) and stellar masses. To evaluate our method, we use galaxies from the Sloan Digital Sky Survey with available object classifications (AGN and host galaxy morphology) and spectroscopic estimates of SFR and stellar mass. We find that ULISSE is able to retrieve AGNs with an efficiency ranging between 21% and 65% depending on the prototype (compared to the random-guessing baseline of 12%). We find it to be most effective at retrieving AGN in early-type host galaxies, as opposed to prototypes with spiral- or late-type properties. For the second task, between 65% and 83% of the lookalikes retrieved by ULISSE are within 1dex of the SFR and stellar mass of the prototype, regardless of its morphological type. This improves to between 89% and 99% when considering the separate analysis for SFR and stellar mass parameters, respectively. Based on these results, ULISSE is a promising tool for rapidly retrieving different types of astrophysical objects in current and future wide-field surveys (e.g., Euclid, LSST) that target millions of sources every single night.

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