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# Networks Learning the Universe: From 3D (cosmological inference) to 1D (classification of spectra)

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With new astronomical surveys, we are entering a data-driven era in cosmology. Modern machine learning methods are up for the task to optimally learn the Universe from low to high redshift. In 3D, tomography of the large-scale structure (LSS) via the 21cm line of hydrogen targeted by the SKA (Square Kilometre Array) can both teach about properties of sources and gaseous media between, while producing data rates of TB/s. In this talk I first showcase the use of networks that are tailored to directly infer fundamental properties from such tomographic data. I compare network models and highlight how a comparably simple 3D architecture (3D-21cmPIE-Net) that mirrors the data structure performs best. I present well-interpretable gradient-based saliency and discuss robustness against foregrounds and systematics via transfer learning. I complement these findings with a discussion of lower redshift results for the recent SKA Data Challenge, where hydrogen sources were to be detected and characterised in a TB cube. I will highlight my team's lessons-learned; our networks performed especially well when asked to characterise flux and size of sources over several orders in signal-to-noise. Finally, moving from 3D to 1D, for the classification infrastructure group of the new ESO workhorse 4MOST (4-metre Multi-Object Spectroscopic Telescope), I detail the official object classification pipeline layer set to efficiently group the ˜40,000 spectra per night (40 million in total) the instrument will collect.

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