Unsupervised classification of spaxels in astronomy

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We present the first unsupervised classification of spaxels in individual galaxies. Classes describe regions or galaxies by spectral similarity synthetising the whole information in the datacube (spatial and spectral). We used Gaussian mixture models in a latent discriminant subspace to find clusters of spaxels (FisherEM). With a fully data-driven approach, we obtain classes of different physical properties and different scales.

We studied two individual galaxies: JKB 18 a blue diffuse dwarf galaxy and NGC1068 a barred spiral galaxy with an AGN. The spectra from individual galaxies were corrected for small-scale motion within the galaxy with an automated algorithm. Most of the 11 classes that we find for JKB 18 are identified as photoionised by stars. Some are known HII regions, but we mapped them as extended, with gradients of ionisation intensities. One compact structure has not been reported before, and according to diagnostic diagrams, it might be a planetary nebula or a denser HII region. For NGC 1068, our 16 classes are of active galactic nucleus-type (AGN) or star-forming regions. Their spatial distribution corresponds perfectly to well-known structures such as spiral arms and a ring with giant molecular clouds.

In the case of complex objects such as NGC 1068, a sub-classification on the nuclear regions reveals the complex interaction of the AGN and the jet with the interstellar medium in a single map.

This fruitful approach on individual galaxies is a first step. We started investigating its application on wide, deep field. We also intend to compare with the unsupervised deep-learning code GEMINI that benefits from the inherent non-linearity of the latent subspace.