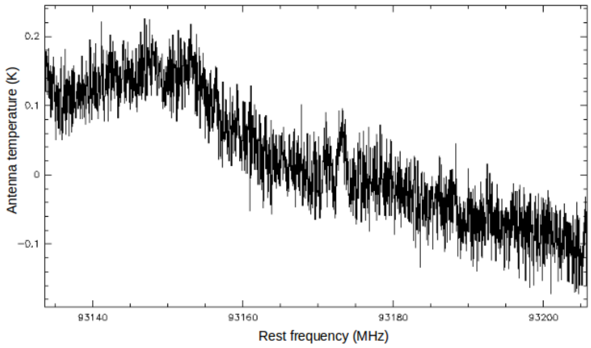
Using neural networks to remove the baseline of radioastronomical spectra

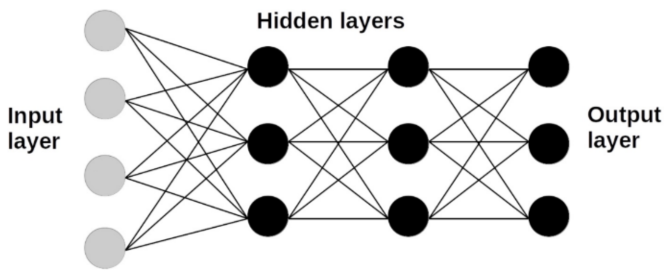
Spectroscopy in the radio electromagnetic domain is one of the most fruitful observational methods in astrophysics. It opens the way to a wealth of diagnoses, from chemical composition to gas dynamics of comets, interstellar clouds, circumstellar envelops, or galaxies.

Typical raw spectroscopic data are composed of three main contributions: the astronomical signal, a medium-to-high-frequency noise, and a low frequency noise. The latter, generally called “the baseline”, is traditionally removed by fitting the spectrum by a polynomial. However, it can happen that the actual shape of the baseline is too complex to be well fitted by polynomials. In such cases, it is challenging to identify a well-suited functional form to describe the baseline.

With artificial neural networks (ANNs) it is possible to circumvent these difficulties. When using appropriate architecture and neuron activation function, ANNs behave as universal function approximators, without the necessity to provide an analytic function explicitly.

The aim of this project is to propose an efficient ANN architecture to automatically remove the baseline of astronomical spectra. The student will start be generating simple mock spectra composed of simulated baseline, noise, and line. These mock data will be used to train an ANN, and the ANN properties will be varied to search for optimal parameters (e.g. number of layers, number of neurons per layer, type of activation function, ...). The trained ANN will then be used to analyze real observational spectra of various levels of quality.





Left: Example of a raw astronomical spectra obtained with the IRAM 30-m telescope. Right: Example of a typical ANN architecture.

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