ORIGINAL ARTICLE

Application of self-organizing map to stellar spectral classifications

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Abstract We present an automatic, fast, accurate and robust method of classifying astronomical objects. The Self Organizing Map (SOM) as an unsupervised Artificial Neural Network (ANN) algorithm is used for classification of stellar spectra of stars. The SOM is used to make clusters of different spectral classes of Jacoby, Hunter and Christian (JHC) library. This ANN technique needs no training examples and the stellar spectral data sets are directly fed to the network for the classification. The JHC library contains 161 spectra out of which, 158 spectra are selected for the classification. These 158 spectra are input vectors to the network and mapped into a two dimensional output grid. The input vectors close to each other are mapped into the same or neighboring neurons in the output space. So, the similar objects are making clusters in the output map and making it easy to analyze high dimensional data.

After running the SOM algorithm on 158 stellar spectra, with 2799 data points each, the output map is analyzed and found that, there are 7 clusters in the output map corresponding to O to M stellar type. But, there are 12 misclassifications out of 158 and all of them are misclassified into the neighborhood of correct clusters which gives a success rate of about 92.4%.

Keywords Self organizing map · Stellar spectra · Classification · Clustering

1 Introduction

Artificial neural networks are now becoming a more popular tools for handling astronomical data. It is very important

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to have some automatic means of analyzing large databases like the surveys and upcoming space missions which would release terabytes of data to the community. That is why, ANNs are widely used as an automatic tools for analyzing astronomical data. Some of the previous attempts on ANNs in astronomy are: Gulati et al. (1994, 1995), Von Hipple et al. (1994), Weaver and Torres-Dodgen (1995), Singh et al. (1998, 2003), Gupta et al. (2004), Allende (2004), Bazarghan et al. (2008), Bazarghan (2008), Bazarghan and Gupta (2008), Wyrzykowski and Belokurov (2008).

Artificial neural network techniques used in the field of astronomy have been mostly supervised algorithms. Here we introduce an application of unsupervised technique to identify different classes of objects and try to make a cluster of similar type of stars using this technique.

The Jacoby et al. (1984) library is used for classification using SOM algorithm as unsupervised ANN. This algorithm configures output into a topological presentation of the original multi-dimensional data, producing a SOM in which input vectors with similar features are mapped to the same map unit or nearby units. In this way at the output map we will have the clusters of similar objects at different positions of the map. The expected clusters in this case are the stellar spectral type ranging from O to M.

The Self-Organizing Map algorithm is explained in Sect. 2. In Sect. 3 we describe the input data and their preprocessing. The result of classification and discussion are presented in Sects. 4 and 5 respectively.

2 Self-Organizing Map

Self-Organizing Map neural net developed by Kohonen (1981a, 1981b, 1981c, 1981d, 1982a, 1982b) is important