Chapter 16
Machine Learning Approaches for Supernovae Classification

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ABSTRACT

In this chapter, authors have discussed few machine learning techniques and their application to perform the supernovae classification. Supernovae has various types, mainly categorized into two important types. Here, focus is given on the classification of Type-Ia supernova. Astronomers use Type-Ia supernovae as "standard candles" to measure distances in the Universe. Classification of supernovae is mainly a matter of concern for the astronomers in the absence of spectra. Through the application of different machine learning techniques on the data set authors have tried to check how well classification of supernovae can be performed using these techniques. Data set used is available at Riess et al. (2007) (astro-ph/0611572).

INTRODUCTION

Cosmology is a data starved science. With the advancement of technology and new advanced technological telescopes and other such instruments, here we have a flood of data. Data which is not easy as well to be interpreted, very complex data. So, astronomical area requires various techniques which help in dealing with the problem of interpretation and analysis of such vast complex data. Out of several astronomical problems, here we have taken one such problem i.e. the problem of supernovae (SNe) classification using certain machine learning algorithms. But the question is why we need to classify supernovae or why is it important?

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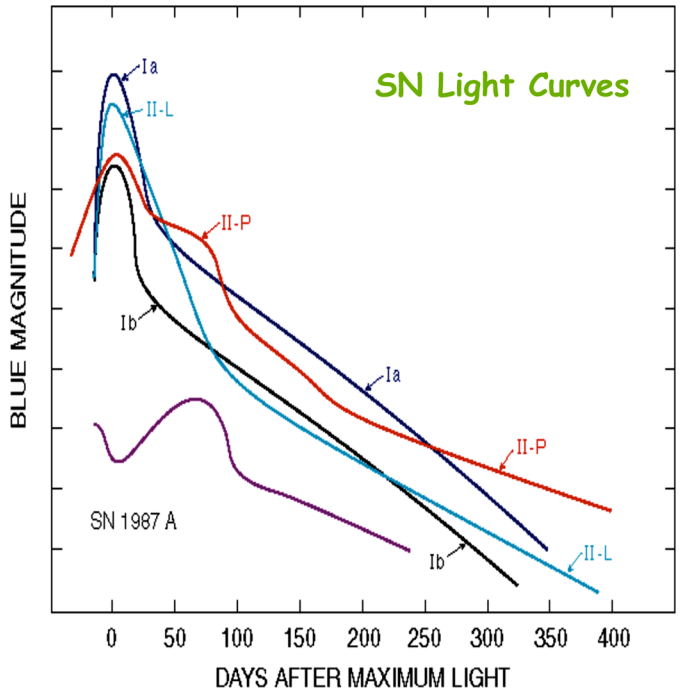
A supernova is a violent explosion of a star, whose brightness for an amazingly short period of time, matches that of the galaxy in which it occurs. This explosion can be due to the nuclear fusion in a degenerated star or by the collapse of the core of a massive star, both leads in the generation of massive amount of energy. The shock waves due to explosion can lead to the formation of new stars and also helps astronomers indicate the astronomical distances. Supernovae are classified according to the presence or absence of certain features in their orbital spectra. According to Rudolph Minkowski there are two main classes of supernova, the Type-I and the Type-II. Type-I is further subdivided into three classes i.e. the Type-Ia, the Type-Ib and the Type-Ic. Similarly, Type II supernova are further sub-classified as Type II-P, Type II-L and Type IIn. The detail classification of these two types of supernova is discussed in the following section. Astronomers face lot of problem in classifying them because a supernova changes itself over the time. At one instance a supernovae belonging to a particular type, may get transformed into the supernovae of other type. Hence, at different time of observation, it may belong to different type. Also, when this spectra is not available, it poses a great challenge to classify them. They have to rely only on photometric measurements for their classification. This poses a big challenge in front of astronomers to do their studies. Figure 1 shows the supernova classification from their light curves.

Figure 1. Supernova light curves
*courtesy: www.astro.princeton.edu/~burrows/classes/403/**supernovae**.pdf*



Machine learning methods help researchers to analyze the data in real time. Here, we build a model from the input data. A learning algorithm is used to discover and learn knowledge from the data. These methods can be supervised (that rely on training set of objects for which target property is known) or unsupervised (require some kind of initial input data but unknown class).