Chapter 6

Conclusion and Future Outlook

In this final chapter, we summarize the conclusions that can be established from the results obtained in this thesis, and present a brief outlook on future possibilities.

We have implemented the use of Artificial Neural Network (ANN) for classification and parametrization of the astronomical database using both spectral and photometric (band) data in the ultra-violet (UV) wavelength. There exists other methods, like the metric-distance technique, also used for automated classification. The advantage of using ANN over metric-distance technique is that it does not require the shape of the continuum from the spectra to be removed.

The stellar classification and parametrization have been done following a hierarchical scheme. To segregate stars from galaxies, a mixture of stellar spectra and galaxy spectra have been used as the train set for ANN. For stellar classification and parametrization, the ANN has been trained on two independent sources of theoretical stellar spectra with interstellar reddening added to them. The scheme employed is to first classify the spectra into
different classes and then find the interstellar extinction of objects in each class separately.

The measurement of the cross-correlation (CCF) function by analyzing the temporal data available from space missions can tell about the size and shape of the emitting region of the source. To estimate the error on CCF, standard method is to split the light curves into many segments and then find the standard deviation as the error. In the thesis we have worked out an analytical expression to estimate the error on the cross-correlation function for light curves, containing relatively small number of points ($\approx 1000$).

In the following we provide a chapter wise summary of the work presented in the thesis.

Classification provides a fundamental characterization of a survey data base and forms a vital step before proceeding to any further scientific study or investigation. A general overview on the spectral classification, the galaxy morphology classification and on the parametrization of interstellar extinction has been provided in Chapter 1. A literature survey has been done on the work so far done for the automatic analysis of spectroscopic and photometric database. The mathematical expressions relevant to the thesis work has also been worked out in this chapter.

A pedagogical introduction to ANN is provided in Chapter 2. The chapter discusses the supervised, and the unsupervised learning method used for training an ANN. It also features different learning laws that are used to minimize the error in the network. The multilayer back propagation algorithm has been discussed separately in the chapter.

The underlying factors that shape stellar spectra are the effective temperature and the gas pressure at their outer surface. They resulted in a two dimen-
sional classification system for stellar spectra. To automatize stellar spectral classification in this two dimensional system, ANN has been used earlier also for stellar classification and parametrization using spectra. Most of them are confined in the optical or infra red range of the waveband. Chapter 4 has demonstrated, using IUE satellite data, that the ANN can be successfully employed to classify stellar spectra as well as photometric (band) data in the UV waveband. Interstellar extinction has been calculated in terms of $E(B - V)$ magnitude using ANN. The chapter also describes the stellar spectra in UV band.

Galaxies inevitably get caught up along with the stars in the field of view of large telescopes looking at distant universe. The spectra of the galaxies are the integrated spectra of their constituent stars. Chapter 5 presents some of the special features of the spectra of different galaxy morphological structures and demonstrate the application of ANN to separate stellar spectra from galaxy spectra.

In temporal analysis of astrophysical sources, the multiband study reveals the relationships between variability in different bands giving better understanding on the phenomenology. The study is usually done by calculating the cross correlation function (CCF) in different energy bands using numerically expensive simulations or by dividing the light curves in large number of segments to find the variance. This makes ineffective the method for the shorter light curves from the transient sources. Chapter 6 presents an analytical expression to find the error on the CCF for light curves containing relatively small ($\approx 1000$) number of points. The expression has been verified using simulated light curves.

To conclude, in this thesis (i) the use of ANN has been implemented for
astronomical classification and finding interstellar extinction of large data base, (ii) the basic expression for error estimation in the cross correlation between two light curves has been worked out.

It is expected that our automated pipeline will be used extensively to extract and validate data from virtual observatories as well as the upcoming satellite data base expected from the TAUVEX mission, in particular, and also the ASTROSAT and GAIA missions, where one will be able to provide the interstellar extinction maps of Galaxy. This in turn could be modeled for dust distribution [15, 17, 128] in the Galaxy. Further, the ANN tools developed for the thesis will be useful for classification type applications in several areas even outside astronomy. In the temporal analysis the analytical error estimate on the cross-correlation has been worked out. However, to have the true temporal behavior of a source one must also have an estimate of the errors on the phase and time-lag. Then there is a great deal of scope for applying the technique to AGN X-ray light curves, reverberation mapping and Gamma-ray bursts. While this technique is useful for short duration light curves, coherence and frequency dependent time lags provide naturally more information and should be preferentially computed for long data streams. There are scopes to further optimize the technique and hence for the development of better methods provided they give robust and physically interpretable results.