One of the primary objectives of astronomy is the observation and study of celestial objects such as stars, galaxies and quasars. These sources emit electromagnetic radiation in a broad range of wavelengths, from radio to X-ray. It is of great importance to first identify these objects and classify them for a better understanding of the complex physical processes behind their formation and evolution. Both spectroscopic and photometric techniques are used for the identification and study of astronomical objects.

In spectroscopy, which refers to the technique of obtaining and studying the intensity of the radiation in every small frequency window, known as a spectra, features like emission lines or absorption lines or other variation in light intensities at different wavelengths are used to characterise the object and its distance from the observer. Accurate estimation of distance is crucial in various astrophysical as well as cosmological probes. For example, high redshift quasars provide direct information on the physical conditions that existed when the universe was much younger. It also helps to constrain the permissible limits of cosmological parameters in different cosmological models such as the dark energy model. Even though the spectroscopic determination of the redshifts is more accurate than photometric alternatives, observing the spectra of astronomical sources is inherently limited by longer exposure time, higher cost and limitation to go to fainter magnitudes.

In Photometry, the flux of the light coming from an object over a broader band of frequencies, rather than at higher resolution is used for the analysis. The observation is usually done in multiple bands and this is much like a low resolution spectrum in the observed wavelengths. Since photometric detection is
done in wider wavelength bands, they capture more photons per bin as compared to spectroscopy and hence can be done on much fainter objects. We thus say that photometry can go deeper than spectroscopy. This is one of the cutting edge advantages of photometric methods over spectroscopy though the latter is more accurate. The primary focus of this thesis is the photometric studies of astronomical candidates particularly quasars from large sky surveys.

At present, several multi-colour deep sky surveys provide photometric information on a large number of astronomical candidates which are inaccessible for spectroscopic observation. This makes photometric studies ever more significant for estimating the nature and redshift of the huge number of faint objects that are left out without spectra. In such cases, stars, galaxies and quasars can still be classified based on a technique called multi-colour photometry. Though the accuracy of this estimate is less compared to spectroscopic methods, for many cosmological and extragalactic applications, they provide sufficient information.

Technological advancement enhances the efficiency of detectors so that sky surveys are able to do spectroscopy at fainter levels. But the universe is so vast and wide that this produces an even larger number of still fainter objects for which photometric analysis is the only alternative. It is no longer possible to analyse this huge data in a conventional manner. On the other hand, it makes no sense to hold huge data that are not analysed in the life-time of a mission. This demands the development of automated tools that can derive informative content from the data in a useful way. Many automated tools are widely explored for this purpose. They all use a set of features or parameters derived from photometric data to characterize the objects.

In this thesis, we describe the use of one such classifier that was able to photometrically classify about 2.4 million quasars, 3.5 million stars and a small number of
unresolved galaxies from Sloan Digital Sky Survey (SDSS) Seventh Data Release (DR7). The classifier is able to recover 99.96% of spectroscopically confirmed quasars and 99.51% of stars from SDSS DR7 in the colour feature space that we study. This is the largest quasar catalogue available on VizieR which is an astronomical catalogue service available through internet. The catalogue data in comparison with other deep sky surveys in different parts of the electromagnetic spectrum have shown an overall accuracy better than 95%.

Using the same classifier on multi-wavelength photometric data, we estimated the photometric redshift of quasars from SDSS. We used confirmed quasars from SDSS data release ten (DR10) as a guide to training our classifier. We found that, in the case of quasars, inclusion of infra-red (IR) photometric colours helps to improve the accuracy with which redshift could be estimated.

The thesis also addresses time-domain astronomy, which is one of the vibrant area of research emerged over the last few years. It considers entirely new classes of objects by observing rapid changes in their magnitudes through repeated observations. It has also brought with it interesting challenges for the rapid classification of large number of objects observed each night. In astronomy, to complicate things further, there are many occasions when one does not have complete information about the objects. We discuss these issues based on our experiences in connection with the photometric classification of transient objects detected by the Catalina Real time Transient Survey (CRTS). We have used the same classifier to the publicly available data from CRTS for the transient classification.
This thesis has been organised as follows:

- **Chapter 1** provides the general overview about the sky surveys, photometry, magnitude, colour and redshift. It describes time-domain astronomy and Catalina Real-Time Transient Survey. We have also given an introduction to the classification of celestial objects.

- In **Chapter 2** automated classification tools are described briefly. The classifier that we have used is described along with other machine learning classifiers. This chapter also describes the construction of the photometric catalogue of quasars and other point sources from SDSS.

- In **Chapter 3** photometric redshift is explained. Our method for the photometric redshifts of quasars from Sloan Digital Sky Survey is discussed in detail.

- **Chapter 4** describes automated classification of transients. It also discusses the classification of optical transients with missing features.

- **Chapter 5** summarise our results and discuss future possibilities.

**Publications**


4. Photometric Redshifts of Quasar Candidates from Sloan Digital Sky Survey, Sheelu Abraham, Ninan Sajeeth Philip et. al., (In preparation)
