

Abstract

Since the discovery of the first exoplanet in 1995, more than 1900 exoplanets have been discovered. For over 10 years, researchers have been trying to study the parameters of these exoplanets, such as the mass, size, density, etc. The uncertainties play an important part in parameter estimation, especially when combining the findings of different exoplanets together to determine the common characteristics of them. If the uncertainties are too large, the reliability of the results may reduce.

Due to the importance of understanding uncertainty, the aim of our project is to study the uncertainties associated with the derived astrophysical parameters of the exoplanets.

To start with, we used R to build a light curve model for single-planetary systems assuming circular orbits. We then proved that the model is optimizable by simulating arbitrary data with Gaussian noise and successfully recovering the original parameters using an optimization technique. Next, we fitted four known systems and compared our estimates to the literature (Dr. Budding's paper and the NASA Exoplanet Archive). Since our model gives similar results as the literatures, we are confident that our model is applicable to real light curve data. Through fitting the known systems, we found that the Hamiltonian Monte Carlo (HMC) method is the best approach to estimate the uncertainties. Towards the end of the project, we fitted five new systems whose astronomical parameters have not been reported and used the HMC method to estimate the uncertainties associated with the parameter estimates. We also studied the source of errors and concluded that data binning and noise have an impact on the fitting results. Additionally, by analyzing the fitting results, we propose that among our candidate systems KOI 767.01 is an exoplanetary system.