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Testing the efficiency of estimators of the two-point Correlation Function

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Abstract

Since the discovery of the Universe's expansion in 1998, studying its cause has been one of the main interests in cosmology. Today the simplest model that describes our Universe is known as LCDM where dark energy dominates 70% of the Universe's total energy density. The discovery of 1998 motivated great advances in technology and the construction of telescopes, enabling modern cosmology to reach a "era of precision measurements". Studying the distribution of galaxies in the observed Universe is a powerful tool to understanding our Universe's dynamics and correlation functions have long since been used to study these distributions. In this project I study concepts of modern cosmology and statistics in order to be introduced to the two-point correlation function estimated from a catalog of galaxies to test cosmological models, such as the LCDM. The first part of this study was to compare different estimators of the two-point correlation function. In the second part, using the measurements of the first part, I will constrain cosmological parameters that dictate the dynamics of our Universe.

Key words:

Cosmology, Expansion of the Universe, Dark Energy

Introduction

Currently, we do not know what our Universe is mostly made of. The usual matter we see and interact with daily makes up only about 4% of out Universe. To understand these components that dictate our Universe we use cosmological probes to constrain cosmological parameters. One of these probes is the study of galaxy distribution of our Universe.

One of the ways to study galaxy distribution is through correlation functions. These functions use catalogs of galaxies to measure the "clumpyness" of volumes of space. To estimate the error of the correlation function's measurements we calculate its covariance matrix.

With these measurements and the error associated with them we are able to constrain cosmological parameters. These parameters appear in the equations describing the Universe for our cosmological models and constraining them with precision gives us a way to validate each different model.

Results and Discussion

The study of basic cosmology includes: how distances are measured in the context of cosmology, how to describe the Universe through Newton then through Einstein, how to constrain cosmological parameters and what they tell us about our Universe's evolution, and other introductory topics. With these and other related topics of statistics I could begin working on the two-point correlation function.

It was also necessary to learn how to manipulate real data through the use of computational tools. Since all used codes require a lot of calculations (therefore computation power) I ran all codes on servers with more than 3000 cores.

I computed the angular correlation function using a simulated catalog using different estimators to compare their final values. A difference is expected and observed, and is mostly due to geometrical differences in the geometry of the catalog.

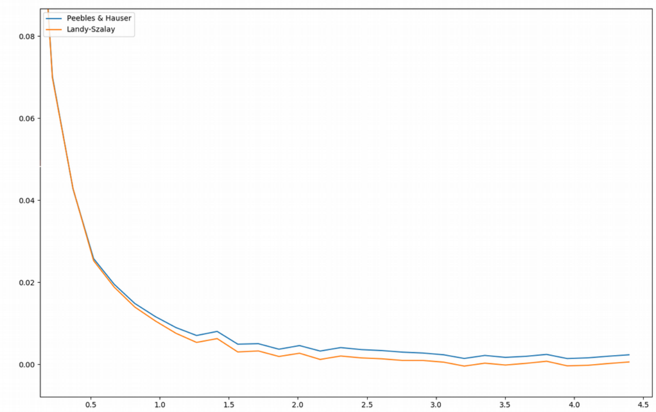

Figure 1. Angular correlation function calculated using two different estimators. The y-axis is the value of the angular correlation function (which is dimensionless) and the x-axis is the angule of separation (in degrees).

Conclusions

The geometry of the catalog affects the measure of the correlation function and choosing an adequate estimator is important, but for most cases Landy-Szalay can be used.

I am currently calculating the covariance matrix using re-sampling methods. With the matrix the error associated with the correlation function values can be estimated. With that I will move on to constrain cosmological parameters.

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