ASTRON98 Final Project: Analyzing the Relationship Between the Absolute Magnitude and Flux of the Sun and the Apparent Magnitude and Distance of Moons in Our Solar System

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1.Introduction

In this project proposal, I outline the approach I will take to analyze the relationship between the absolute magnitude and flux of the Sun and the apparent magnitude and distance of the moons in our solar system. This project involves data analysis, generating random data, the application of quality filters, fitting the data with errors, and providing explanations of the model fit.

2. Chosen Phenomenon and Data Source

The chosen phenomenon for this project is the apparent magnitude of the moons in our solar system. To study this, I will utilize data from the Devstronomy Planetary Satellites Dataset. This dataset contains information about the moons in our solar system, including their mean radius, magnitude, host planets, and mean density. This dataset can be accessed at Planetary Satellites Dataset.

3. Equation to Fit Data

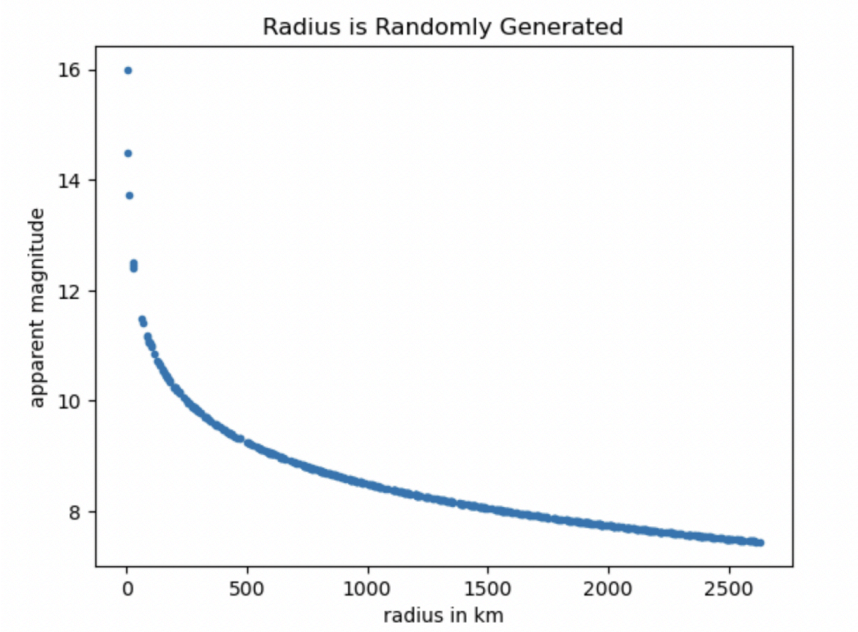
The equation that represents the relationship between the magnitude and flux of celestial bodies is:

$$M1 - Msun = -2.5log_{10}(\frac{\frac{\Pi R^2}{d^2}}{Fsun})$$

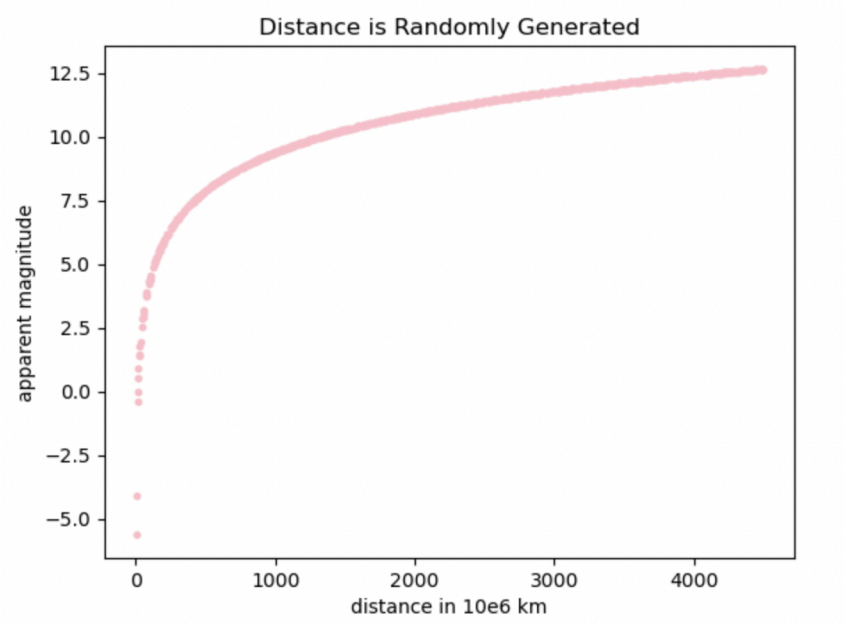
- M1 is the apparent magnitude of a planetary satellite
- Msun is the apparent magnitude of the sun, which equals -26.74
- d is the distance between the planetary satellite and sun
- R is the radius of the planetary satellite
- Fsun is the flux of the Sun, which equals about 1400 W/m^2

4. Data Generation for Testing

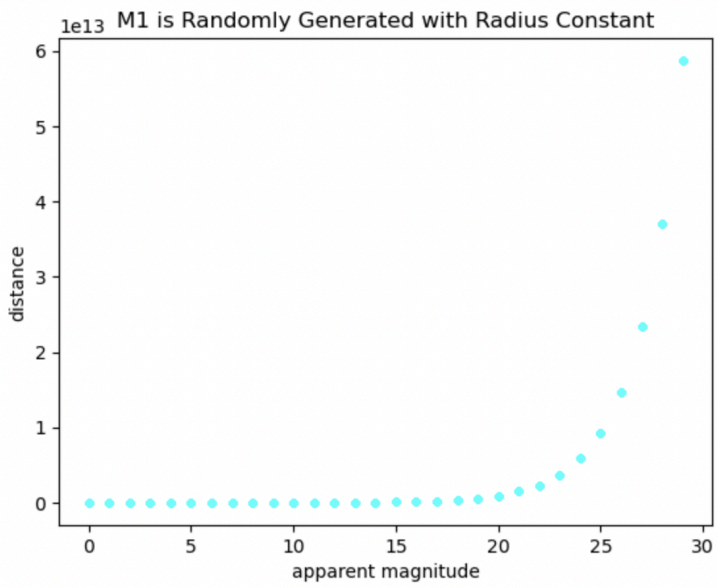
Random data was generated and fitted to the model so that its distribution could be visualized. Since there are three variables in the equation, I created four separate graphs to randomly generate one of the variables (independent variable), keep one variable constant, and have a dependent variable. The aforementioned model was rearranged to derive the needed independent variables.



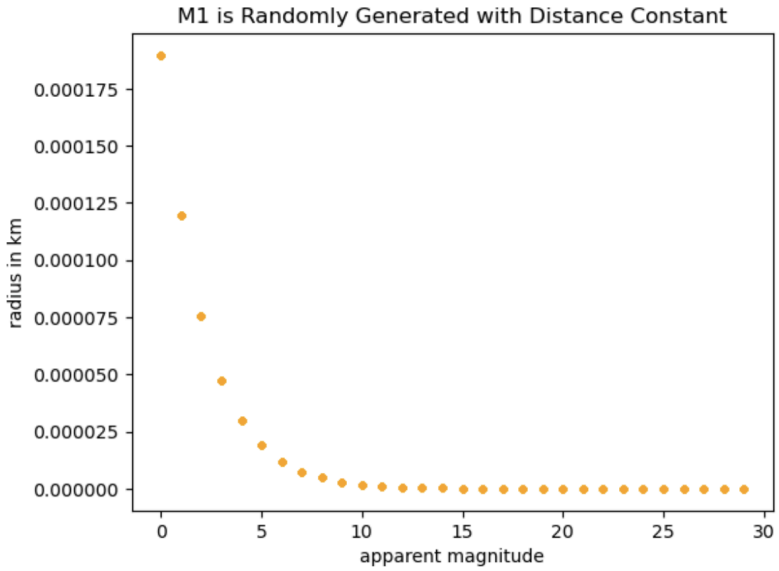
Where the distance used in the equation is the average of the distances of the moons in our Solar System and the range of the radius is based on the ranges of the radii of the moons in our Solar System.



Where R is the average radius of the moons in our Solar System and the range of the distance is based on the range of the distances of the planets in our Solar System.



Where R is the average radius of the moons in our Solar System and the range of the apparent magnitude is based on the range of the magnitudes of the moons in our Solar System.



Where the distance is the average of the distances of the moons in our Solar System and the range of the apparent magnitude is based on the range of the magnitudes of the moons in our Solar System.

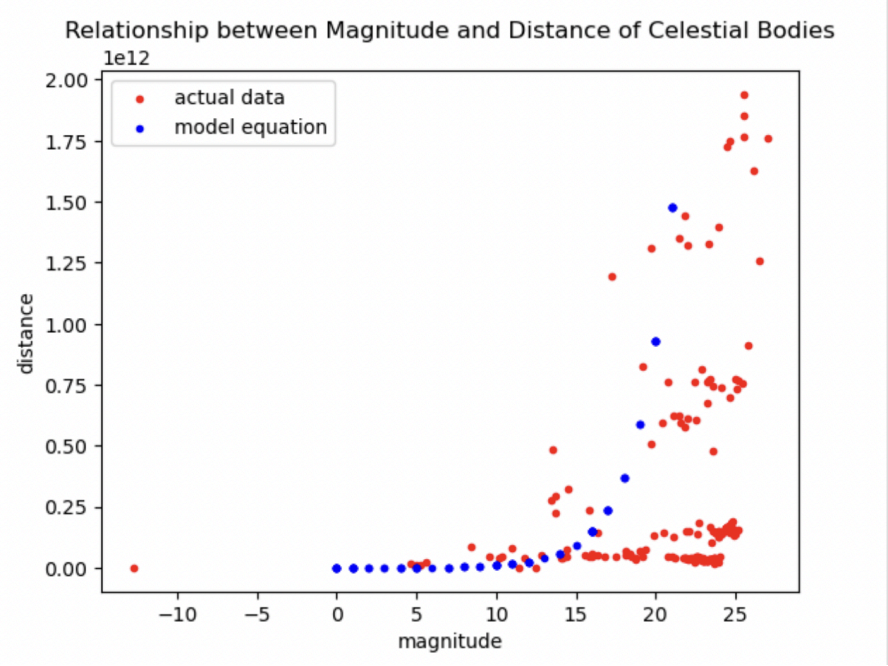
5. Data Filtering

To ensure quality and reliability of the dataset, I applied several quality filters and data preprocessing steps:

1. Duplicate Data: Any entries that were repeated more than once were removed to ensure consistency and accuracy.
2. Missing Data Handling: Some of the entries didn't have any data, so those entries were omitted and other corresponding entries to the same celestial body were also removed to ensure the values were aligned correctly.

6. Data Fitting with Error

To analyze the relationship between magnitude, flux, and distance, I fit the data with the aforementioned mathematical model for the relationship between apparent magnitude and distance.



7. Explanation of Model Fit and Conclusion

After fitting the data with the model graph, you can see that the given model fits the general trend of the actual data. However, there are many points that do not fit the trend either. The randomly generated test data suggest an exponential relationship between the apparent magnitude and distance, an inverse relationship between apparent magnitude and radius, and a logarithmic relationship between distance and apparent magnitude. The final graph with both the model equation and actual data somewhat supports this idea. Although there is clearly some sort of exponential/logarithmic relationship between all these factors, the graph suggests that there are perhaps other factors that determine a celestial body's magnitude besides its radius and distance from the Sun. This means that although you can roughly predict the radius, apparent

magnitude, or distance of a celestial object given one or two of the other variables, there are certainly other factors that come into play.