Python Decal: Project Proposal

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April 1st, 2025

1 Introduction

In this project proposal, I will outline the approach to categorize and analyze already observed and cataloged exoplanets, both habitable and non-habitable. The project will include data analysis, data categorizing, as well as data fitting.

2 Data Source

The chosen data for this project is exoplanets–but more specifically habitable exoplanets that lie within our own galaxy. Out of the five thousand cataloged planets, there are currently 70 discovered potentially habitable worlds outside our own solar system. In studying this data, I will utilize the parameters given and generate multiple plots comparing the parameters to that of Earth, and determine if there are underlying relationships between parameters that satisfy as a "earth-like" habitable exoplanet. The source I will be using is the Habitable Worlds Catalog.

3 Possible Equations

3.1 Comparing $R_\oplus$ and $M_\oplus$

In comparing the radius and the mass of the habitable world, it should follow a square root proportionality relationship–which follows from Kepler's Laws of motion. Essentially,

$$R_\oplus \propto \sqrt{M_\oplus}$$

which simply follows a power law of the form

$$R_\oplus \propto \alpha M_\oplus^n$$

Essentially I'm following **Figure 3** from the source above.

3.2 Comparing Flux (S) and Surface Temp (T_{surf})

As of now, I don't know if there will be a equation to fit to this data, however, it should tell me relatively where the most habitable worlds in comparison to worlds that we know of, the planets in out solar system. I will need to gather the data for the planets in our solar system elsewhere but it shouldn't be too hard to get. Essentially I'm following **Figure 2** from the source above.

3.3 Other realtionships

I'm also thinking of including more plots that compare the ESI of the habitable world to various physical features as well to determine if there are any relationships in the data there.

4 Randomized Data Using NumPy

Along with the data, I will generate NumPy arrays of randomized data that fit within the constraint values of the parameters. Using this randomized data, I will then then plot against the actual data. For example, for the mass-radius plot, I can generate a random numpy array of mass values between 0.2 and 2 $M_{\oplus}$, and another random numpy array of radius values between 0.5 and 1.5 $R_{\oplus}$. Then I can plot these values along with the cataloged data, and separate the two using matplotlib labels.

5 Data Filtering

- Duplicate Data: It could be possible that the randomized data created inside the numpy arrays might already exist within the cataloged data, in that sense–it can be removed from the data set if that were to occur.
- First, I will analyze and include all data–all 70 habitable worlds, however there might be some outliers that lie outside all fitted lines for certain categories and the types of the habitable worlds, so I can filter these out by placing a constraint on the plotting range values. This will reduce the plot to less points that are show are overall more clean data curve where the majority of the points are centralized around the fitted curve

6 Data Fitting and Modeling

After filtering the data, I will fit the data using theoretical approaches. For example, under a mass and radius proportionality relationship, we can use a power/log law model and determine the value of the parameter that best fits both the filtered randomized and cataloged data. After finding this model, I will explain the model and why it is the best fit to the data used. I will use a model selection process and then error estimation by varying the determine parameter with a certain standard deviation from the theoretical fit to see where the data lies with a certain error range.

7 Possible Animation

This is if I have enough time but I am considering focusing on a specific system, particularly the TRAPPIST system and creating a 2D or 3D animation of the system with the habitable zone or the "goldi-lock zone" highlighted in the animation as the planets orbit inside of it.