PYU33C01 Computational Methods Assignment 1

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The Number of Planets Discovered per Year

After the data was formatted as desired after importing it; in order to utilise the file produced by the NASA Exoplanet Archive, the data was sorted chronologically and a counter was set to count the number of instances of lists of tuples corresponding to each year entry. This was used to plot on a bar graph of the number of planets discovered per year as shown below:

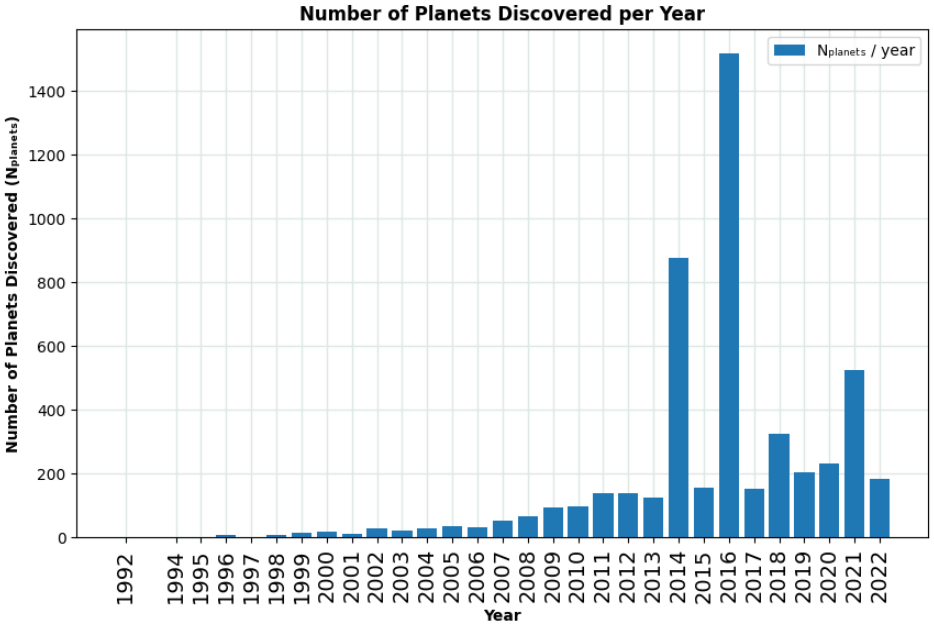

Figure 1: *Number of Planets Discovered per Year as tracked by the NASA Exoplanet Archive*

The results indicate that the number of planets discovered every year appeared to increase roughly linearly with huge outlier years existing for 2014 and 2016 with the latter being orders of magnitudes larger than some of the others. This means that 2016 was a large year for exoplanet discovery with contrastingly no discoveries were assigned by the archive to the year 1993.

Planet-Star Mass Relation

In order to express the relationship between the mass of the stars and their orbiting exoplanets detailed in the file produced by the NASA Exoplanet Archive, the ratio of these quantities were plotted and scaled logarithmically. In order to achieve this, the relevant data was extracted and the lists of tuples which contained any empty strings present where data was not available were ignored. The planet and star masses were provided in Jupiter and Solar masses respectively. These were converted to kg as a relationship could be more easily detailed with standardised units.

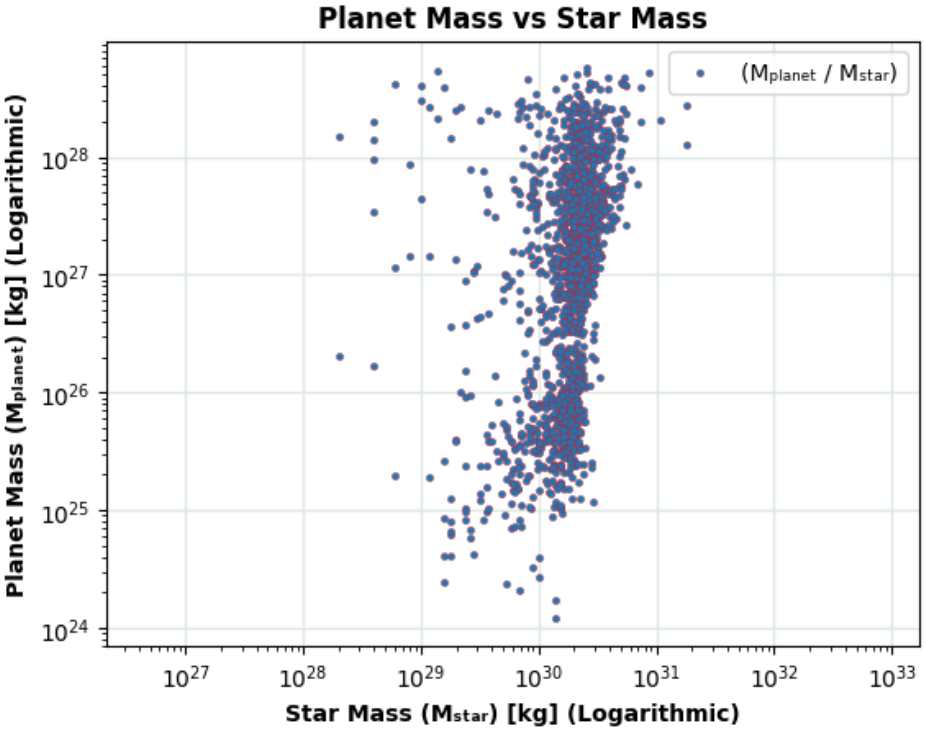

Figure 2: *Planet Mass vs Star Mass according to NASA Exoplanet Archive Data*

Large stars form in primordial gas clouds and accrete with much of the surrounding material leaving relatively little material remaining for planet formation's beginning; planetary accretion. It would ally with theory that the larger the star, the larger the parent gas cloud which would likely allow for the formation of larger planets. This aligns with observation that there seems to be a rough correlation between the masses as shown in the figure above. A linear fit explored above would result in an exponential relation between the planet mass and the mass of its parent star.

Relative Facility Performance

In order to determine the answers to the following questions:

1 The number of planets which have had been discovered at each facility?

2 Which facilities had discovered the most planets so far

3 Over how long a time period have these planets been discovered

The year and facility of discover were listed for each instance an exoplanet were discovered in a list of tuples. This was sorted in chronological order. An empty sorted entries list was declared and appended by each facility except if it was a facility already seen (appended onto the seen facilities list). A counter of each of these facilities were then ascribed to the determined values. The lists of tuples were then sorted by the number of instances the facilities in the planets list in reverse order such that the first ten listed were the largest. This list of tuples was then shortened to ten elements and sorted chronologically. The figure below therefore answers the questions above:

Facility	Discoveries	Year of First Discovery
Multiple Observatories	191	1996
W. M. Keck Observatory	184	1998
La Silla Observatory	270	1999
OGLE	81	2002
HATNet	67	2006
SuperWASP	113	2007
Kepler	2708	2009
HATSouth	73	2012
K2	537	2014
Transiting Exoplanet Survey Satellite (TESS)	253	2018

Figure 3: *Relative Facility Performance of the Top Ten Exoplanet Discovery Facilities According to NASA Exoplanet Archive Data*

The average number of exoplanet discoveries listed in this archive for a facility per year within the top ten was roughly 38.8. The Kepler, K2m and (Tess) facilities were the only facilities with a discovery rate above the average which suggests that the more recently initialized facilities are better suited to finding exoplanets. Kepler was however by a magnitude the largest outlier from this mean value.

Conclusion

In conclusion, the list manipulation involved importing and formatting data from the NASA Exoplanet Archive, enabled the analysis of three aspects: the number of planets discovered per year, the relationship between planet and star masses, and the relative performance of exoplanet discovery facilities. The data was organized and processed, allowing for graphs and a tabulation which revealed trends being the increasing number of exoplanet discoveries by newer facilities over the years, the correlation between planet and star masses.