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**Project Proposal: Georeferencing Exoplanets**

I am interested in blending the fields of Geospatial Sciences with Astronomy, so for my project I am aiming to find a way to spatially link detected exoplanets to Earth. An exoplanet is any planet that is outside our solar system, that is, any planet not in orbit around our Sun. According to NASA, there are over 4,000 confirmed exoplanets in over 3,000 planetary systems (meaning some stars have multiple exoplanets orbiting them). This would be the size of my data. I would obtain the data necessary for this project from the NASA Exoplanet Archive, located at <https://exoplanetarchive.ipac.caltech.edu/>. From there, I can download the archive as a CSV file which has all the all the known information about each exoplanet in it. This information ranges from the name of the exoplanet, the name of the star it orbits, how far away it us from us, when it was discovered, its mass, etc. Not all of the given information is very important to this project, so I will need to process the data by removing the unnecessary information (like “solution type” or “controversial flag” which aren’t related to any of the characteristics of the planet) and then setting the information that I need (like distance) into variables for use in the program. Some of the limitations in this data are that not every exoplanet has the same amount of knowledge on it. Due to the nature of exoplanet detection, there are gaps in the data available for some exoplanets. Furthermore, not all the information is 100% accurate. There are varying degrees of uncertainty in information like their orbits and size.

The study area will be our little corner of the Milky Way galaxy as the furthest exoplanet detected is 8,200 parsecs away (1 parsec = 3.26 light years) and the Milky Way is approximately 30,000 parsecs across. I chose this project specifically because I got into GIS so that I could “map” the universe. Even though the first exoplanet was not detected until the 1990’s, the sub-field of astronomy has boomed and there is tons of literature and research about exoplanets today. However, I have not been able to find any actual attempts to display this data spatially. I would like to try and do this. It could be used to study trends among exoplanets in certain regions of space (are exoplanets in this region of the galaxy more likely to have gaseous planets over rocky ones? Are they more affected by “dark matter” here? Etc.) as well as help expose areas where research/detection has been lacking and guide future observations (are there any areas around us that we have not searched for exoplanets yet? Maybe we have been over focusing on one region). My primary outcome will be to get the exoplanets spatially linked to Earth. There are of “artistic renditions” of our galaxy and exoplanets, but nothing I have seen that uses the observed data for accurate precision. Alternatively, I would be able to display this data in a 3D environment and make it interactive so that you could select an exoplanet and read all the information about it, and then set this up as a webservice for public use. But, my overall goal is to get them linked in a 2D environment first (the stars and planets all orbit on a plane, so 2D would not be an issue anyways). Those alternatives are just stretch goals for this project and things I could continue to work towards after the course is over. I believe the main modules that I will need to complete my primary outcome are Numpy, Matplotlib, and Pandas. These modules will allow me to write the custom code required to edit the data, run it through equations as necessary, provide analysis on the data, and eventually visualize the data. I think the main issue is going to be accurately displaying the exoplanet’s direction from Earth. NASA provides the straight distance from Earth, but they do not directly provide what direction that distance is in. I also think that creating a website for this would be challenging, as I have zero experience with web development and setting up a website. I also think visual displays could be jarring as there are extreme differences in the distances of exoplanets (the nearest one being 1.3 parsecs away, and the furthest being 8,200 parsecs away). Overall, this is an exciting project for me as it has not been done before and allows me to literally map the universe using real data. I hope to be able to turn this into a long-standing personal project, even once this course is over.