Midterm - Phys 1211
Feb. 2020

NAME:

Background

Exoplanets are planet's beyond our solar system. Scientist have discovered thousands using various methods, mostly with the help of NASA's Kepler Space Telescope. The file *exoplanets.txt*[1] contains information on over 2600 of them. This information includes (**Take special note of the units, ask if you don't know what these units mean**):

Description	Field Name in File
Official name	Name
Mass of planet (in Earth masses)	Mass
Planetary Radius (in Earth radii)	Radius
Orbital Radius (AU)	Orbit
Star's Mass (in Sun masses)	Smass
Distance from Earth (parsecs)	Distance
Possibly Habitable (true/false, 1/0)	Habitable
Method of Discovery	Method
Year of Discovery	Year

We have already explored a little orbital mechanics in your programs. You have programmed functions to calculate the altitude h of a satellite orbiting earth with a specific period T according to

$$h = \left(\frac{GMT^2}{4\pi^2}\right)^{1/3} - R.$$

This equation comes from Kepler's third law, which relates the orbital period T (in Earth years) of any body to the radius of its orbit a (as measured from the center of the orbit in Astronomical Units, AUs),

$$a = (T)^{1/3}, \tag{1}$$

For instance, given the period of 1 Earth year, you can calculate that the orbital radius of the earth, 1 AU (or about 150 million km).

On the surface of a planetary body of mass M and radius R, objects feel a force of

$$F_g = \frac{GMm}{R^2} = mg$$

giving an acceleration due to gravity as

$$g = \frac{GM}{R^2}, \tag{2}$$

where for Earth, of course, $g = 9.81 m/s^2$.

[1]taken from http://phl.upr.edu/projects/habitable-exoplanets-catalog/data/database

Problems

The Midterm contains 2 problems, **which you can complete using either MATLAB or Python**. Please feel free to use past programs to get started, there is also starter files in the midterm folder. In the first problem, you should write a function. In the second problem, you should write a script, which will use the function. Remember, I don't want "hardcoding" in the script, meaning I should be able to run your script on a different dataset (of the same format) and get the correct results out. **Don't forget to label plots or histograms**.

1. (20 points) Write a function, call it `planet`, that takes the (i) planet's mass, (ii) planet's radius, (iii) planet's star's mass, and (iv) the orbital radius of the planet; and returns the planet's (i) period of orbit (the planet's year, in Earth years) and (ii) g for that planet (in terms of Earth's g), *in that order*. This function should be able to take and return single values and entire arrays. *You will have to consider what units to use.* ***It is advantageous to use the units as specified above (everything in terms of Earth units because the calculations become trivial in those units)***.

   You should test your function using Earth's data.

   For instance, your program should return

   ```
   >>[pT, pg] = planet(1,1,1,1)
   pT = 1
   pg = 1
   ```

2. (20 points) Write a script in a live editor or jupyter notebook that imports the file *exoplanets.txt*. Then answer the following questions using the data and the function you just wrote. *DO NOT spend time having the script produce full sentences, just the raw output is fine*.

   (a) What is the name of the closest, (possibly) habitable exoplanet discovered? When and how was it discovered? What is its period of orbit (the planet's year, in Earth Years) and its g value (in terms of Earth's g)?

   (b) How many habitable exoplanets are listed in the file? Create a scatterplot of their g values and orbital periods T?

   (c) What is the most common method for detecting exoplanets? What percentage of the exoplanets were found using this method?

Submission

Please put all relevant files in a folder called `midterm` in your repository and push it up by the end of class.