Aubrey Cramer 5/1/2024

I chose the package PyEphem: Astronomical Ephemeris for Python. This package consists of various exercises in order to calculate the coordinates of various celestial objects according to the time, date, and latitude of the observer any place on Earth. The package was first introduced in 1998, it originally served as a SWIG around the raw libastro C structures, allowing for data collection of astronomical objects in Python. The program PyEphem went through various updates and bug fixes ending with the version 3.7 which was released in 2014. The code for this was originally written in C by Elwood Charles Downey (XEphem), he then allowed Brandon Rhodes to translate it into python, which still maintains it but its last update was in 2022.

The package itself was fairly easy to use, it consisted of using pip install and then importing the package.The package had extensive detail on what each function did as well as examples on what to expect using Python code. It was originally in C but as previously stated it was translated to pure Python. The program itself inputs parameters that the user can manipulate to get the output of desired data of positions of celestial objects. PyEphem has basic unit tests for functionality and potential regression tests, but formal benchmarking tests may not be included. Users can create their benchmarks for performance evaluation.The program does not use any main functions, mostly ephem and compute, as for plotting it uses matplotlib. The code does not produce figures but I have created some later on in my report.

In order to exercise some of the capabilities of this program I first created a plot displaying the movement of Mars on the dates of 1781/3/13 and 1781/4/13. Plotting the declination against the right ascension. I have also printed out these coordinates, the first coord is the right ascension, the second is the declination and the last one is the magnitude.

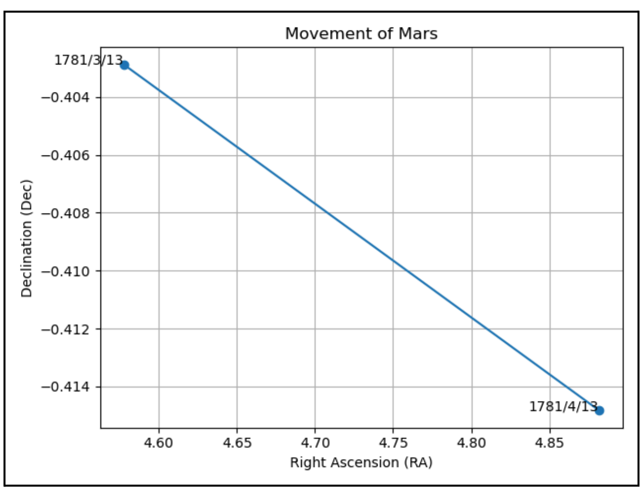

Figure1: Movement of Mars from 1781/3/13 to 1781/4/13

```
Distance traveled by Mars
------------------------------
17:29:06.38 -23:04:59.5 0.48
18:38:50.03 -23:46:03.9 -0.18
++++++++++++++++++++++++++++++
```

Data Chart 1: Coordinates of Mars at two different dates

My second exercise was to find the coordinates of the Moon and Neptune on the same date, 2005/8/24. It then computes the angular separation between the two celestial bodies.

```
------------------------------
Position of the Moon and Neptune on 2005/8/24
------------------------------
1:45:30.49 12:17:09.8 -12.4
21:13:11.25 -16:14:20.5 7.84
73:06:00.5 <-- angular seperation
------------------------------
```

Data Table 2: Coordinates of The moon and Neptune on 2005/8/24 and the angular separation between them

To test the length of dates I could pick I chose a date in the far future (3045) as well as a far back date (-1000004, around a million years ago). To which the system calculated these values based on years of data and knowledge allowing me to find the movement of positions anywhere in time. I did this by using the first exercise and tested the limits of time, using a date in the future and one well into the past. However I attempted to do it before the formation of Mars 4.63 billion years ago and was left with blank numbers allowing me to assume it cannot go back the calculated formation of a celestial object and that the program does have limits.

```
Distance traveled by Mars (Future)
------------------------------
19:04:42.73 -22:48:59.9 1.08
20:30:27.43 -19:48:29.8 0.68
++++++++++++++++++++++++++++++
------------------------------
Distance traveled by Mars (Past)
------------------------------
6:23:27.14 74:17:23.8 65.68
23:15:56.12 -64:12:02.9 0.0
++++++++++++++++++++++++++++++
```

Data Table 3: Example of a futuristic estimate of the movement of Mars as well as an early estimate of the movement of Mars.

Lastly I wanted to find the position of the sun for 5 hours out of the day utilizing the date and time function as well as the function allowing me to pick a latitude for the observer. I then graphed this with altitude against azimuth showing the position of the Sun from various increasing hours.

```
------------------------------
Suns position over 5 hours
------------------------------
7:08:05.0 291:32:19.8
-2:44:05.6 299:46:57.6
-14:29:00.9 309:19:34.3
-23:18:09.2 320:43:46.1
-30:00:12.2 334:24:11.5
------------------------------
```

Data Table 4: Coordinates of the Sun at various hours in the day.