Recreating the Kirkwood Gaps

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Space Facts / Laurine Moreau

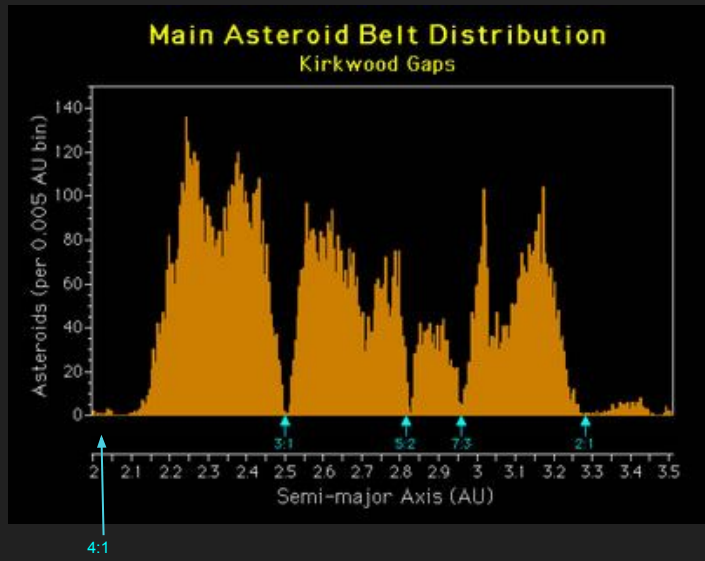
Goal of Project

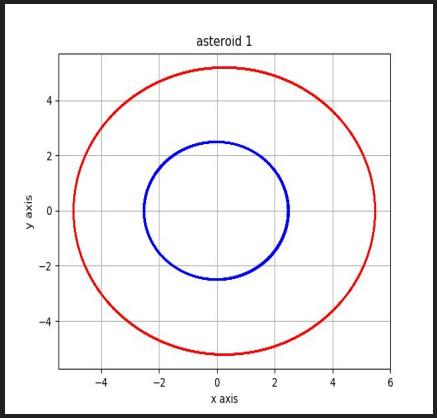
Simulate the Asteroid Belt, Jupiter and the Sun

- Input n number of asteroids in a range of semimajor axis
- Gather data for every run

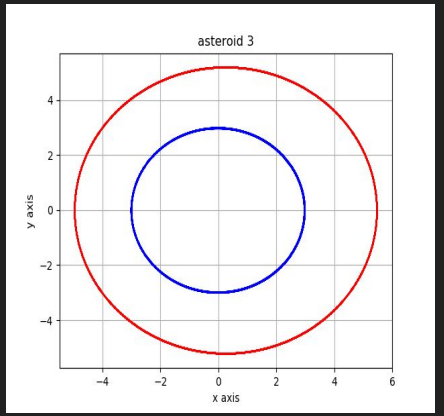
Create a histogram of the data

- Recreate Kirkwood Gaps
  - Little to no asteroids found
  - Resonance ← Jupiter's gravity clears the orbit

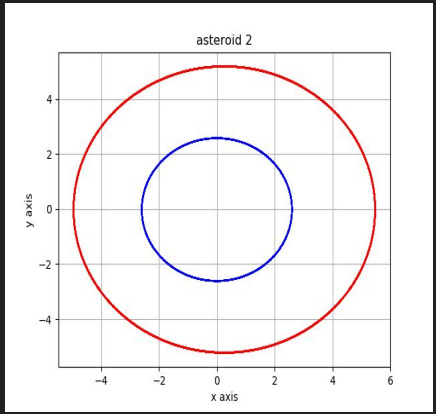


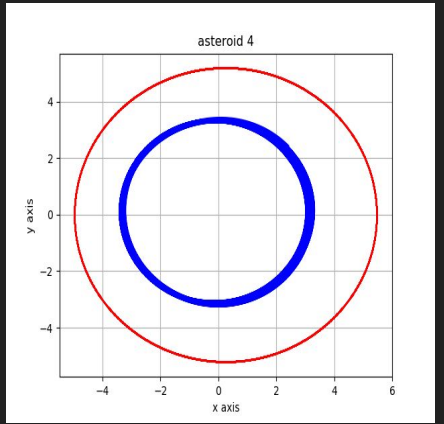


Where did I start?



- 3 body problem: Jupiter, the Sun, and an Asteroid
  - Homework 6: asteroid problem
  - Euler Cromer Method





Modifications and Problems to Face

1. How to input an n number of asteroids and keeping track of the parameters for each asteroid throughout the code

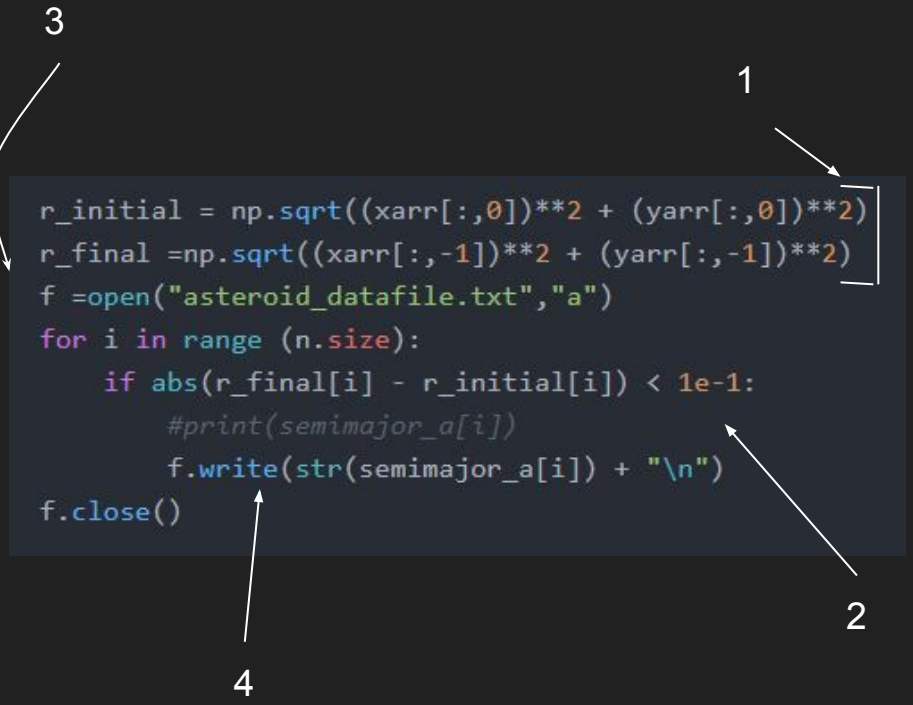
```
for i in range(0,1000):
    number= 1.5*np.random.random()+2.0
```

```
for i in range(n.size):
```

2. Finding which orbits were stable and finding the semimajor axis of those orbits.

3. Finding a way to get multiple runs of data into one place in order to make a better histogram.

Hardest Solutions- Problem 2 & 3:



Choosing values to keep:

1. Find initial and final radii
2. Difference is less than a certain percent = stable

Allow multiple runs of program:

3. Create/open txt file and append data to file
4. Write in file the values to keep

Running the program

f’ string prints cycle number every 200 cycles

Super cool!!!

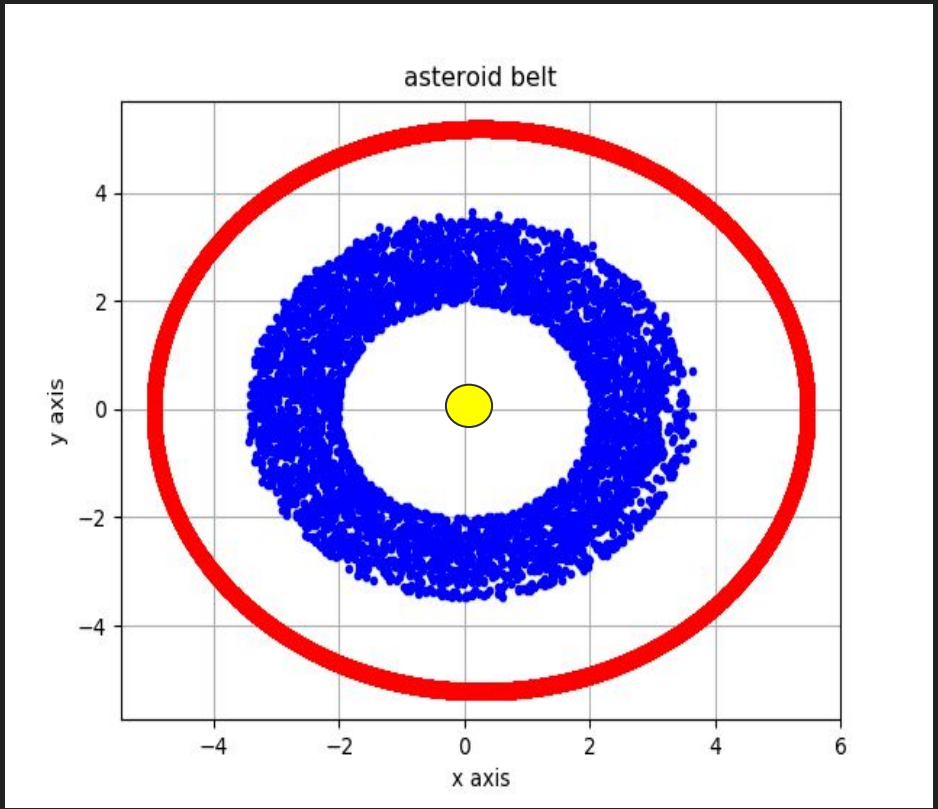
```
if (count %200 ==0):
    print(f'{count}')
```

Run time:

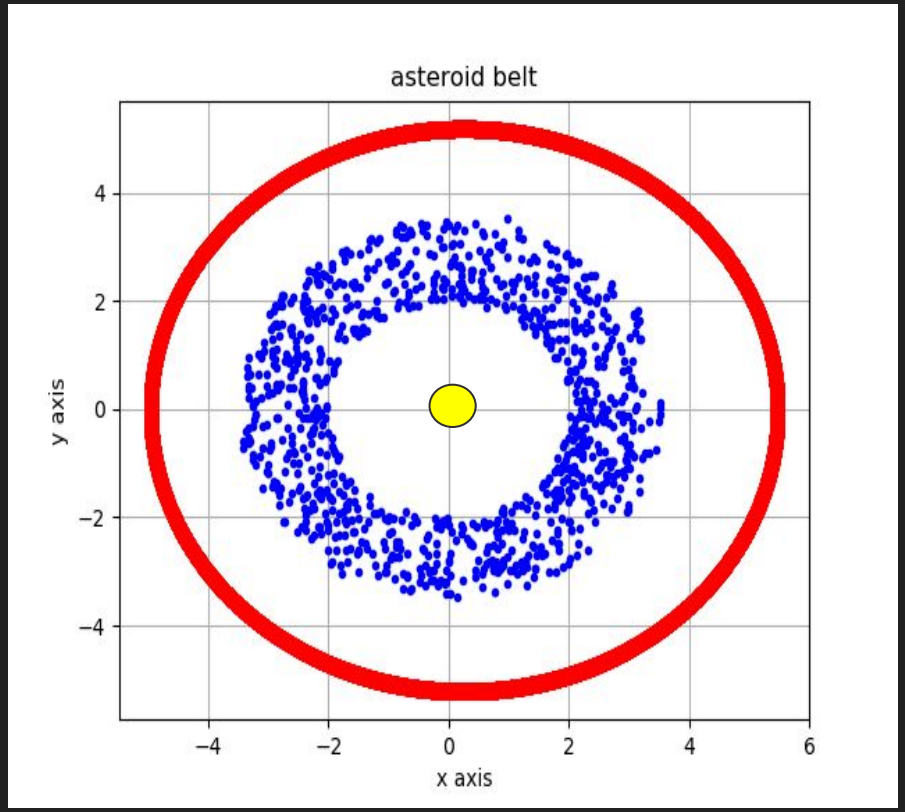
- 5000 asteroids: 7+hrs
- 1000 asteroids: 1hr 17min 32sec
- 500 asteroids: 20min 36sec
- 100 asteroids: 5min 9sec
- 50 asteroids: 5min 3sec

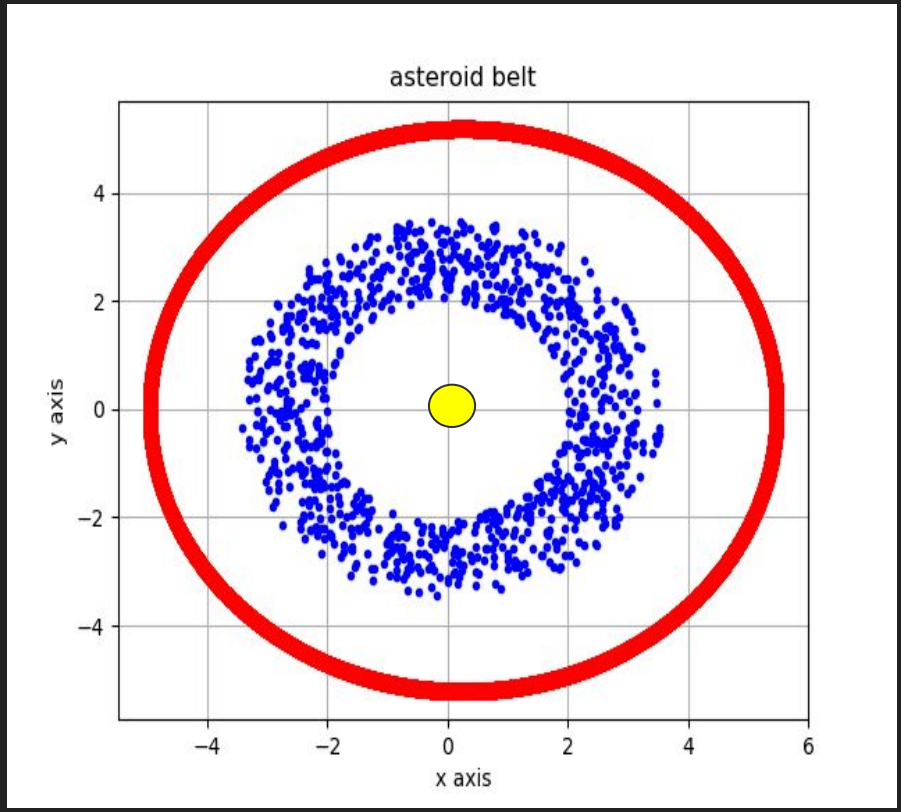
What did the plots of the asteroids look like →

5000 Asteroids

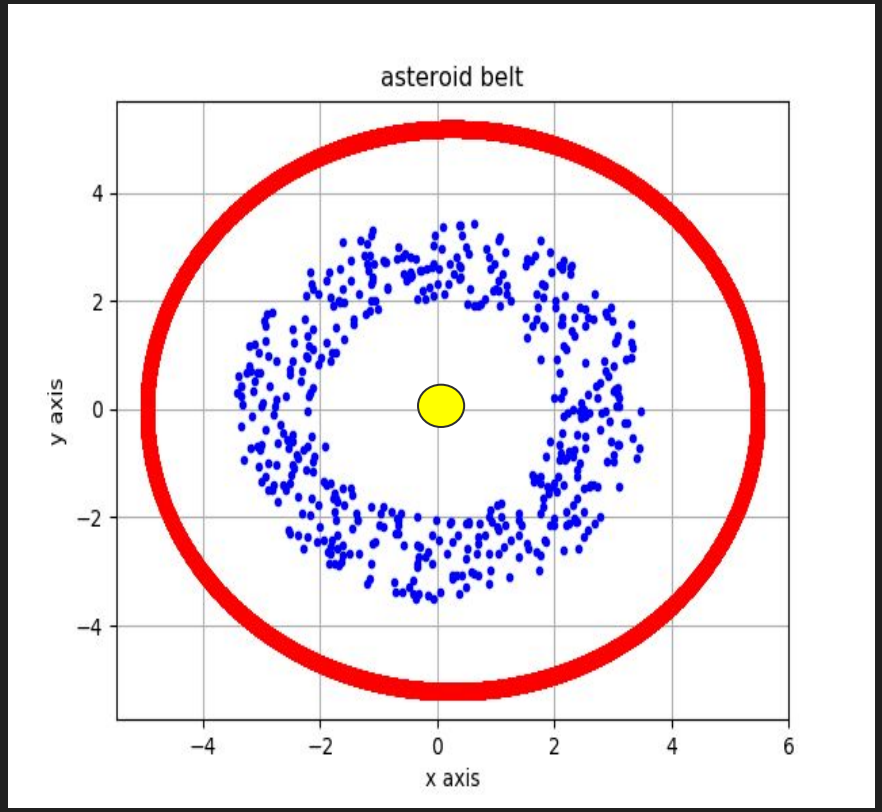


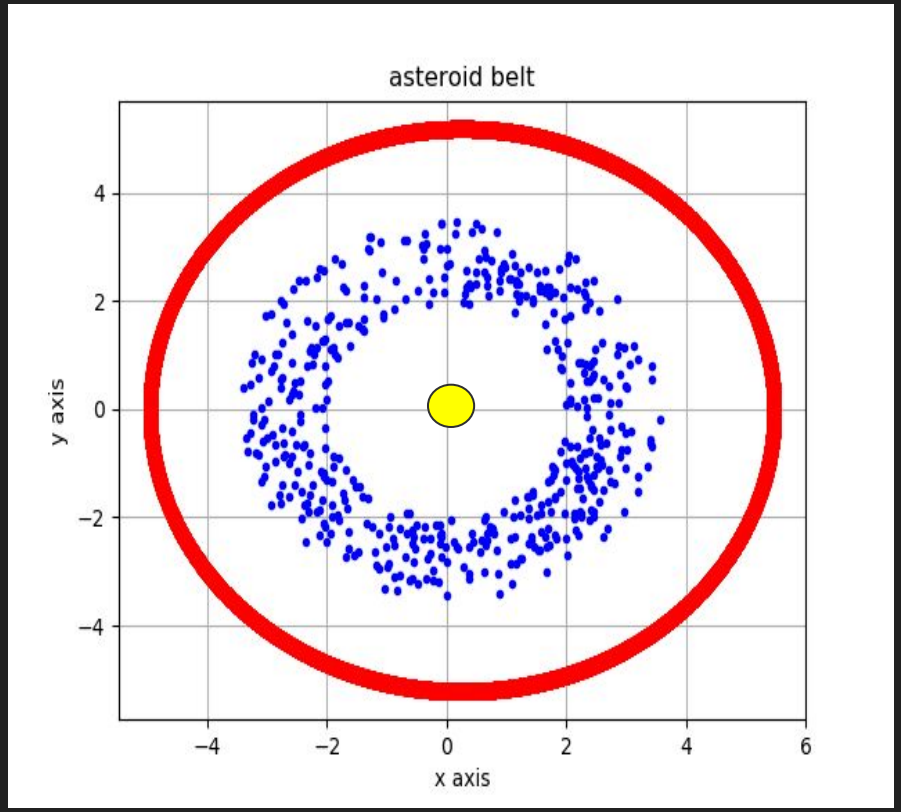
1000 Asteroids



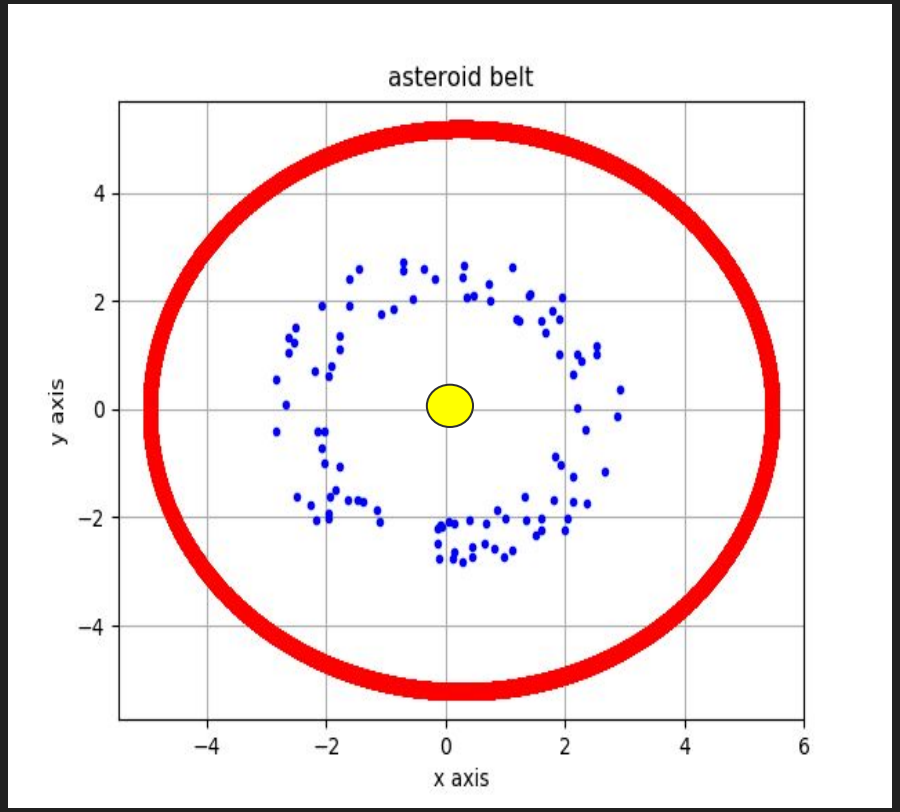


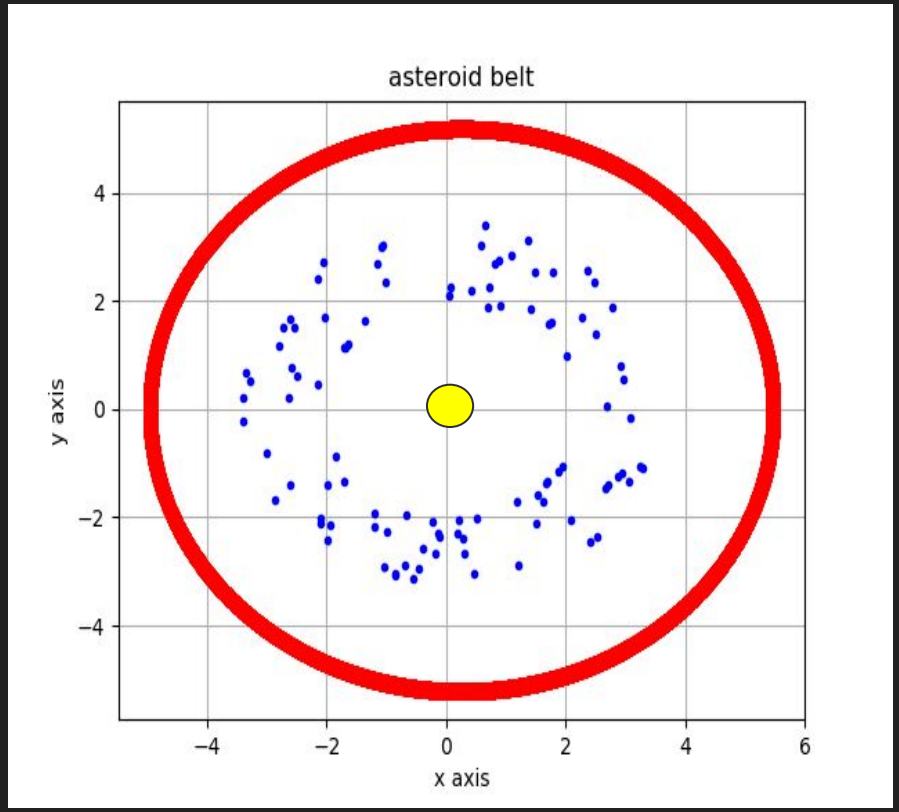
500 Asteroids



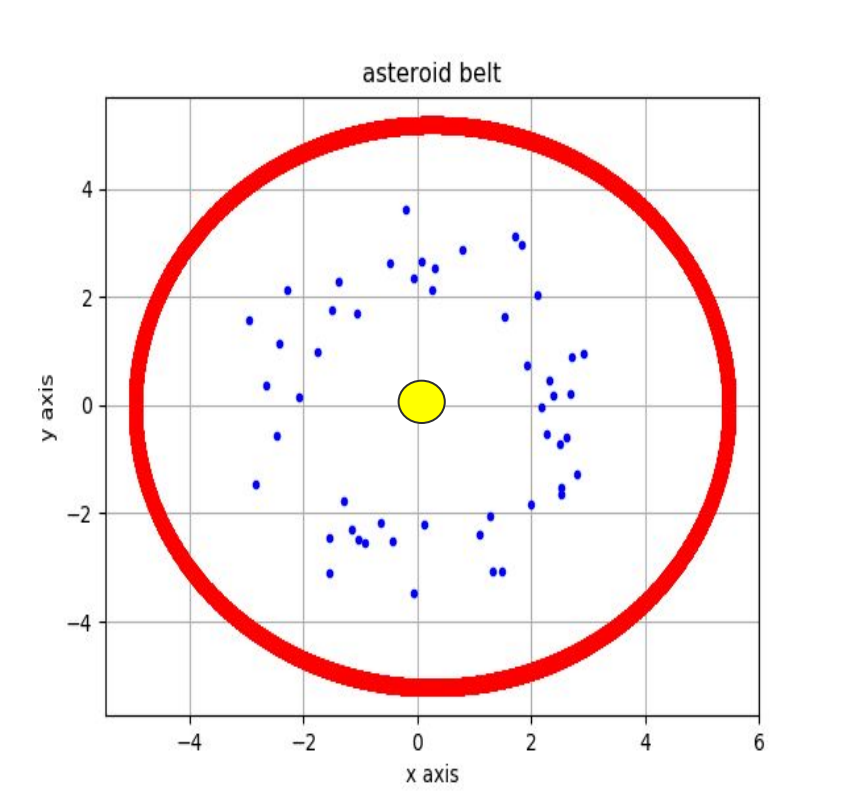


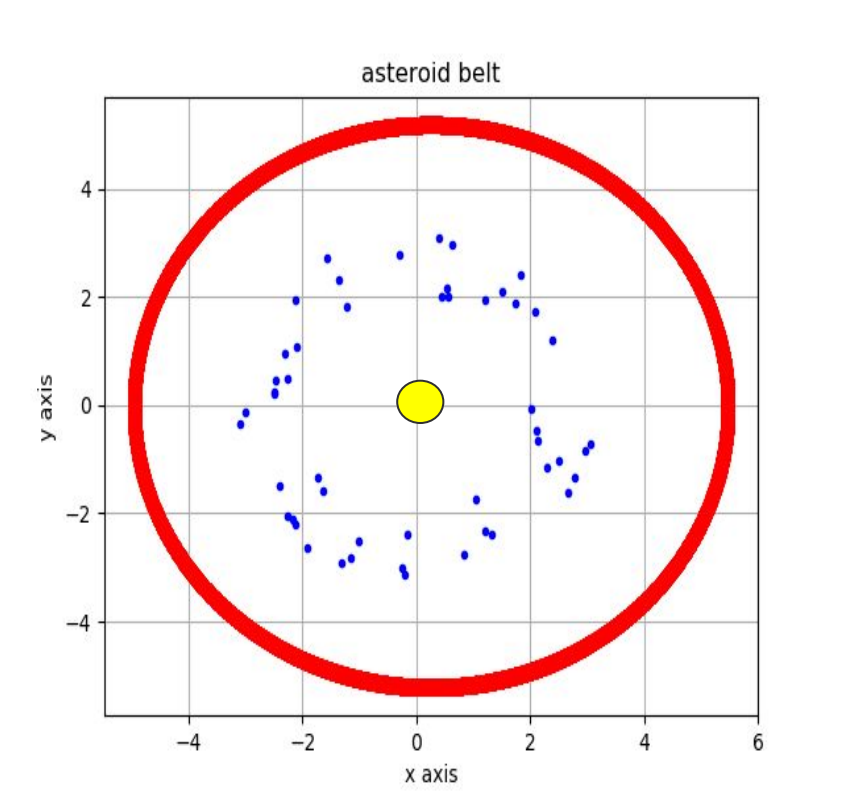
100 Asteroids





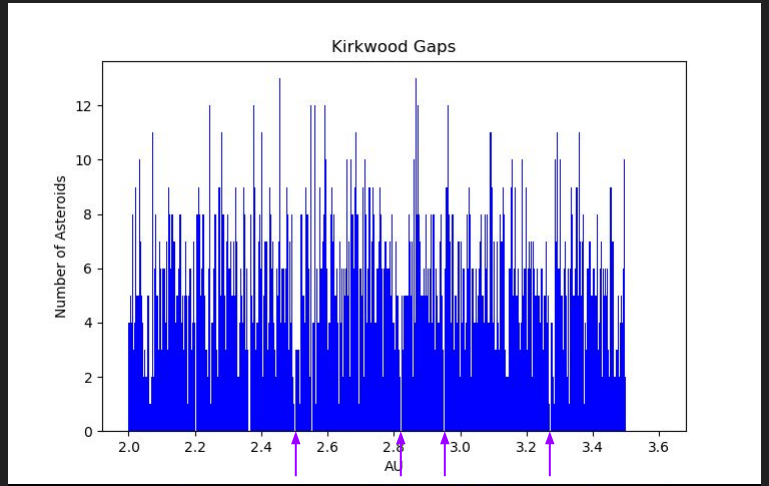
50 Asteroids

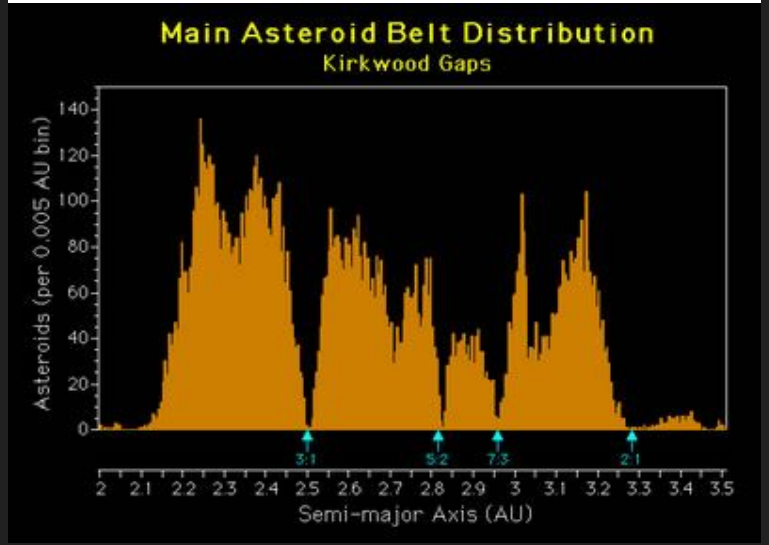




Results/Comparison:

- Data File contains 2636 asteroids
- Gaps in the right spots!!!
  - 2.5 AU, 2.82 AU, 2.95AU, 3.27 AU
- My histogram
  - Extra gaps at: 2.2, 2.36, 2.55
  - Does not show resonances





Conclusion:

How accurate was it?

Was there error? What caused it?

- Not as many asteroids
- Used randomly distributed asteroids, not real ones
- Radii deleted from set, deemed unstable

Ideas for future:

- Using real data
- Resetting parameters to sort which are stable or unstable
- Run program more

Questions?

Bibliography

Title page image- https://space-facts.com/asteroid-belt/ created by Laurine Moreau

Histogram comparison image- http://astronomy.swin.edu.au/cosmos/K/Kirkwood+Gaps created by NASA