Phys 304: Assignment 2

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[Survey question: The homework took me about 5 hours to complete. I learned about how to plot imported data and non-Cartesian functions. The Curve plotting problem was the most interesting, because I didn't know that matplotlib could plot those types of functions. The problem set length was just right.]

1. PROBLEM 1: PLOTTING SUNSPOTS

The Sun, like most stars, has a very strong magnetic field. In some areas across the Sun's surface, the magnetic field concentrates. This acts to dampen the the convection of heat from the Sun's surface. To observers on Earth, this appears as dark spots in the sun, called sunspots. The change in magnetic field is periodic, so sunspots change their location and number with time and can be plotted.

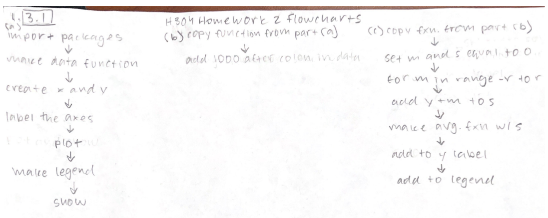

FIG. 1: [Pseudocode of the following plots in this problem can be seen here.]

1.1. Part (a): A graph of sunspots as a function of time

The observed number of sunspots on the Sun for each month since January 1749 is plotted.

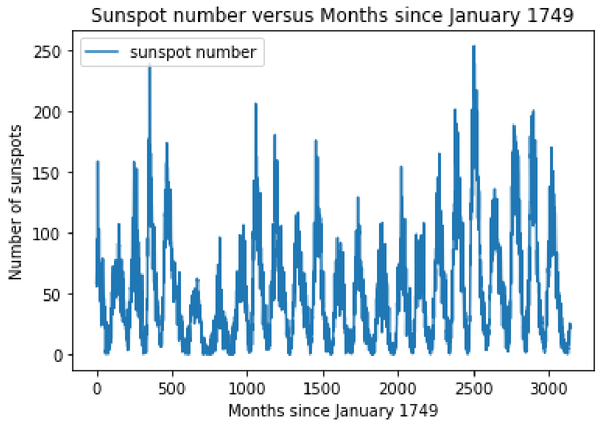

FIG. 2: [A graph of sunspots since January 1749. The periodic nature of sunspots can be clearly observed.]

1.2. Part (b): Limiting the data

The plot was then limited to the first 1000 data points.

1.3. Part (c): The running average

The running average of the data is defined by the following:

$$\Upsilon_k = \frac{1}{2r+1} \sum_{m=-r}^{r} y_{k+m}, \tag{1}$$

where y_k are the sunspot numbers, and r=5 in this case. The running average, given by Eq. 1, is then graphed with the original data.

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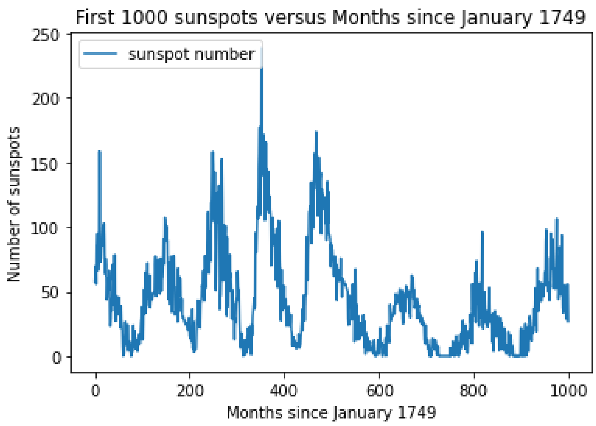

FIG. 3: [A graph of sunspots since January 1749. The graph is limited to the first 1000 data points.]

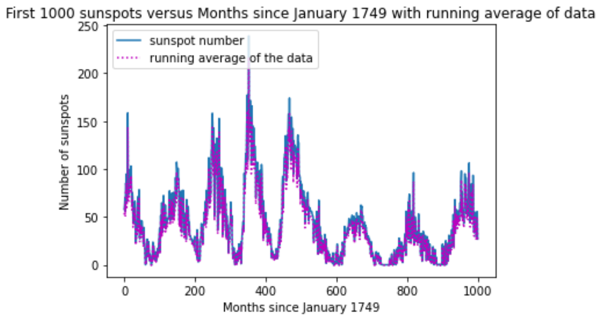

FIG. 4: [A graph of sunspots since January 1749, limited to the first 1000 data points. The running average of the data is plotted with the data itself.]

2. PROBLEM 2: CURVE PLOTTING

The plot function is adapted for use of parametric functions. The pseudocode in Fig. 5 is used to create the following plots.

2.1. Part (a): The deltoid curve

The deltoid curve is given by the following parametric equations:

$$x = 2cos\theta + cos2\theta$$
$$y = 2sin\theta - sin2\theta, \qquad (2)$$

where θ is $0 \leq \theta < 2\pi$. This is then plotted in Fig. 8.

2.2. Part (b): The Galilean spiral

Polar plots are created by taking $r = f(\theta)$ for some function f over a range of θ, and then converted into

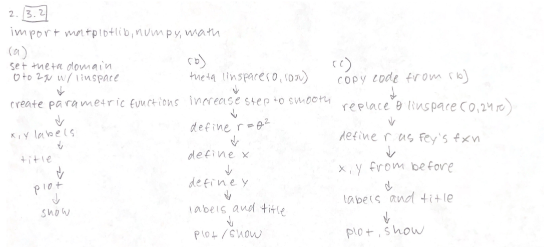

FIG. 5: [The pseudocode for problem 2.]

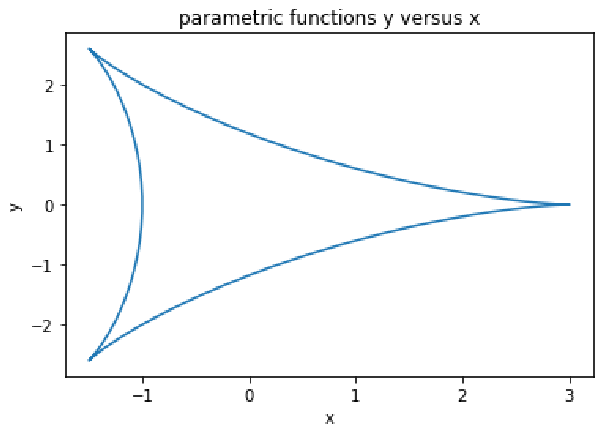

FIG. 6: [From Eq. 2, y is plotted as a function of x to obtain the deltoid curve.]

Cartesian coordinates in the code. The Galilean spiral is for $r = \theta^2$ over a range of $0 \leq \theta \leq 10\pi$.

2.3. Part (c): Fey's function

Fey's function is given by:

$$r = e^{\cos\theta} - 2\cos 4\theta + \sin^5 \frac{\theta}{12}, \qquad (3)$$

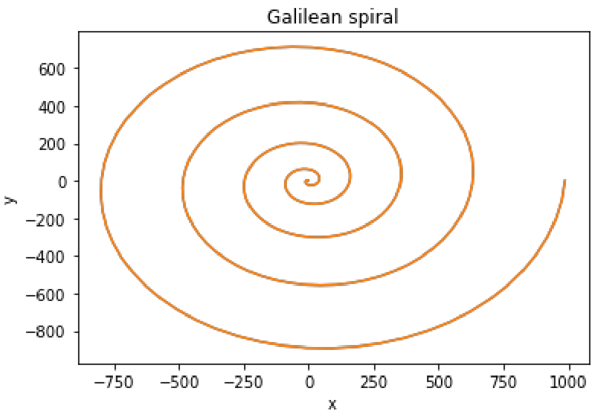

FIG. 7: [The Galilean spiral is plotted over $0 \leq \theta \leq 10\pi$.]

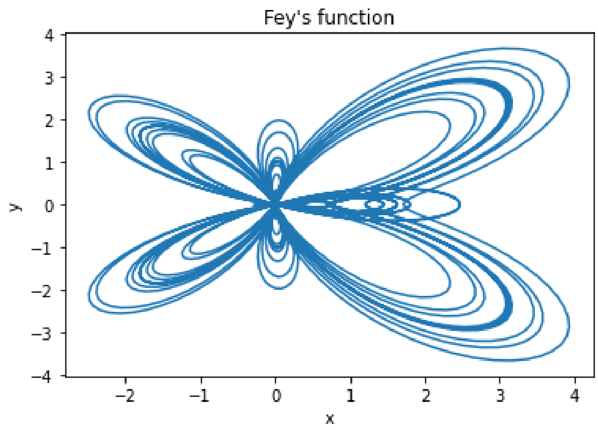

FIG. 8: [Fey's function is plotted over $0/leq\theta/leq24\pi$.]

taken over the range of $0/leq\theta/leq24\pi$.