PHYS 304 AS2

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Required (graded) exercises (I did all three problems. I would like to have my first and third problems for grading.)

1. EXERCISE 3.1

(a) See the file $sunspots\_PHYS\_304\_AS2\_Xiyue\_Shen$ part a, as shown in Figure 1

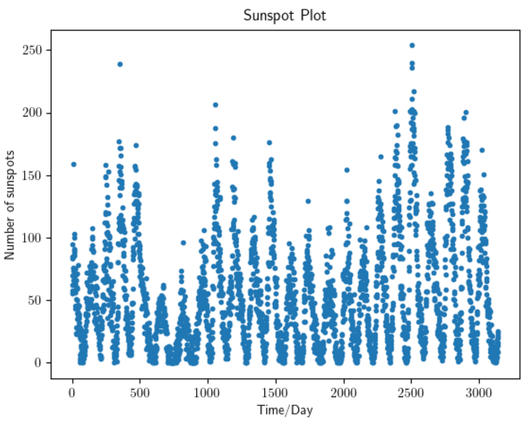

FIG. 1: Sunspots plot for all data

(b) See the file $sunspots\_PHYS\_304\_AS2\_Xiyue\_Shen$ part b, as shown in Figure 2.

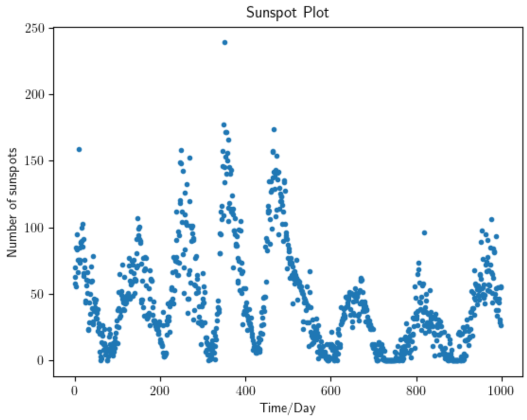

FIG. 2: Sunspots plot for the first 1000 data

(c) I used the equation

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

I have $r = 5$, which indicates that every datapoint is averaged over 10 points with the previous 5 and after 5 points, as shown in Figure 3.

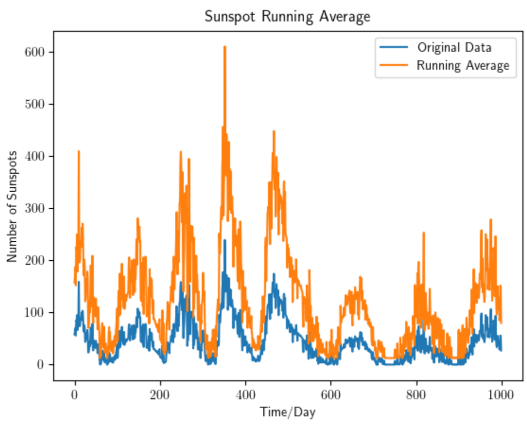

FIG. 3: Sunspots plot for averaging the first 1000 data points

2. EXERCISE 3.2

I have done exercise 3.2 last time, and I attached my answer here again

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I assigned θ with evenly distributed values using "linspace". Then, set x and y as functions of θ given in the problem.

(a) We have $x = 2\cos(\theta) + \cos(2\theta)$ and $y = 2\sin(\theta)\sin(2\theta)$, referring to Figure 4

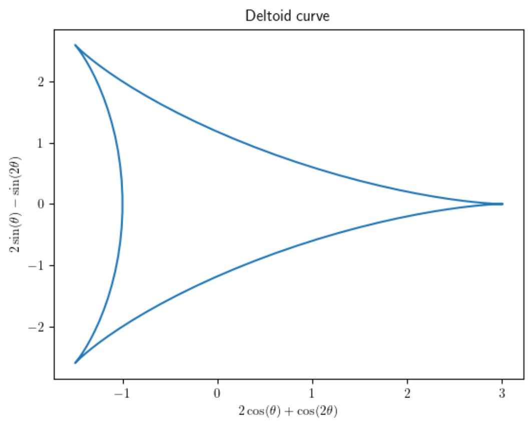

FIG. 4: Deltoid curve

(b) We have $r = \theta^2$; then, $x = \theta^2\cos(\theta)$ and $y = \theta^2\sin(\theta)$. In the coding, I used ϕ instead of θ to avoid confusion with part a, referring to Figure 5

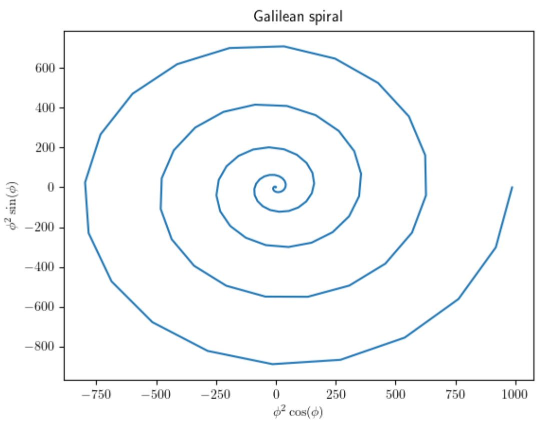

FIG. 5: Galilean spiral

(c) We have $r = e^{cos\theta} - 2\cos(4\theta) + \sin^5(\frac{\theta}{12})$; then, $x = [e^{cos\theta} - 2\cos(4\theta) + \sin^5(\frac{\theta}{12})]\cos(\theta)$ and $y = [e^{cos\theta} - 2\cos(4\theta) + \sin^5(\frac{\theta}{12})]\sin(\theta)$. I used α instead of θ to avoid confusion with part a in the coding, referring to Figure 6

3. EXERCISE 3.6

(a) For fixed point, there's only one x corresponding to a fixed r. This will be stable as x converges to a

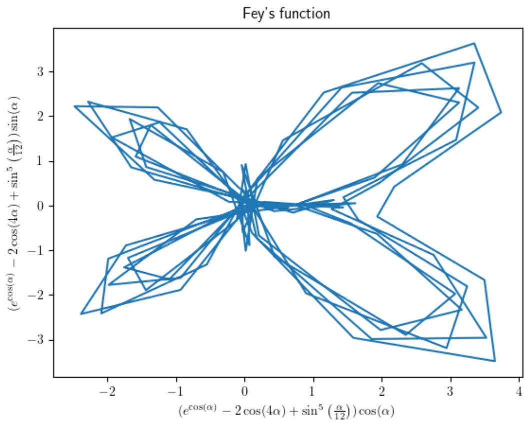

FIG. 6: Fey's function

single point. For the limit cycle, for a given value of r, there will be several points for x with a periodic pattern. For a chaotic system, there will be a random distribution of x, which has no regularity. The next value of x is not predictable.

(b) Based on the plot, the "edge of chaos" is around 3.5 on the scale. As we can tell from Figure 7, after $r = 3.5$, the x starts to behave randomly.

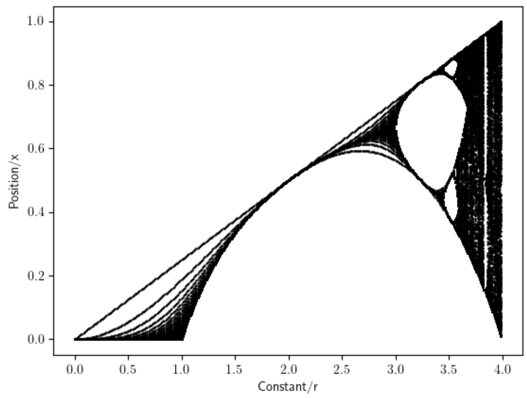

FIG. 7: Feigenbaum plot

Required (ungraded) exercises

- I have downloaded the repository.
- I have followed along with class notes.
- I have completed. Jupyter notebook tutorials. These have lots of great examples.