Homework 9 Write-up

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1 Part 1

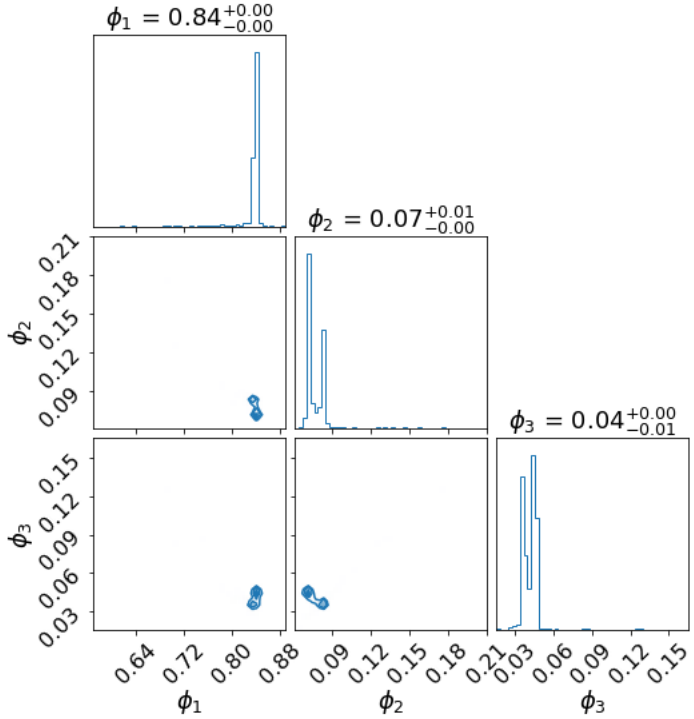
The model that I created for this data set has three parameters ϕ_1, ϕ_2, and ϕ_3. ϕ_1 accounts for the month-to-month values and how the relate to each other and ϕ_2 relates the values by year or every 12 months and ϕ_3 relates the values for every 11-year solar cycle or ever 132 months. The model equation would look something like

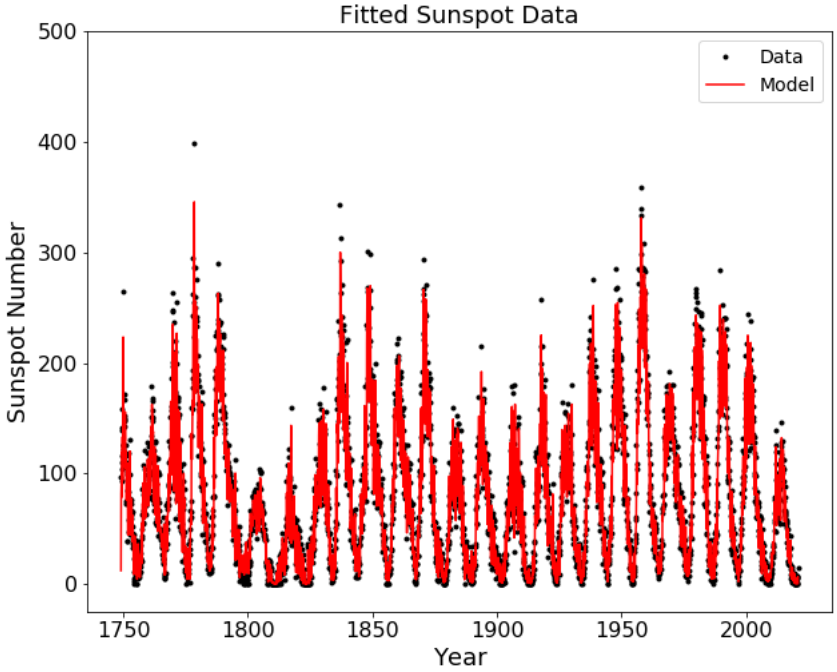
$$X_t = \phi_1 X_{t-1} + \phi_2 X_{t-12} + \phi_2 X_{t-132} + Z_t \tag{1}$$

where Z_t is the noise in the signal.

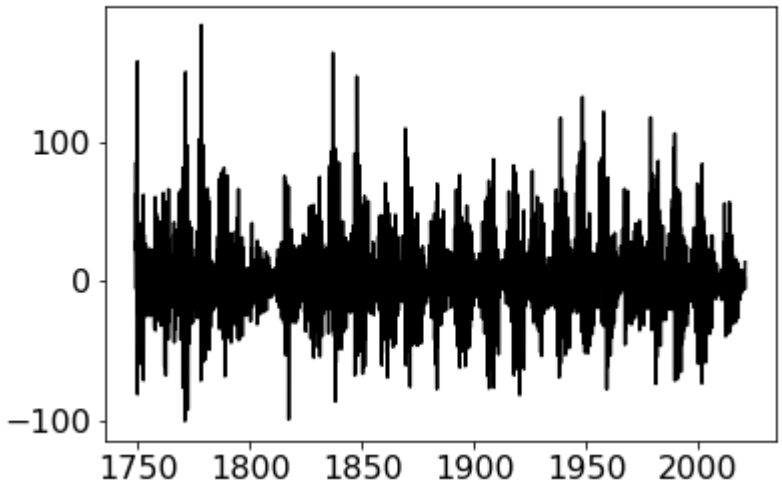
2 Part 2

After using the emcee package and the code provided I produced the following corner plot and the values $\phi_1 = 0.84$, $\phi_2 = 0.07$, and $\phi_3 = 0.04$.





Above is the model fitted to the data and this following is the plot of the residuals:

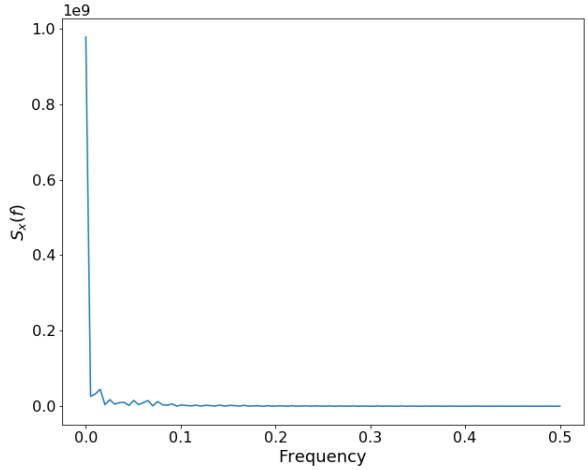


3 Part 3

Plotting the spectrum of the model using the equation

$$S_x(f) = 2\sigma_z^2 \frac{\left|1 - \frac{1}{\phi_1}e^{-2i\pi f1} - \frac{1}{\phi_2}e^{-2i\pi f12} - \frac{1}{\phi_3}e^{-2i\pi f132}\right|}{|1 - \phi_1 e^{-2i\pi f1} - \phi_2 e^{-2i\pi f12} - \phi_3 e^{-2i\pi f132}|} \tag{2}$$

Where frequency is only between 0 and 1/2. I also multiplied by 2 to include only positive values. I don't think that the spectrum plot below is correct because It only really peaks around 0 and that doesn't seem right to me.



4 Part 4

To estimate some future values of the Sunspots up to 2050, I started with getting the number of months that would be in this future time and then used the model to get a value for each of these new times. However I think that my model might have been missing something because these new curves are very low and just keep getting lower. There might even be too much going on in my model that is dampening the values. I'm not sure why this is. All the values are based off of previous ones and as the model progresses into the future the values just keep getting lower because of the poorly predicted values.