# ASTP-720 Homework 9

Zach Diermyer

December 1, 2020

Github Link: `https://github.com/zrd7527/ASTP720.git`

## 1 Task 1

Using the given notebook, I created a 3 parameter autoregressive model for the sunspot data. The parameters are $\phi_1$, $\phi_2$, and $\phi_3$, corresponding to the change in monthly, yearly, and 11 year solar cycle values. The mathematical form of the model can be seen in Equation 1. The powers of the backshift operator are in months because the data is given with corresponding monthly values. The shock term, $Z_t$, is the residual when assuming a normally distributed shock value. I subtracted the backshifted data values from each point in the data array in order to fit my model to the data. After subtracting those values I found the residuals by summing $Z_t^2$. Plugging these residuals into emcee returned my likelihood plot for the 3 parameters.

## 2 Task 2

The corner plot showing the most likely values of the 3 parameters can be seen in Figure 1. The model can be seen plotted over the data in Figure 2.

## 3 Task 3

The model fits the data fairly well overall. It tends to have lower values than the data at peak values, becoming more inaccurate with increasingly larger peak values. There is almost no dependence on $\phi_2$, the yearly change parameter. There is a strong dependence on the cyclic, 11 year parameter and the monthly change parameter, $\phi_1$ and $\phi_3$.

## 4 Task 4

The prediction can be seen on the right side of Figure 2. The red line is the model prediction and the shaded region is the error. It matches the expected values well for the first solar cycle but then continues to increase. The error region has local maxima at the first 2 expected peak sunspot values but then continues to climb.

$$X_t = \sum_i X_t(B + B^{12} + B^{131}) + Z_t \tag{1}$$

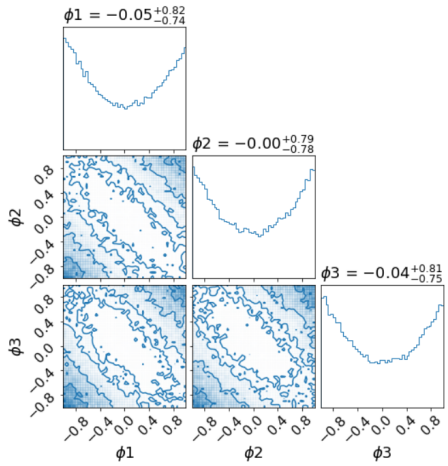


Figure 1

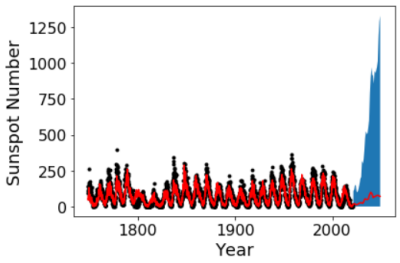


Figure 2