ExercisePreWhiten: Introduction

The simulated data in file **ExercisePreWhitenData.dat** are given in course home-page. These data are a sum of third order polynomial trend and two sinusoidal signals (Figure 1). The two signal periods are between $P_{\min} = 0.5$ and $P_{\max} = 10.0$. Your problem is to determine these unknown periods using the Discrete Fourier Transform pre-whitening technique.

Figure 1: Simulated data.

ExercisePreWhiten: Problem

Edit your own **python** program **ExercisePreWhiten.py** that performs **all following four** pre-whitening analysis stages.

1. Create the **detrended data** by bemoving the third order $K_3 = 3$ trend

$$p(t) = p(t, K_3) = \sum_{k=0}^{K_3} p_k(t)$$

$$p_k(t) = M_k \left[\frac{2(t - t_{\text{mid}})}{\Delta T} \right]^k$$

$$\Delta T = t_n - 1_1$$
$$t_{\text{mid}} = t_1 + \Delta T/2.$$

from the **original data**. In other words, perform a least squares fit to the **original data**, where the free parameters are $\bar{\beta} = [M_0, M_1, M_2, M_3]$. You get the **detrended data** by subtracting the values of this fit from the **original data**. Plot the polynomial fit and the **detrended data** to your file **ExercisePreWhitenDetrendPlot.eps**. Your results should resemble those shown in Figure 2.

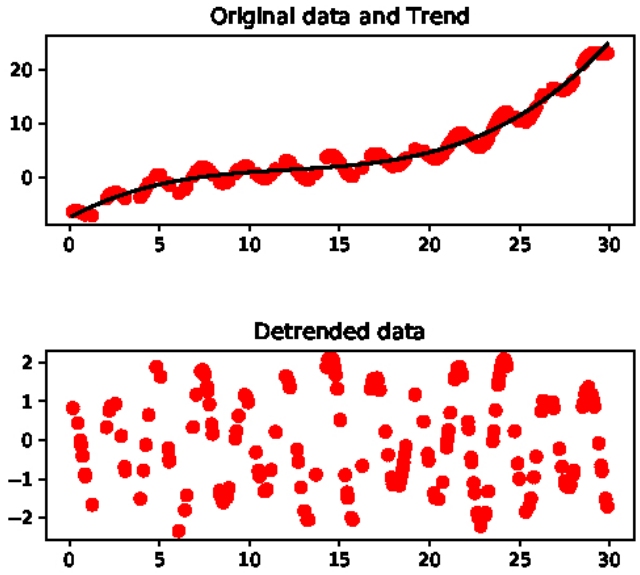

Figure 2: Upper panel: Simulated data and third order $K_3 = 3$ polynomial trend. Lower panel: **Detrended data**.

2. Compute DFT for the **detrended data**. This gives you the first P_1 period. Plot your DFT to file **ExercisePreWhitendft1.eps**. It should resemble Figure 3.

3. Perform a sinusoidal least squares fit to **detrended data**. Use LSF model

$$g(t) = \beta_1 \cos(2\pi t/P_1) + \beta_2 \sin(2\pi t/P_1),$$

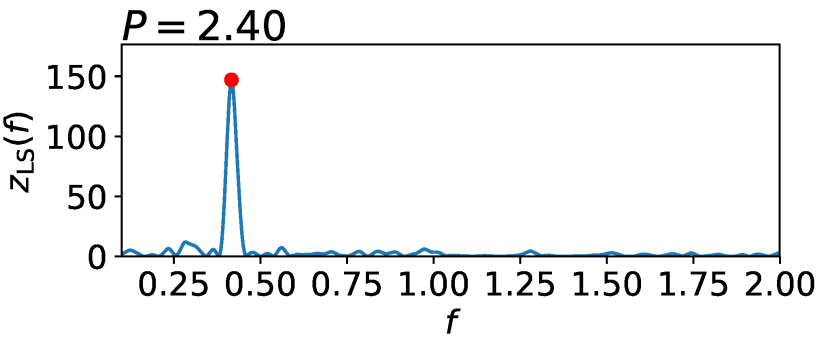

Figure 3: DFT for **detrended data**.

where the free parameters are $\bar{\beta} = [\beta_1, \beta_2]$. Compute this sinusoidal fit residuals (**1st residuals**). Plot your results to file **ExercisePreWhitensine1.eps**. It should resemble the results shown in Figure 4.

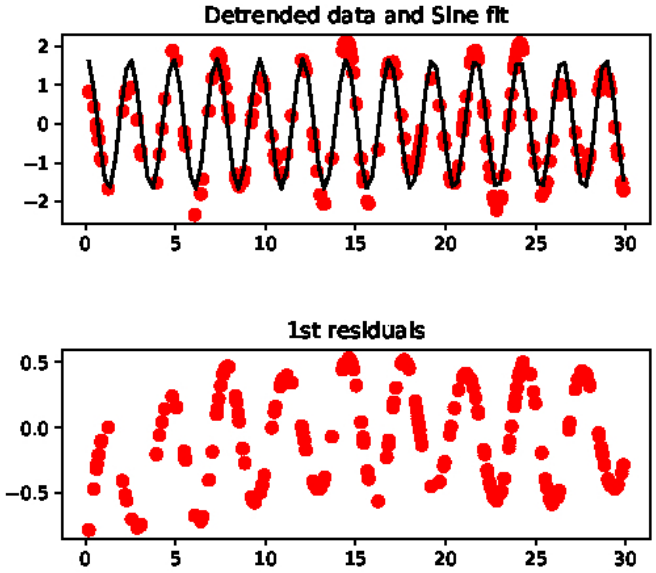

Figure 4: Upper panel. Sinusoidal fit to **detrended data**. Lower panel. Sinusoidal fit residuals (**1st residuals**).

4. Compute DFT for the **1st residuals**. This gives you the second P_2 period. Plot your DFT to file **ExercisePreWhitendft2.eps**. It should resemble Figure 5.

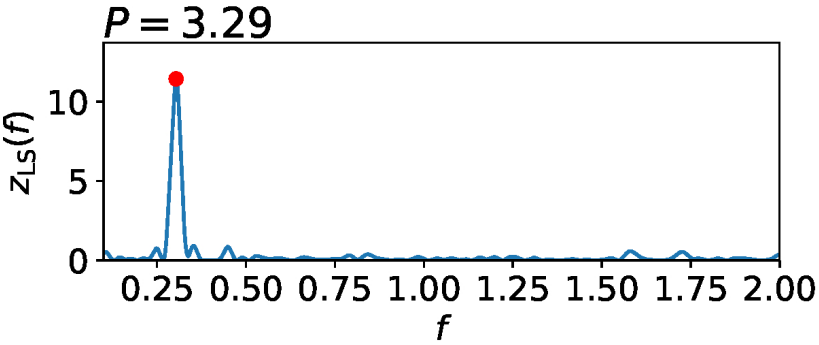

Figure 5: DFT for **1st residuals**.

After completing stages 1-4, **send your following files to the assistant:**
ExercisePreWhiten.py
ExercisePreWhiteDetrendedPlot.eps
ExercisePreWhitendft1.eps
ExercisePreWhitensine1.eps
ExercisePreWhitendft2.eps

Tips: Use **OFAC=40** in your DFT subroutine. This should give approximately same P_1 and P_2 values, as those given in Figures 3 and 5.