Tutorial 3

Time Series & Data Analysis
NASSP – UCT

Due 11am on 31 March 2020

You may use any programming language.

Submit both the code (can be as Jupyter notebook) and a pdf by email.

Question 1: Phase Dispersion Minimization

1.1 Write your own implementation of the PDM algorithm

1.2 Run your implementation on the sunspot data (`zuerich-monthly-sunspot-numbers-.csv`) and plot the PDM statistic vs period.

1.3 Run the PyAstronomy implementation of the PDM on the sunspot data and compare results of the two implementations in terms of any periodicity in the dataset.

Question 2: Event data

2.1 Read in the event data of the magnetar Swift J1834.9−0846 and plot a light curve.
(see Kargaltsev et al. 2012 – `acisf14329N002_evt2_reg_filtered.txt`)

2.2 Calculate the Z_1^2 statistic for this time series, and plot the statistic vs the input period.

2.3 Can you identify the 2.48 s spin period of the neutron star?

Question 3: Non-Fourier methods

Explain the differences and similarities between the epoch-folding, phase dispersion minimisation and the minimum string length methods for period finding.

Question 4: Dynamic periodogram

Use the data on the unusual X-ray binary Her X-1 (`herx1_asm.txt`) for this question. The columns are Modified Julian Date, Count rate, and an error on the count rate.

4.1 Create a series of Lomb-Scargle periodograms for overlapping stretches of the Her X-1 lightcurve, using the frequency grid from 0.01 to 0.1 with a frequency resolution of 0.001. Use a data window of 200 d with an overlap of 50 d.

4.2 Visualize the dynamic periodogram by constructing a three-dimensional map in (time, frequency, power) space with spectral power being represented by the colour scale.

4.3 What can you say about the evolution of the 35 d period?