Tutorial 4

Time Series & Data Analysis
NASSP – UCT

Due 5pm on 1 June 2020

You may use any programming language.

Submit both the code (can be as Jupyter notebook) and a pdf on cloudcape.saao.ac.za

Question 1: Maximum Likelihood

Suppose our data obeys a Poisson distribution with parameter μ, and in successive identical intervals we observe n_1, n_2, ... events. Form the log-likelihood function by taking the product of the distributions for each n_i, and differentiate to find the maximum-likelihood estimate of μ.

Comment on whether it is what you expect.

Hint: go back in the notes to find the Poisson probability distribution

Question 2: Bayesian Blocks

Use the event data from the gamma-ray burst `00551`, and bin the events using the Bayesian blocks methods.

2.1 Report the bin edges as generated by the Bayesian blocks method.

2.2 Plot the lightcurve (in units of events/second) using the bins you've generated.

2.3 Illustrate the effect of varying the prior by changing the value of p_0.

Question 3: ncp_prior

Following the method outlined in section of Scargle et al. 2013, generate signal free data sets of length N to validate the relationship between `ncp_prior`, p_0 and N, i.e. equation 21.

Question 4: Finding outbursts

Use the Swift-BAT lightcurve of the X-ray binary V0332+53 (`Swift_BAT_V0332+53.txt`) for this question.

4.1 Use a sigma-clipping method to find the outburst in the lightcurve. Plot the lightcurve, highlighting the outbursts.

4.2 Report the timestamps of the outburst peaks.

4.3 Employ a Bayesian blocks algorithm to find the outbursts.

4.4 Are the results consistent between the sigma-clipping and the Bayesian blocks?