Searching for signals in noise

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I: Motivations

Astrophysics contains a huge number of interesting observed phenomena, let alone those that we have yet to see. The problem we often have is that that our observations are in a low signal to noise regime; this can mean several models can explain the observed data.
In this poster we discuss a method for quantitatively assesing how well several models fit some data. The aim being to decide, eventually, given the observed data which astrophysical model do we think is most likely.

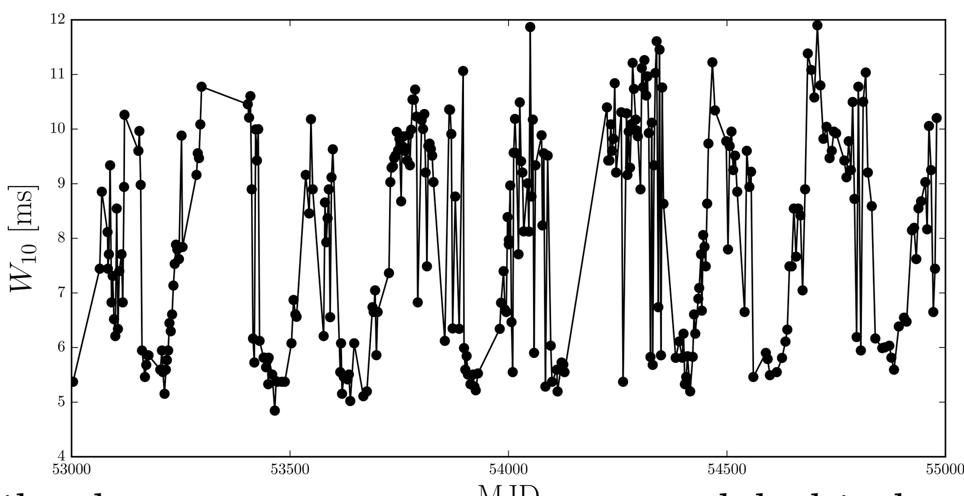
II: Bayesian Data Analysis

While many methods exist for comparing some models, an intuitive approach can be found by using Bayes rule

$$P(A|B) = P(B|A)\frac{P(A)}{P(B)} \tag{1}$$

where by $P(A|B)$ we mean "The probability of A, given that B *is* true". The A and B here can be anything.

III: Example



To illustrate how we can apply Bayesian data analysis consider the data shown in the figure on the left. This is a plot of the measured beam width of pulsar B1828-11 showing a distinct periodic behaviour. This data was originally published in figure 5 of **?**, we are thankful to the original authors for allowing us access to this data.
Prior to this paper, slow periodic modulation of the spindown was cited as evidence for precession in this pulsar. Clearly the beam width is also being modulated at this same time-scale. The authors argue that the beam width is not smoothly varying between, but instead *switching*. This has important implications for neutron star physics.
While there are many ways to model this beam width, we can start by asking a simple question: is the observed data best explained by a square wave model, or a smoothly varying sinusoid. While neither of this captures all of the physics it at least addresses the issue of whether the modulation is smooth or instantaneous.

V: Parameter estimation

VI: Model comparison