Kernel Based Approaches for Change-Point Detection
Multivariate change point analysis

Anirudhan J. Rajagopalan, ajr619

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1 Change point detection using spectral density

As per section 4 in [1], we proceed to try and find change points using spectral density.

We created a sample timeseries data that contains four frequenceis of the range

1. 1.5, 3.5 — delta Unconscious, deep sleep

2. 3.5, 7.5 — theta Reduced consciousnenss

3. 7.5, 12.5 — alpha Physical and mental relaxation

4. 12.5, 19.5 — beta Engaged mind

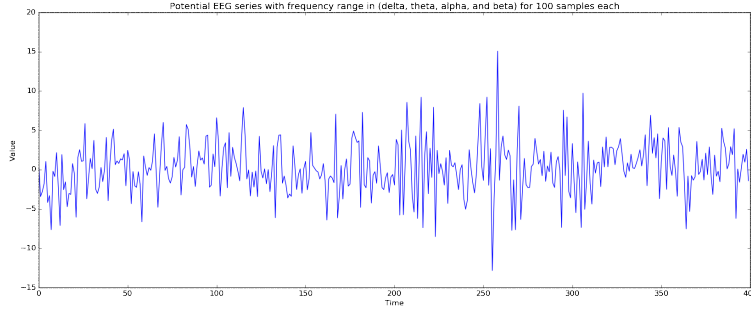The timeseries is as given in figure **??**

Figure 1: Time series formed by linear combination of sinusoidals with same frequency as that of brain signals.

The peridogram is given by the function:

$$I_k(u) = \frac{1}{2\pi n_k} | \sum_{j=\tau_{k-1}+1}^{\tau_k} Y_j e^{iju} |^2 \tag{1}$$

The peridogram for this time series is given by:

The energy of the window defined by $Y_{\tau_{k-1}+1}, \ldots, Y_{\tau_k}$ in frequency band $[\lambda_j, \mu_j)$ is given by:

$$F_{kj} = \int_{\lambda_j}^{\mu_j} I_k(u) du \tag{2}$$

The process for finding the energy band is still not clear. In the below experiments we assume the energy band to lie between 0 and π. The penality term is given by

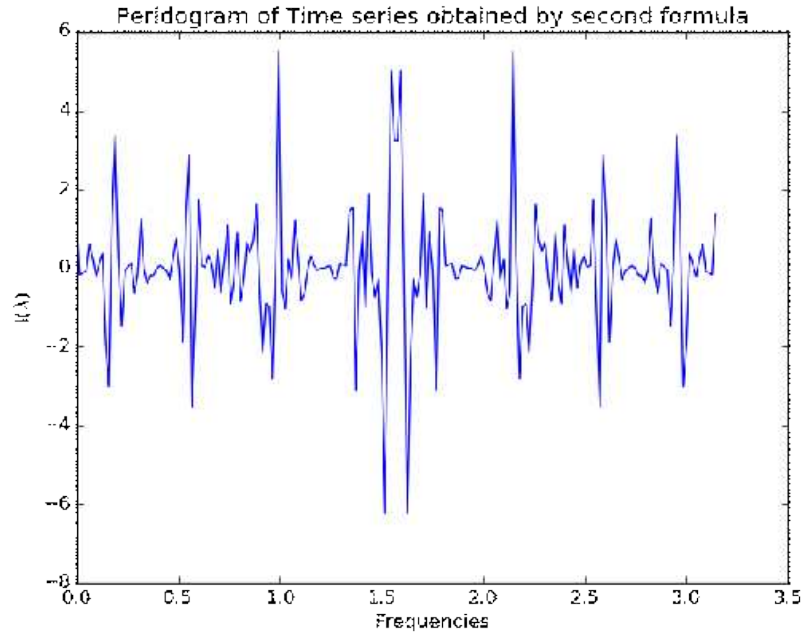$$J_n(\tau, y) = -\frac{1}{n} \sum_{k=1}^{k^*} (n_k \sum_{j=1} JF_{kj}^2)$$

2

Figure 2: Peridogram for the timeseries.

The plot got by plotting J using a sliding window of 5s over the time series defined above is shown in figure below.
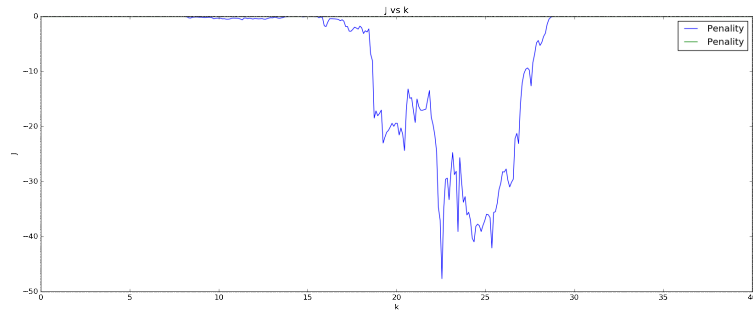

Figure 3: Penality vs k.

3

2 Questions

- The frequency range of a periodogram lies between $[0, \pi]$. How to convert a frequency, say 12Hz, to the one viewable in periodogram

- How to describe the energy landscape defined in equation 29 of [1]

References

[1] Marc Lavielle. Using penalized contrasts for the change-point problem. *Signal processing*, 85(8):1501–1510, 2005.