

Experiment two:

Unknown parameters - Frequency bands location

Select one kernel family and take k elements from it corresponding to different hyperparameters sets (generated in Experiment 1). Take each set, aggregate the k elements together. Repeat this experiment for 1000 time-series. The procedure goes for each kernel considered in Experiment 1. That aggregation provides a synthetic observation set. Mathematically, it will be equivalent to simulate Gaussian Processes with mixture kernel. Once that 1000 time series are simulated, for each of them, we perform the EMD. For each IMF, take the IF and score the number of times it lies inside the partitions implied by the hyperparameters sets. Such frequency bands correspond to each kernel partition (histogram to do it). Do this for every replicate. Alternatively, we could do clustering on the frequency.

Stationary kernel considered:

- Square exponential. Hyperparameter: length scale l

$$K(t, t') = \exp \left(-\frac{(t - t')^2}{2l^2} \right)$$

- Periodic. Hyperparameters: length scale l , period p

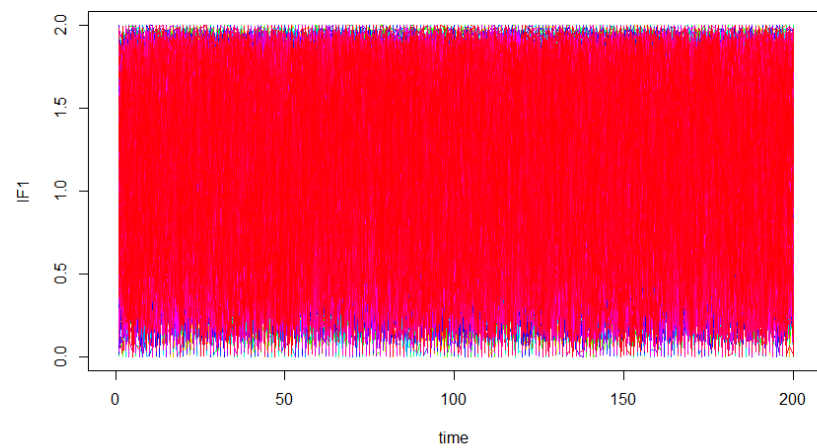
$$K(t, t') = \exp \left(-\frac{2 \sin^2 (\pi(t - t')/p)}{l^2} \right)$$

- Rational quadratic. Hyperparameters: length scale l , relative weighting of large-scale and small-scale variations α .

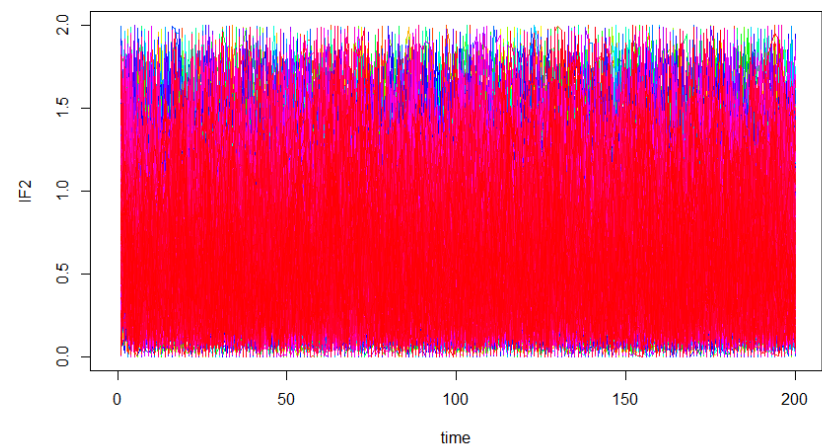
$$K(t, t') = \left(1 + \frac{(t - t')^2}{2\alpha l^2} \right)^{-\alpha}$$

- Locally periodic. Hyperparameters: square exponential and periodic kernels.

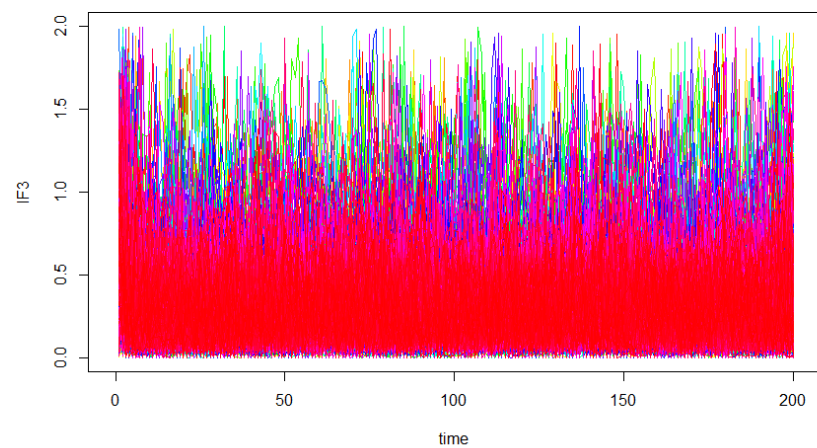
$$K(t, t') = \exp \left(-\frac{2 \sin^2 (\pi(t - t')/p)}{l^2} \right) \exp \left(-\frac{(t - t')^2}{2l^2} \right)$$



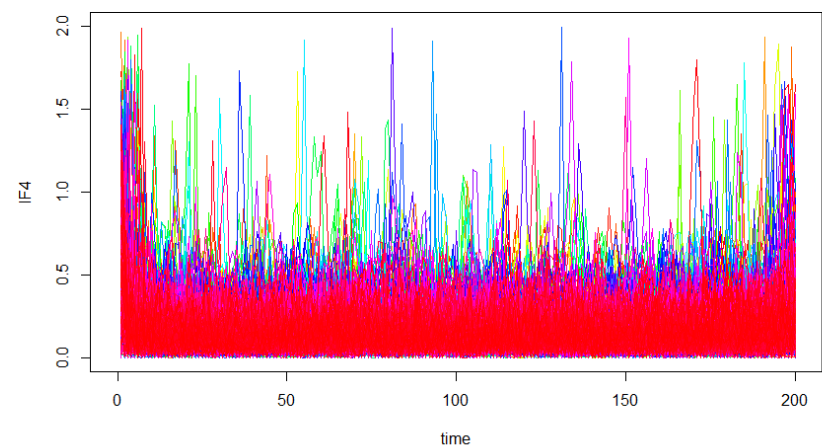
(a) Instantaneous Frequency IMF1.



(b) Instantaneous Frequency IMF2.



(c) Instantaneous Frequency IMF3.



(d) Instantaneous Frequency IMF4.

Figure 1: Periodic Kernel. Instantaneous Frequencies of first,second, third and fourth IMFs extracted by the aggregated GP.