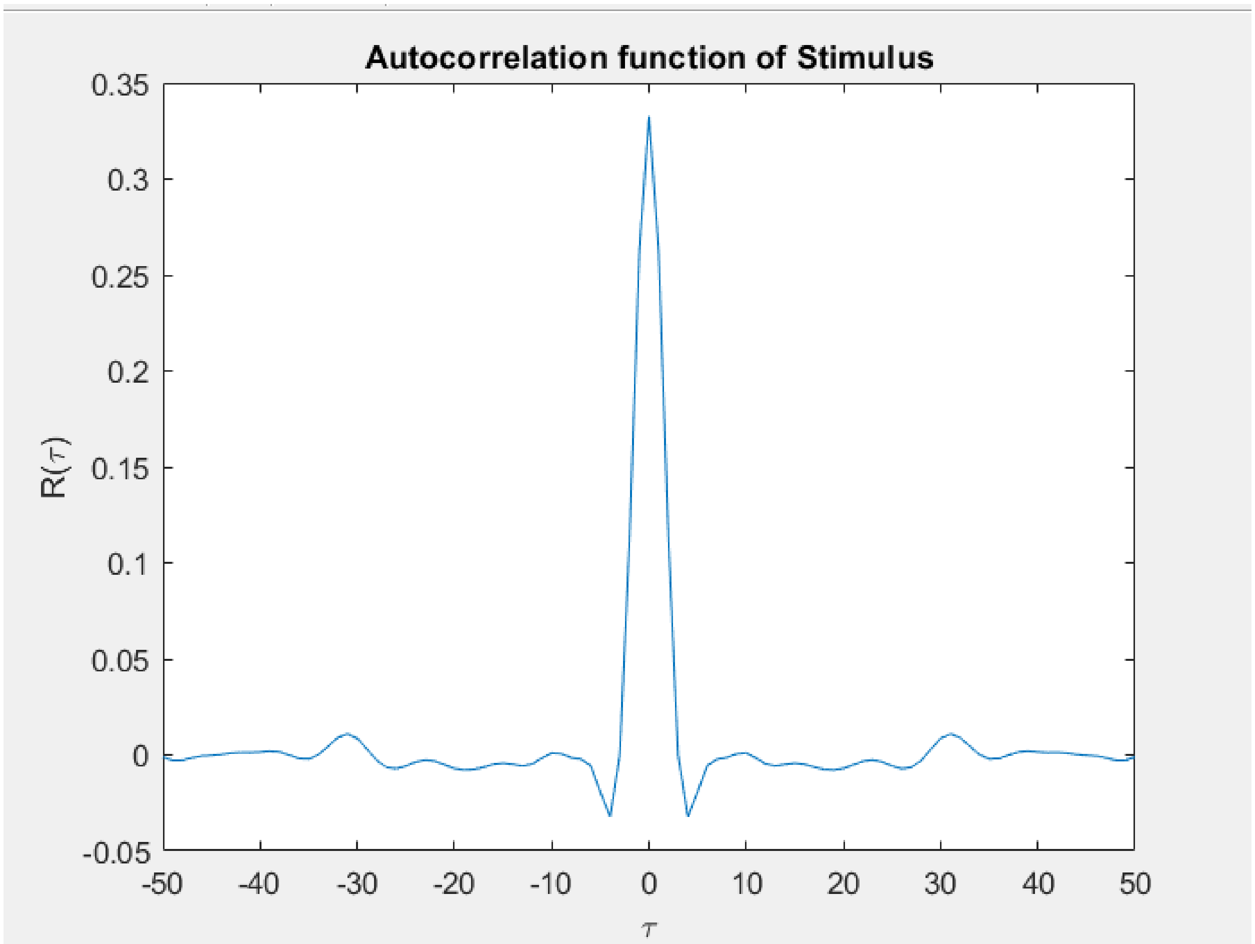
EC60007 Project-3

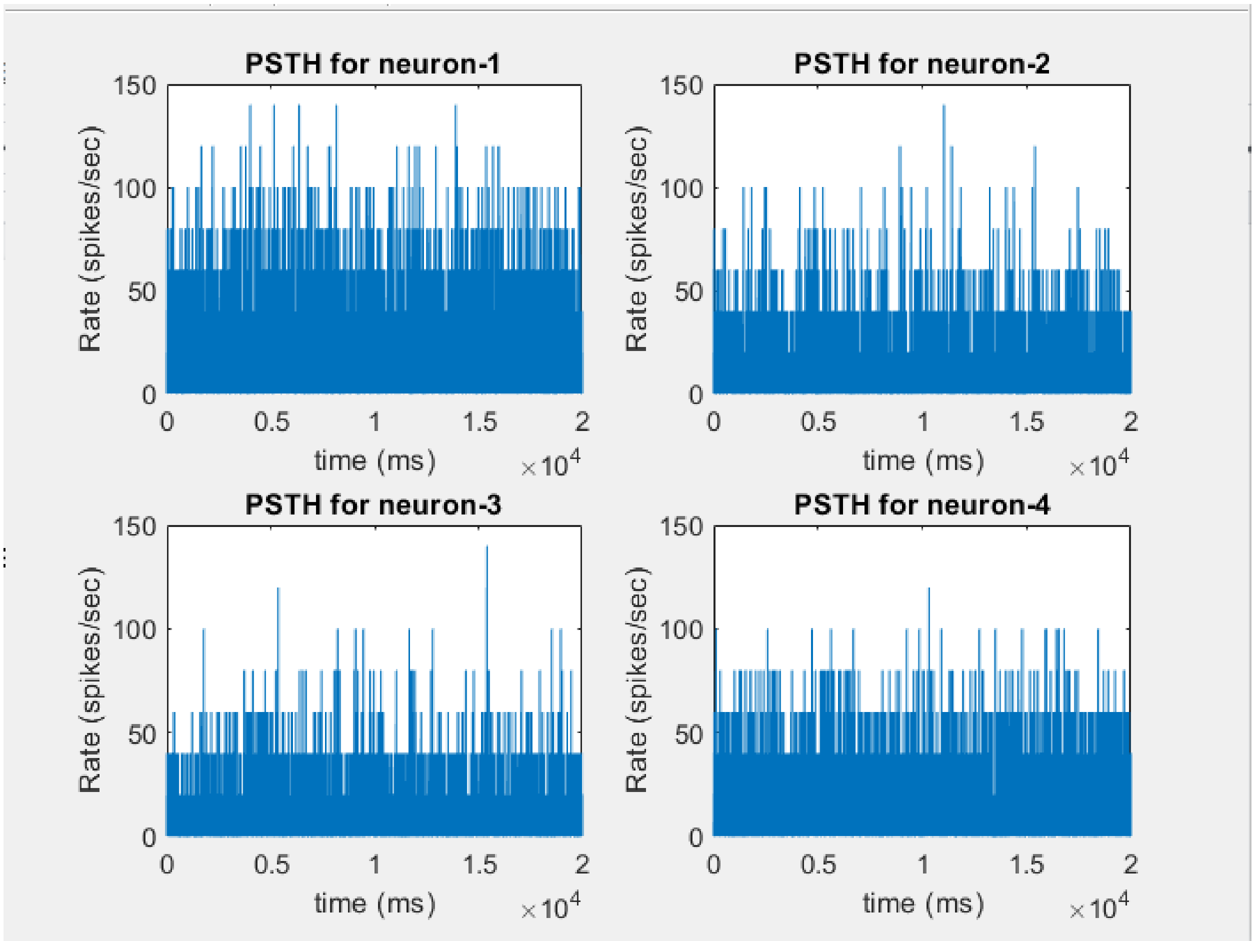
Yashaswini (20EE30032)

1. Autocorrelation function of the stimulus R(τ) for τ = -50 to 50ms in steps of 1 ms



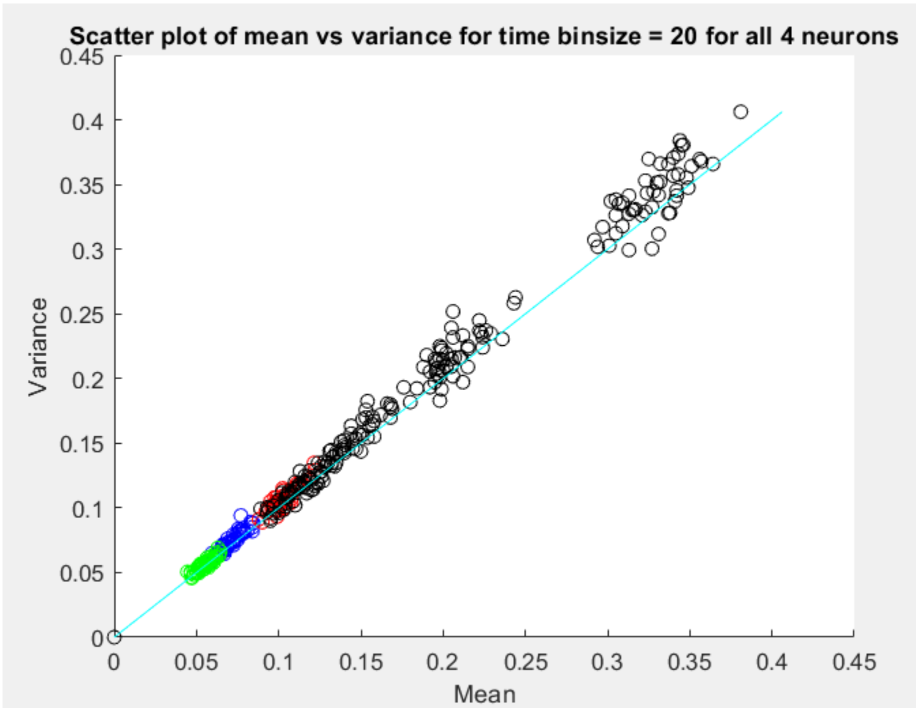
If we assume that stimulus is a white noise process $\sim N(0, \sigma^2)$, the autocorrelation function would be a delta function with maximum value of σ^2 The above graph is not a perfect impulse function, although it peaks at τ = 0 ms with maximum value = 0.3326 (σ^2). Therefore, we conclude that the stimulus is approximately a white noise process.

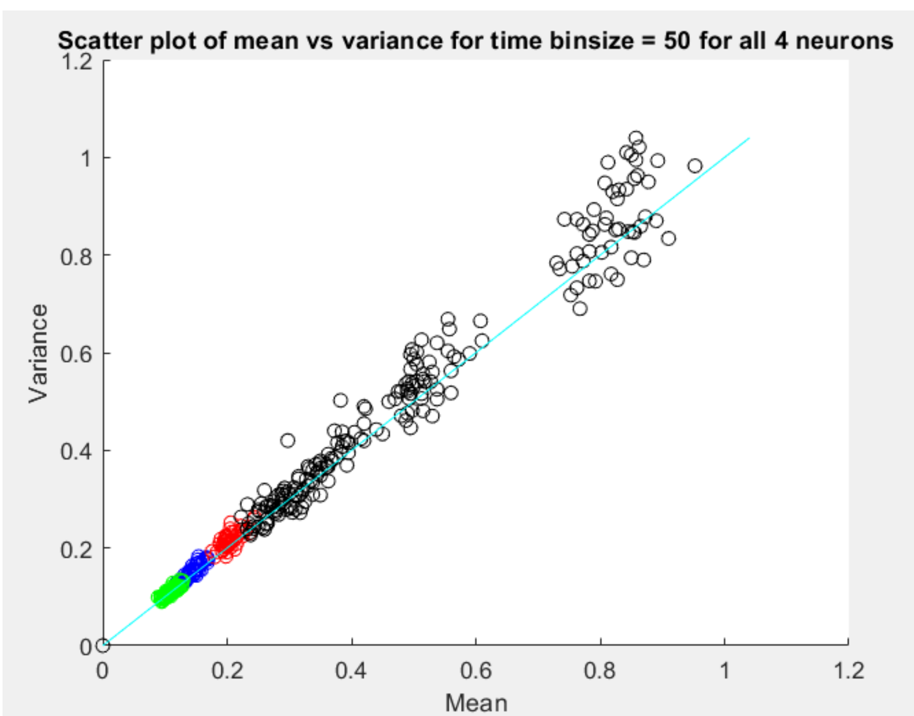
2. Peri Stimulus Time Histograms (PSTH) for all neurons

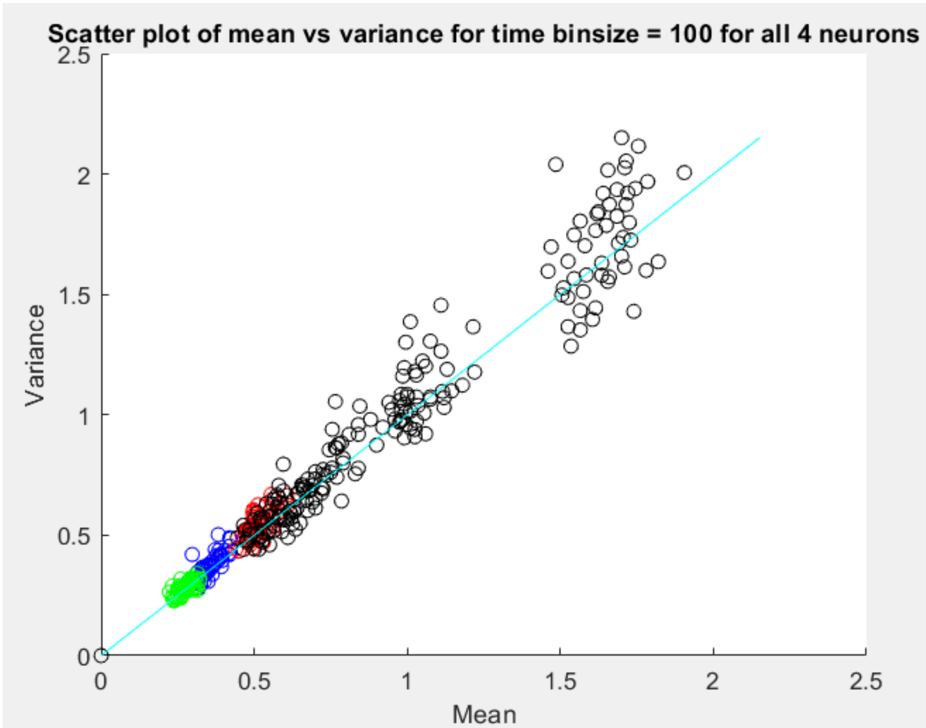


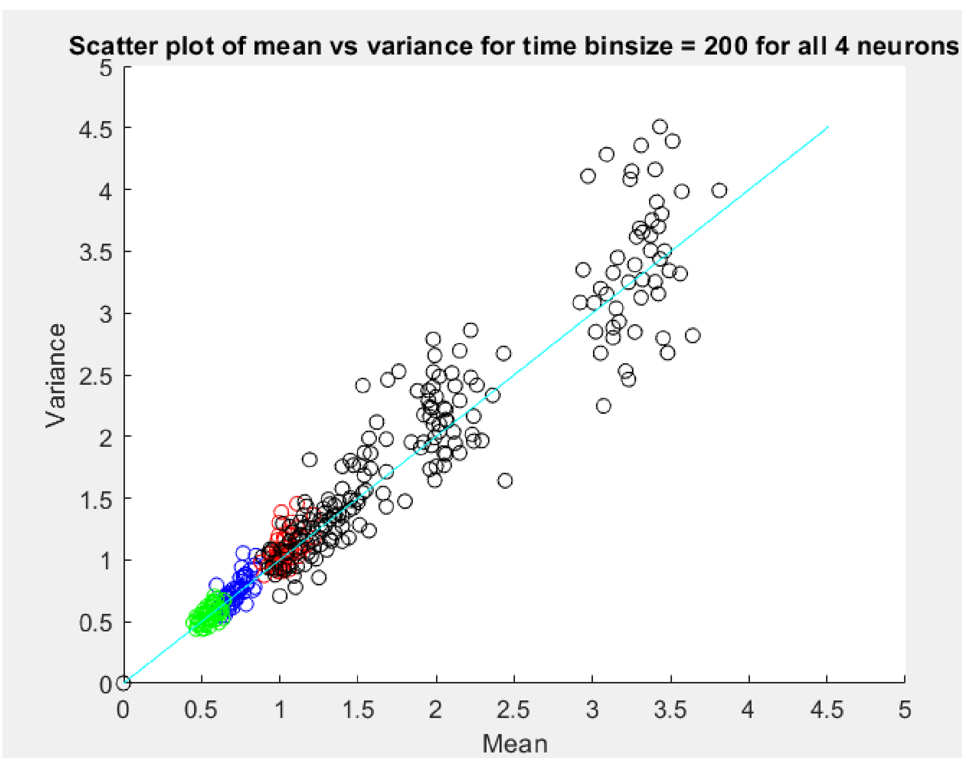
For calculating the above PSTHs a time bin of 1 ms is taken. For small time bin sizes, PSTH is approximately equal to the probability of spike and hence, this also shows the mean firing rate of neurons as a function of time.

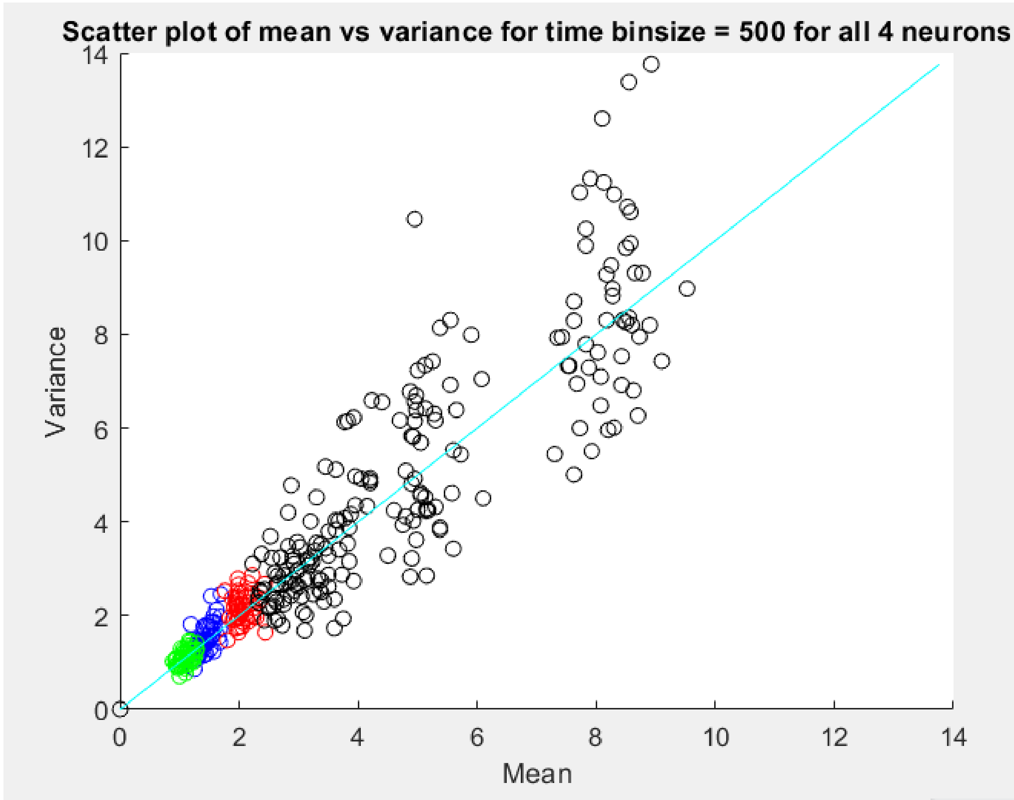
3. Mean vs. Variance plots of the number of spikes for different time bin sizes for 50 repetitions of the stimulus for all neurons
(Black - Neuron 4, Red - Neuron 3, Blue - Neuron 2, Green - Neuron 1)
(Cyan - Mean = Variance line)






Scatter plot of mean vs variance for time binsize = 100 for all 4 neurons
Variance
Mean
0
0.5
1
1.5
2
2.5

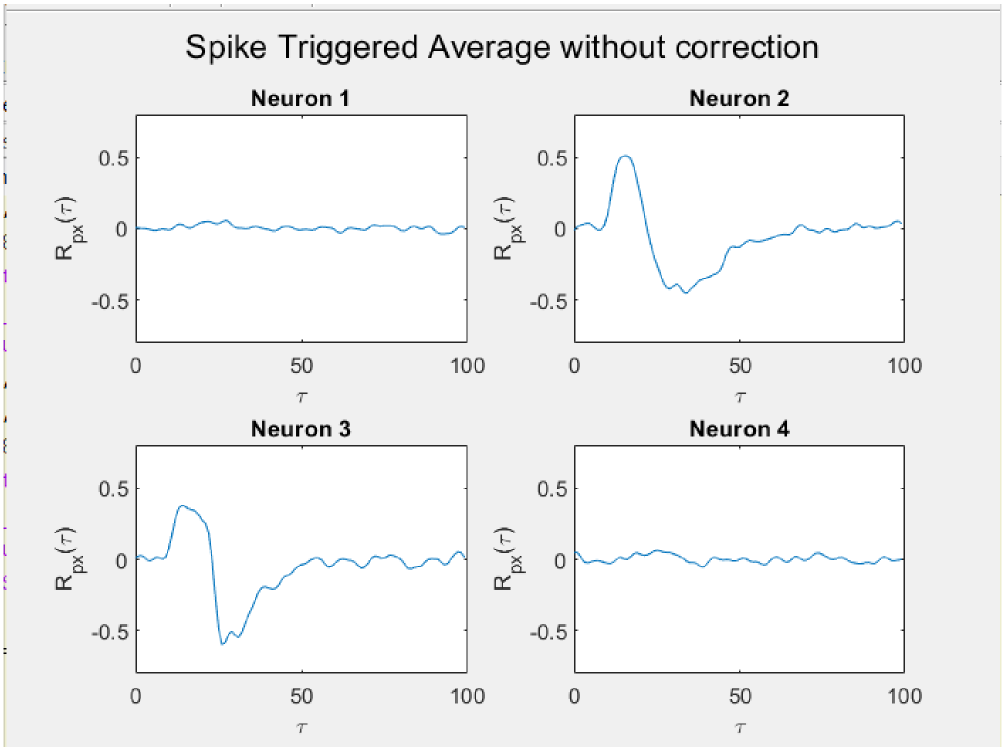

Scatter plot of mean vs variance for time binsize = 200 for all 4 neurons
Variance
Mean
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

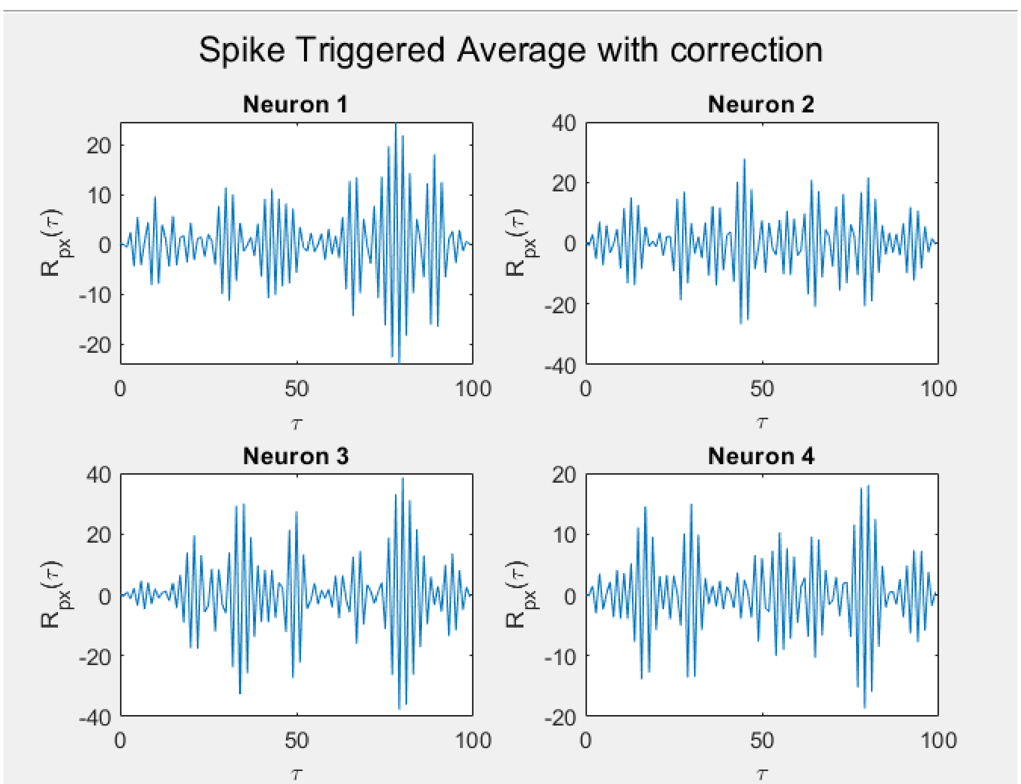


It is observed from the above plots that as the bin size increases, the data points of mean vs variance deviate further away from the mean = variance line.

In a Poisson process, mean = variance. Therefore, we conclude that for smaller time bin sizes, i.e, 20 ms and 50 ms, the number of spikes or the occurrence of spikes (as the time bin size decreases, each time bin can either have one spike or no spike at all) is a Poisson random variable. However, for larger time bins, it no longer remains a Poisson random variable.

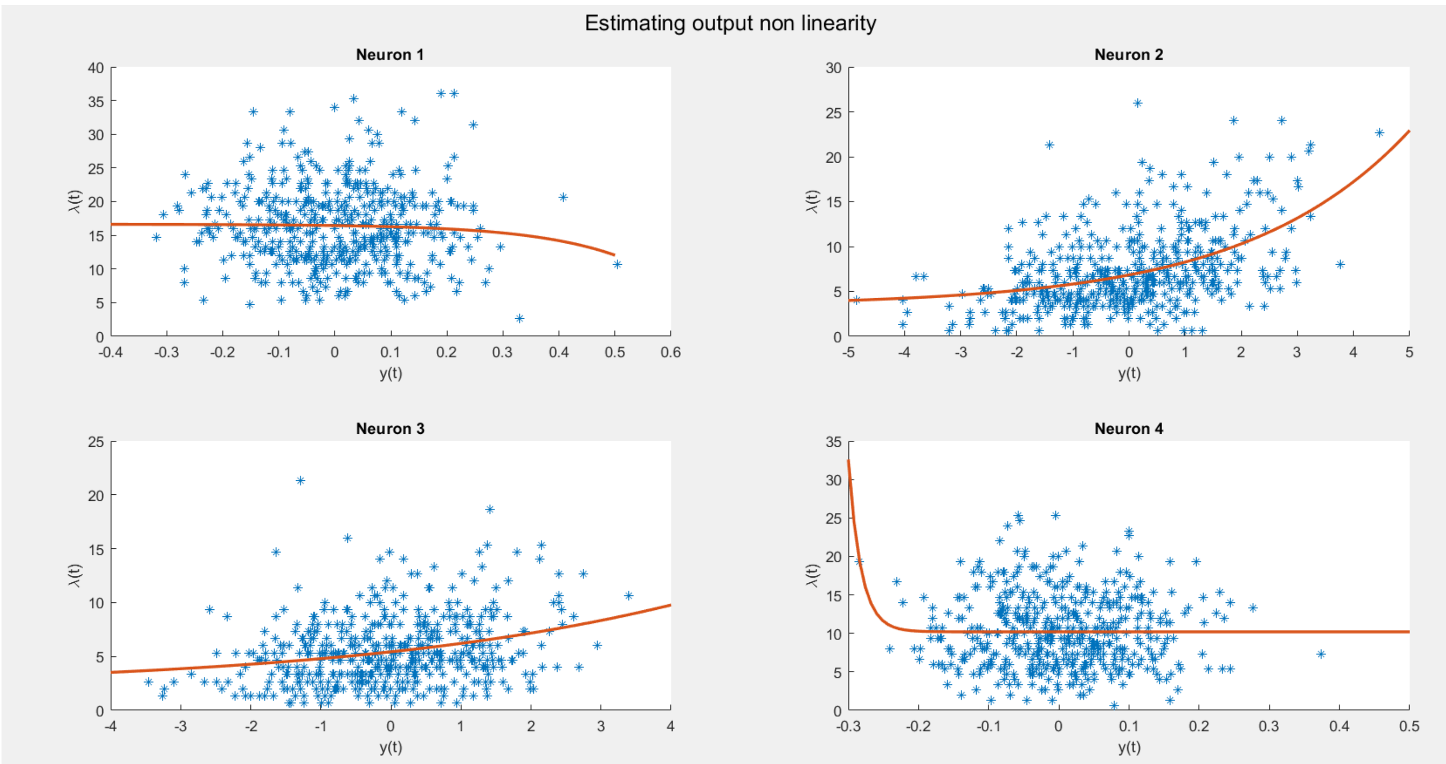
4. Spike triggered average, and correction for non-Gaussianity





The spike triggered average with correction due to non-Gaussianity shows a lot of fluctuations. This is why for small σ^2, we can ignore the correction term C_{ss}^{-1} while calculating the spike triggered average.

5. Determining $\lambda(t)$ as a nonlinear function of y(t)



In order to fit a sigmoidal curve to the data, the parameters for the first 15 seconds of the data, for all neurons, were calculated. The predictions for the last 5 seconds of the data were stored in an array.

6. Prediction performance and pruning of filter parameters

From the above fitting, r^2 values were calculated on the prediction arrays of the last 5 seconds of data to find the prediction performance

r_1^2 = 3.8944e-05

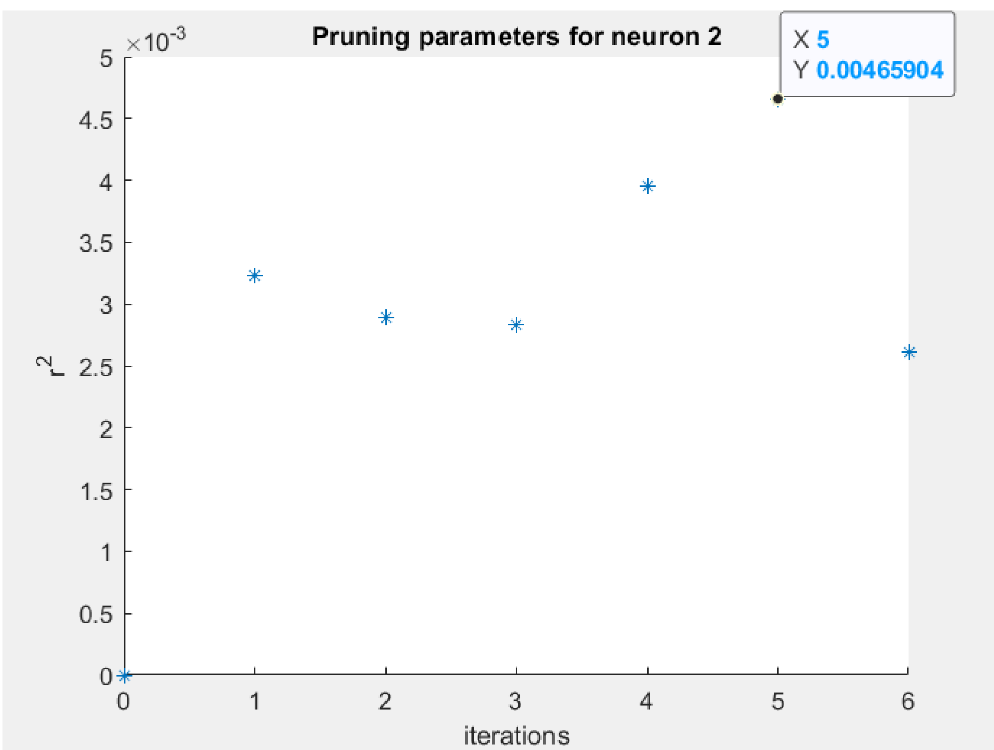
r_2^2 = 0.0026

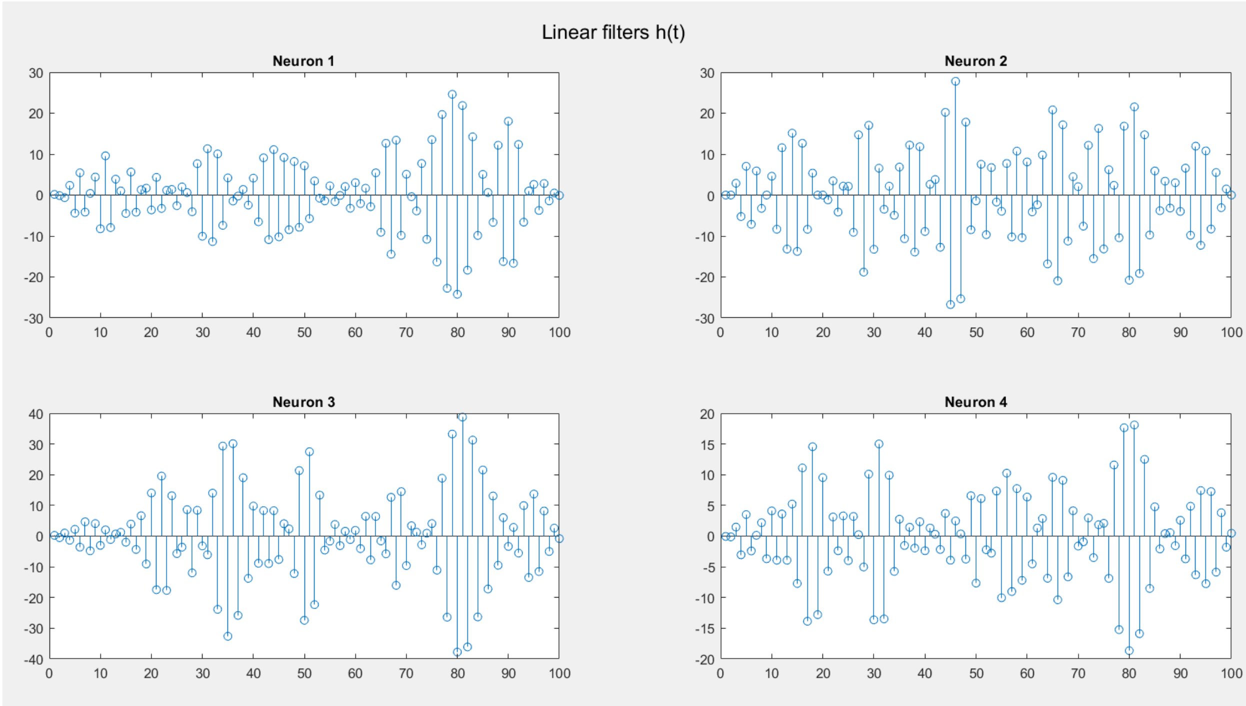
r_3^2 = 9.2401e-05

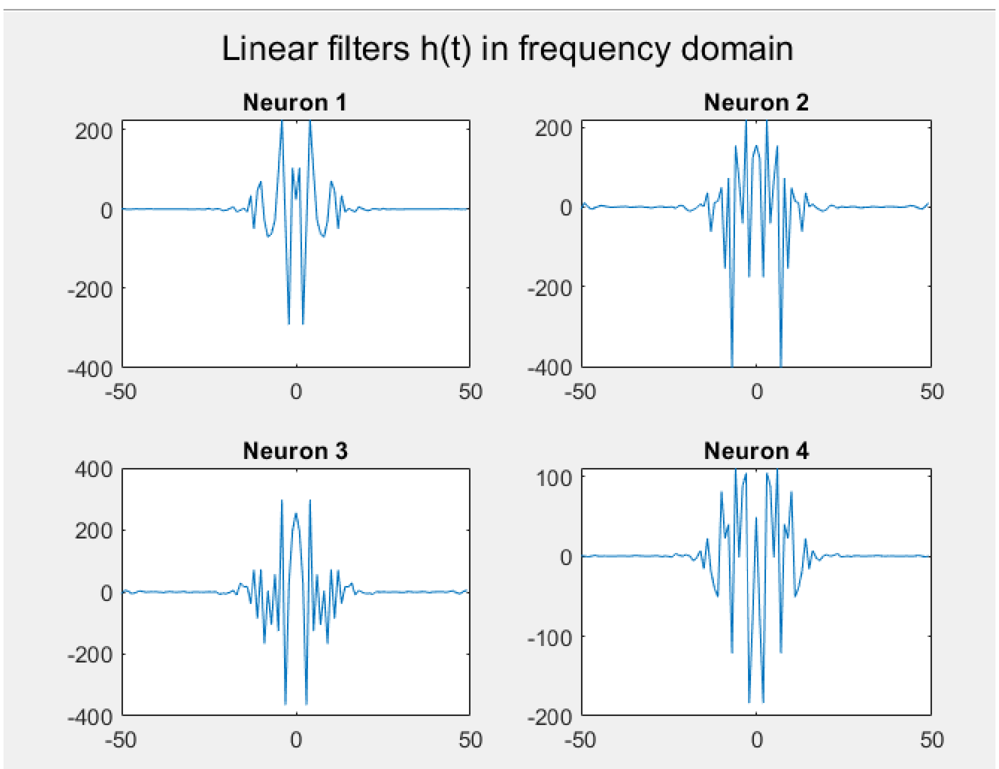
r_4^2 = 5.9053e-05

Since the r^2 values for neuron 1, 3 and 4 are very low, further pruning of filter parameters is not done on their respective h(t)s.

For neuron-2, on pruning the filter parameters by setting a few h(t) values to 0, the maximum correlation coefficient obtained was 0.0047, that is higher than that previously obtained. Hence, we conclude that if we prune the filter parameters we obtain better models of the neuron.







From the above plot, we can conclude that the linear filters act as low pass filters, since most of the frequency content of the filters for all neurons are centred around 0.