Assignment 4: Dr. Pack

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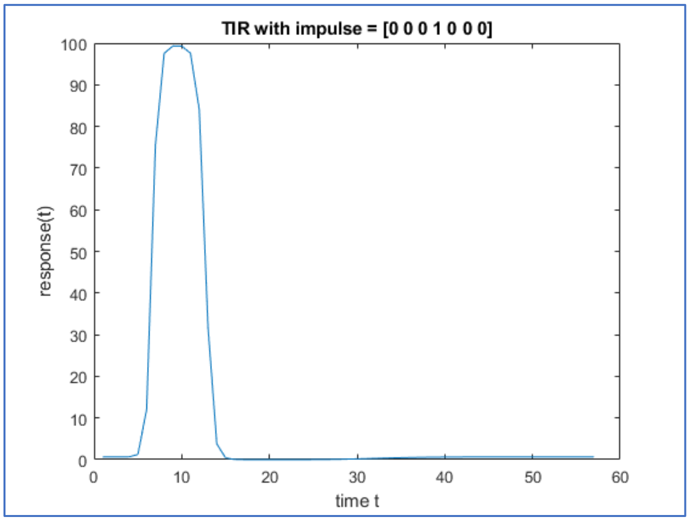
Note: An arbitrary RNG seed of 1234 was chosen for the assignment for testing and reproducibility.

Part A) Reverse correlation with one-dimensional input

A) Recovering the filter

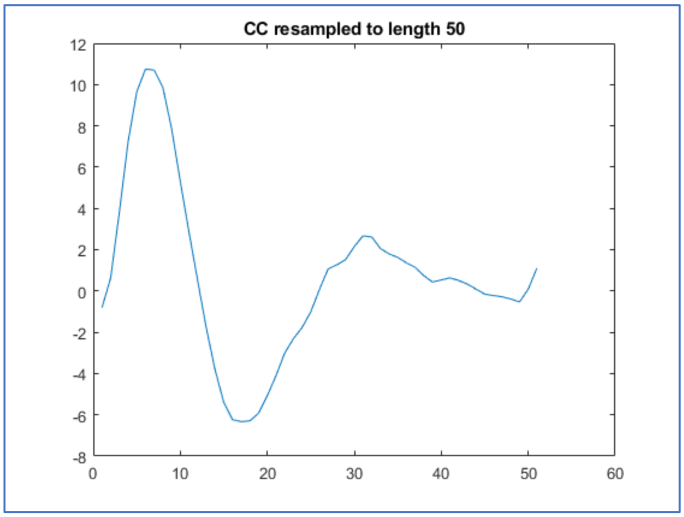
a) Measure the temporal impulse response



b) Measure TIR with a random noise as input & c) Feed this input into the model neuron & d) Recover the linear temporal filter by computing CC of input and output

Nothing to report for these sections.

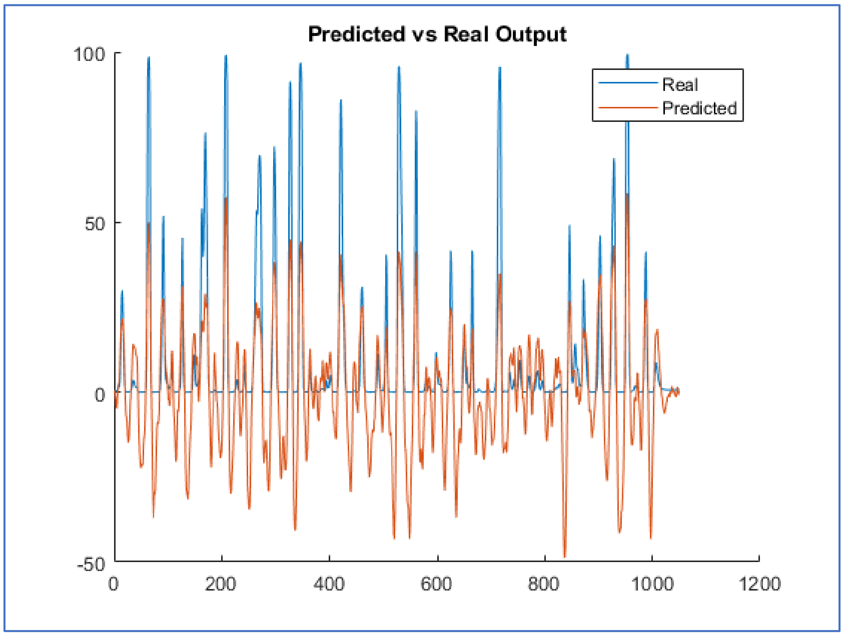
e) Resample the xcorr duration & f) Normalize



Where the stimulus and output overlap in cross correlation is 2100/2 = 1050, and with a duration of 50 results in the range selected of 1050:1100 in the code.

The filter via impulse input is only able to represent a growth then decay to the initial baseline, while the e)&f) filter is capable of fluctuations with values below the initial as it 'originally' had values ranging from -1 to 1, while the impulse was a discrete set of either 0 or 1.

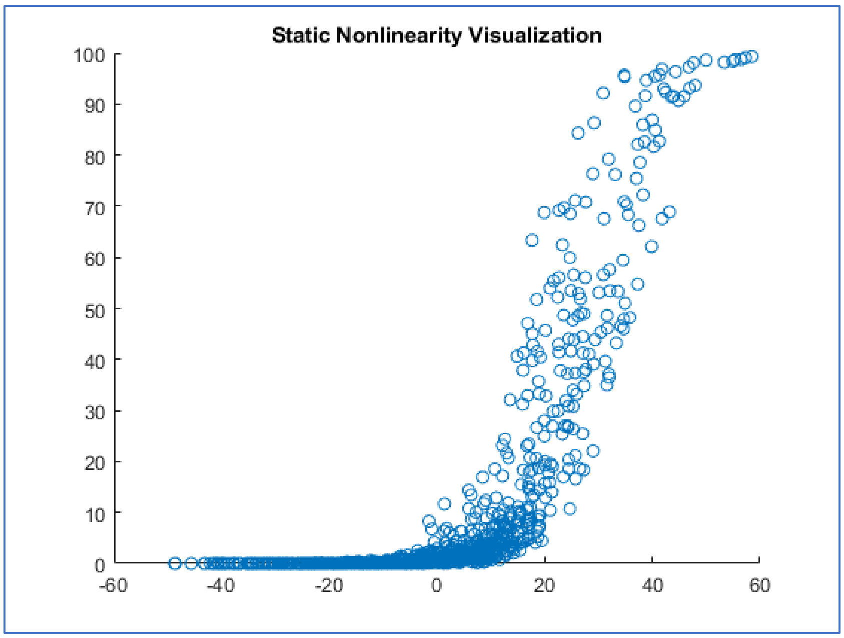
g) Calculate predicted output using convolution



The real values do not have negative values.

While the predicted does generally follow the local maxima, it also models negative troughs.

h) Visualize static nonlinearity



Predicted output (x)

Observed output (y)

The scatter plot appears to be nonlinear as it appears to look like a sigmoid curve.

B) Testing the filter

a) Compute MSE between estimated and observed (MSE of 100 trials)

Input Vector Length	MSE between estimated and observed
100	585.1604
500	406.4649
1000	368.4893
2000	306.2351
5000	262.2269

b) Find parameters of the static nonlinearity; apply the static nonlinearity to predicted output and show how it affects MSE (again, 100 trials).

From the lecture, the equation: $F(R_{est}) = \frac{r_{max}}{1+exp\left(g_i(L_{1/2}-L)\right)}$ was given to correct for nonlinearity by the given sigmoid curve function. The hyperparameters $g_i = 0.15$ and $L_{1/2} = 35$ were chosen by trial-and-error, changing the values and plotting the following for visual inspection: superimposing the corrected-prediction output and the observed output. Resulting in the following figure that I was satisfied with:

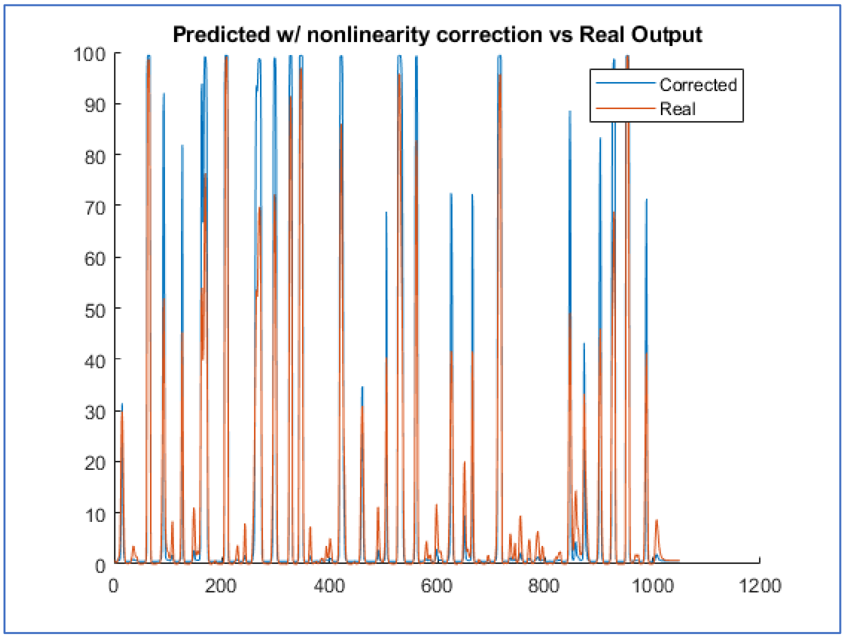


Table: the MSE(s) with correction is smaller than before correction.

This is expected since the correction should result in an improved fit: reduced differences between predicted and the real outputs.

Input Vector Length	MSE between corrected and observed	Difference from noncorrected
100	580.0547	5.1057
500	280.5242	125.9707
1000	216.6759	151.8134
2000	143.2536	162.9815
5000	92.883	169.3439

Part B) Spike-triggered averaging with a three-dimensional input

A) Recovering the filter

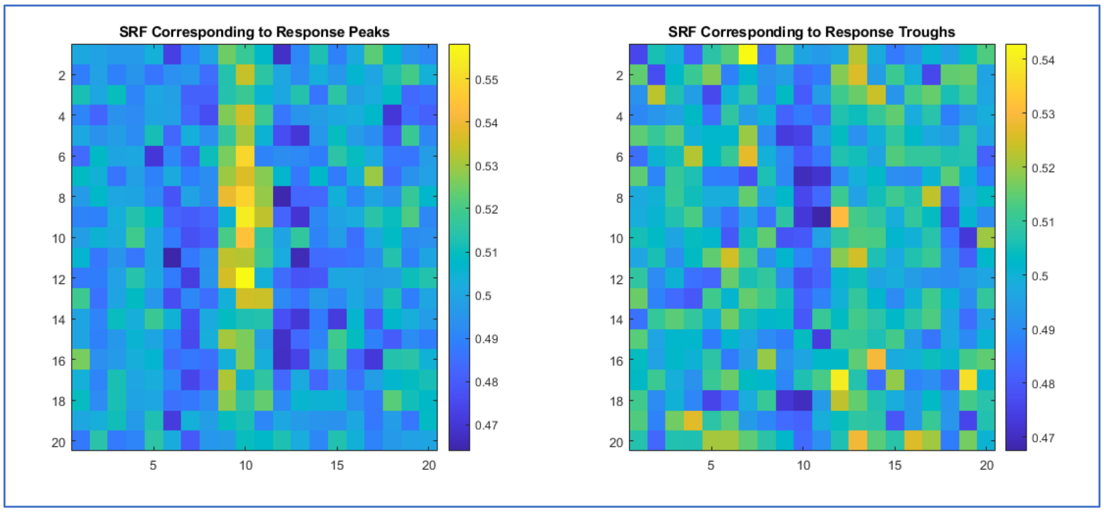
a) Create white noise input & b) Feed this input into the model neuron

Nothing to report for these sections.

c) Calculate the spike-triggered averages of the spatial receptive field at peak temporal response. & d) Evaluate the SRF at the trough temporal response.

In the RNG seed *1234*, the peak and trough response occurs at 6 and 17 timesteps after, in the filter (this would most likely change in other RNG seeds).

Then, the ∀indices of spikes – (index of max or min) is used to generate the array of indices which then the (max/min) values could be averaged, and generated the following for the 20x20 dimensions:



It can be inferred that the preferred orientation of the neuron is vertical (since an elevated response alike to a vertical bar | is observed in the spatial receptive field at peak temporal responses).

The SRF corresponding to through temporal responses appear to be inversed to the peak figure. Where in general the center vertical region generally has the minimum regions, while the rest of the plot has more activity.