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NEUR 603 Assignment 4

ROC Neurometric Analysis

a) For each neuron, two histograms of the number of spikes occurring during each 100 ms window were created (Figure 1 and Figure 2, for neurons 1 and 2, respectively).

b) A MATLAB function was written to compute the ROC neurometric score for each neuron. The area under ROC curve (AUC) was computed to be 0.68 for neuron 1 and 0.77 for neuron two.

c) These ROC neurometric scores denote the best possible performance of a two-alternative forced choice (2AFC) task. From the AUC scores, neuron 1 and neuron 2 signal the occurrence of a motion pulse more reliably than chance, and neuron 2 signals the occurrence of a motion pulse more reliably than neuron 2. To see this visually, see ROC curve in Figure 5. Interestingly, the neurometric scores are better than the animal performance – the animal shows detection of the motion stimulus only 45.2 % of the time (whereas, from the ROC neurometric score, an ideal observer could detect the motion stimulus from neuron 2 data 77% of the time).

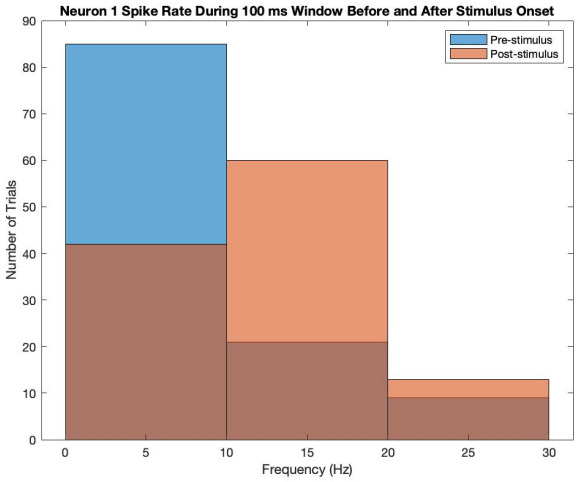

Figure 1 - Histogram showing neuron 1 spike rate in a 100 ms window before stimulus onset (blue) and 40-140 ms after stimulus onset (orange). Overlap is in brown

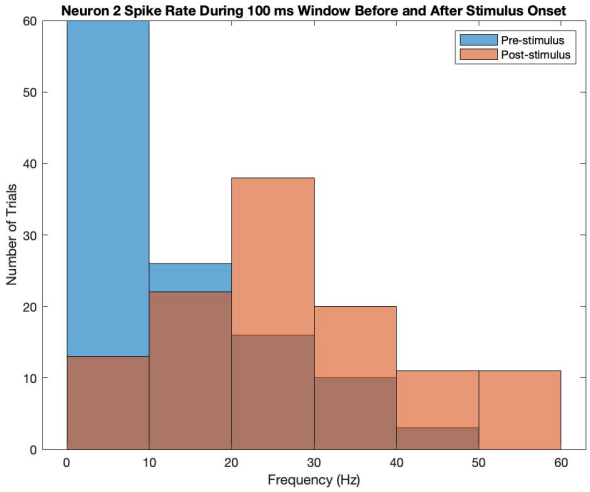

Figure 2 - Histogram showing neuron 2 spike rate in a 100 ms window before stimulus onset (blue) and 40-140 ms after stimulus onset (orange). Overlap is in brown

ROC Detect Probability

a) The neural response from 40 to 140 ms after the motion stimulus was used to compute a detection probability using ROC analysis. Two histograms of the number of spikes occurring during this 100 ms window corresponding to correct and failed trails (Figure 3 and Figure 4, for neurons 1 and 2, respectively).

b) The area under ROC curve (AUC) was computed to be 0.53 for neuron 1 and 0.69 for neuron two.

c) These scores denote the best possible performance of a two-alternative forced choice task. From the AUC scores, neuron 1 is approximately no more correlated with animal behavior than chance, and neuron 2 is correlated with animal behaviour somewhat more strongly than chance (to see this visually, see ROC curve in Figure 6).

d) A different analysis one might perform on this data to examine if neural response is correlated with the animal's perception of the motion stimulus might be computing the cross-correlation between the stimulus and response and observing where the cross-correlation is significantly non-zero.
Another alternative might be choosing a different test function; for example, one might consider the likelihood ratio (Dayan and Abbott, 2001).

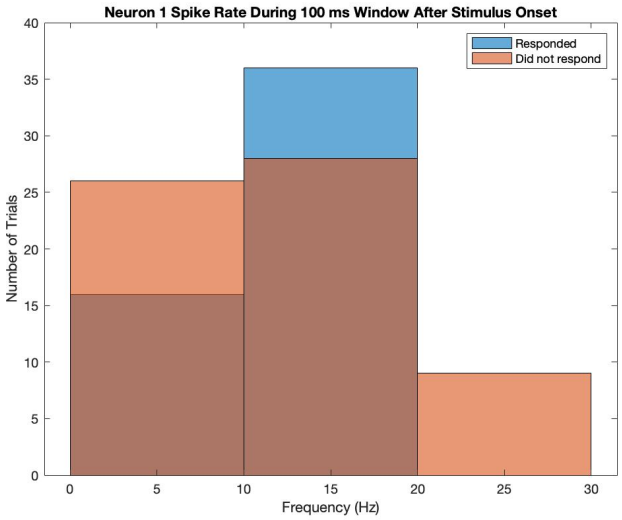

Figure 3 - Histogram showing neuron 1 spike rate in a 100 ms window 40-140 ms after stimulus onset corresponding to correct (blue) and failed (orange) trials. Overlap is in brown

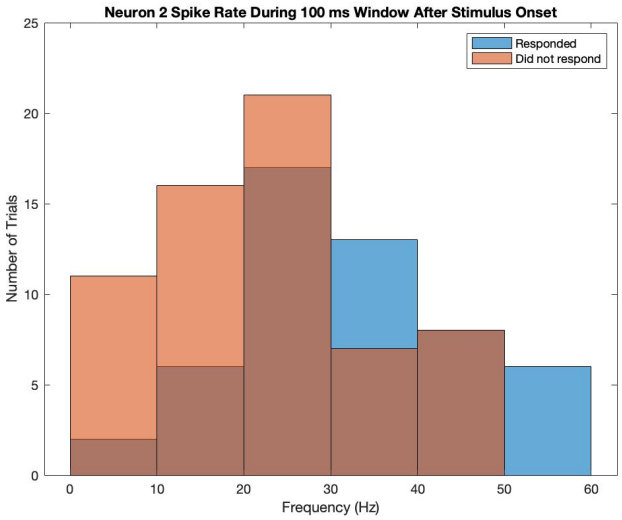

Figure 4 - Histogram showing neuron 2 spike rate in a 100 ms window 40-140 ms after stimulus onset corresponding to correct (blue) and failed (orange) trials. Overlap is in brown

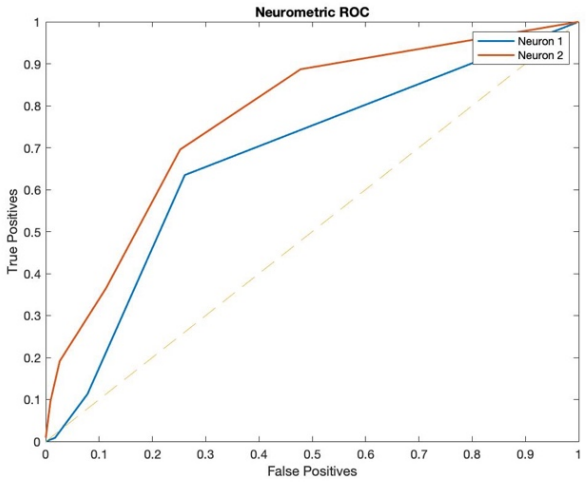

Figure 5 - ROC curve illustrating how well each neuron informs an ideal observer that the motion stimulus has occurred

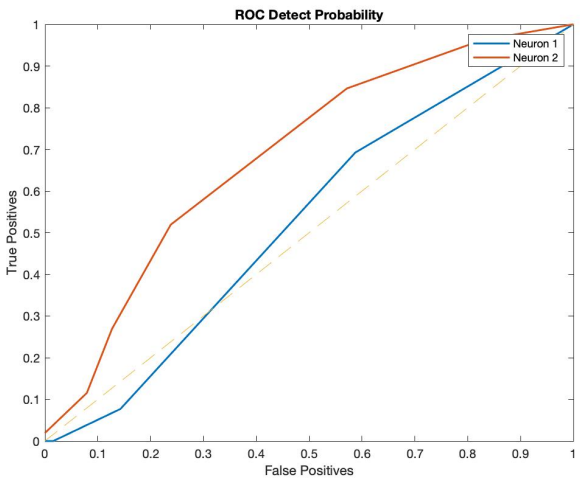

Figure 6 - ROC curve illustrating correlation between neural activity and the animal's detection of the motion stimulus