Report worksheet 5

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Exercise 1: z-scored binned spikes

Figure 1 shows the zscores of the binned spikes of all neurons (bin size=1 sec, unsorted neurons). I choosed `zmin` and `zmax` as the 1% and 99% percentiles of the zscores distribution, because, as shown below, the negative z-values are informative.

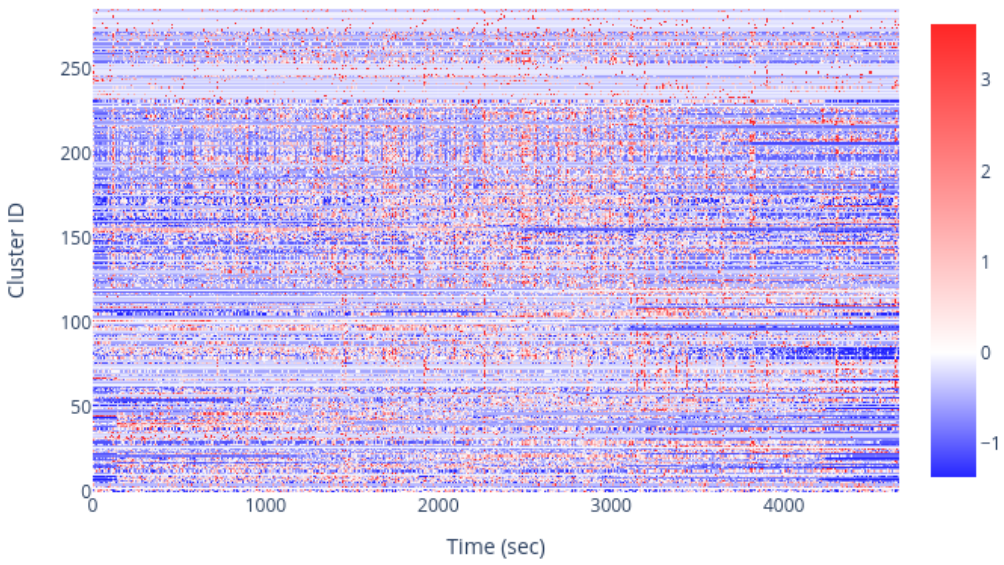

Figure 1: z-scores of binned spikes times of all neurons (bin size=1 sec, unsorted neurons). Generated with this script using its default parameters. Click on the image to see its interactive version.

If I don't limit the `zmax` of the heatmap colors become imbalanced due to a neuron with high firing at one time (Figure 2).

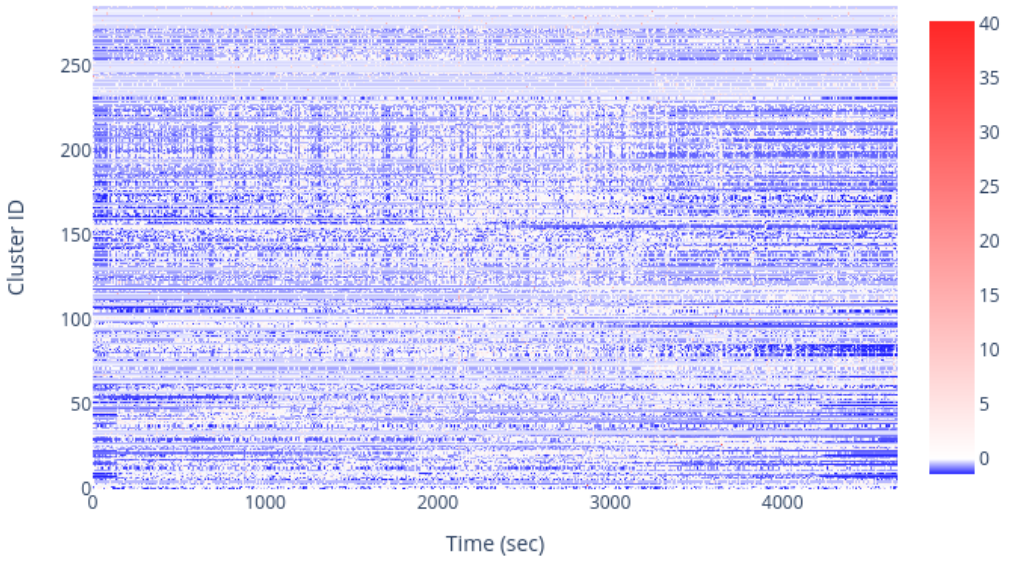

Figure 2: z-scores of binned spikes times of all neurons, plotted without `zmax` (bin size=1 sec, unsorted neurons). Generated with this script using its default parameters. Click on the image to see its interactive version.

If I don't z-score the binned spikes colors become imbalanced due to neurons that have large mean firing rate (Figure 3).

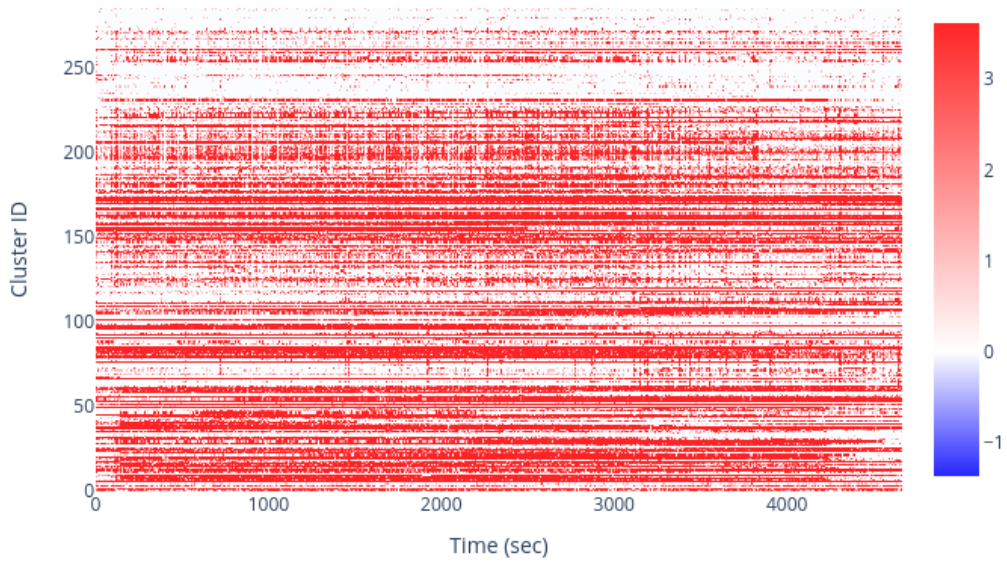

Figure 3: Non-zscored binned spikes times of all neurons (bin size=1 sec, unsorted neurons). Generated with this script using its default parameters. Click on the image to see its interactive version.

Exercise 2: application of the SVD to z-scored binned spikes

Figure 4 plots the same z-scored binned spikes of Figure 1, but with neurons ordered according to their weight along the first right singular vector.

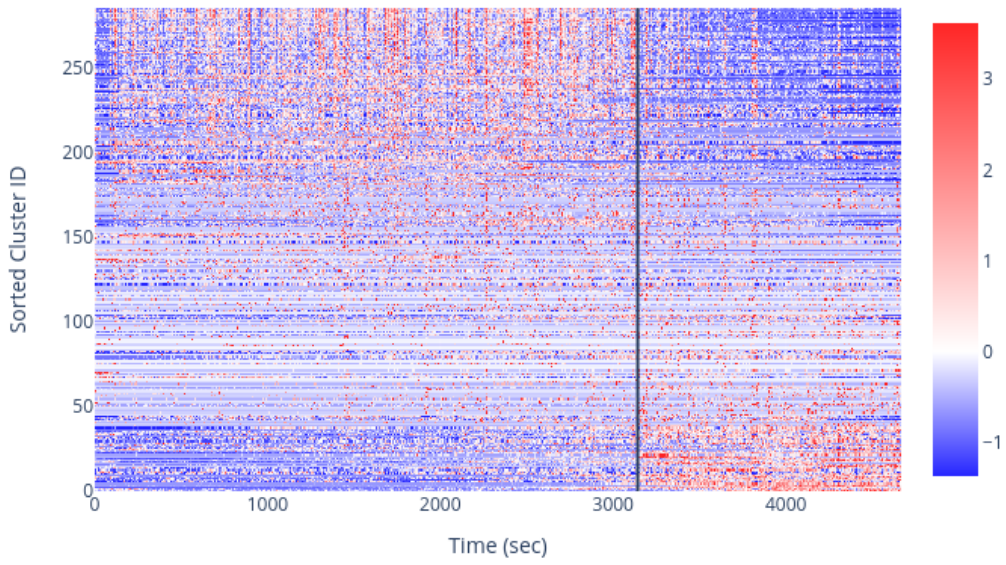

Figure 4: Same as Figure 1, but neurons have been sorted according to their weight along the first left singular vector. The black vertical line indicates the last response time of the subject. Generated with this script using its default parameters. Click on the image to see its interactive version.

The first left right singular vector (scaled by the corresponding entry in the first right singular vector) gives the best rank-one approximation of the binned spikes of any neuron. Figure 5 plots in blue a part of the the first left singular vector between 400 and 650 seconds. The block vertical lines indicate subject response times. Interestingly, we see that this approximation of the binned spikes times tends to peak immediately after the subject response times. This suggest a synchronization between neurons' spikes and subject's responses.

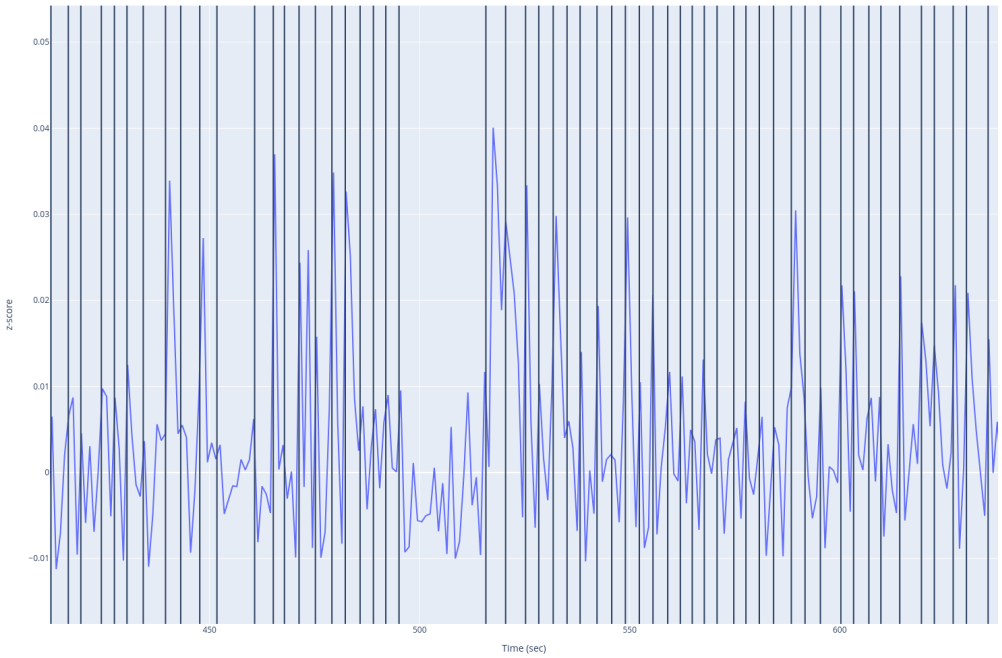

Figure 5: Part of the first left singular vector (blue trace) and subject response times (black vertical lines). This figure suggests a synchronization betweeen neurons' spikes and subjects responses (see text). Generated with this script using its default parameters. Click on the image to see its interactive version.

The n^{th} entry of the first right singular vector gives us the weight of the first left singular vector to approximate the z-scores of the binned spikes of neuron n. Figure 6 plots the histogram of entries of the first right singular vector. We see weights as positive as 0.13, corresponding to neurons with z-scored binned spikes correlated to the first left singular vector. We also see weights as negative as -0.12, corresponding to neurons with z-scored binned spikes anti correlated to the first left singular vector.

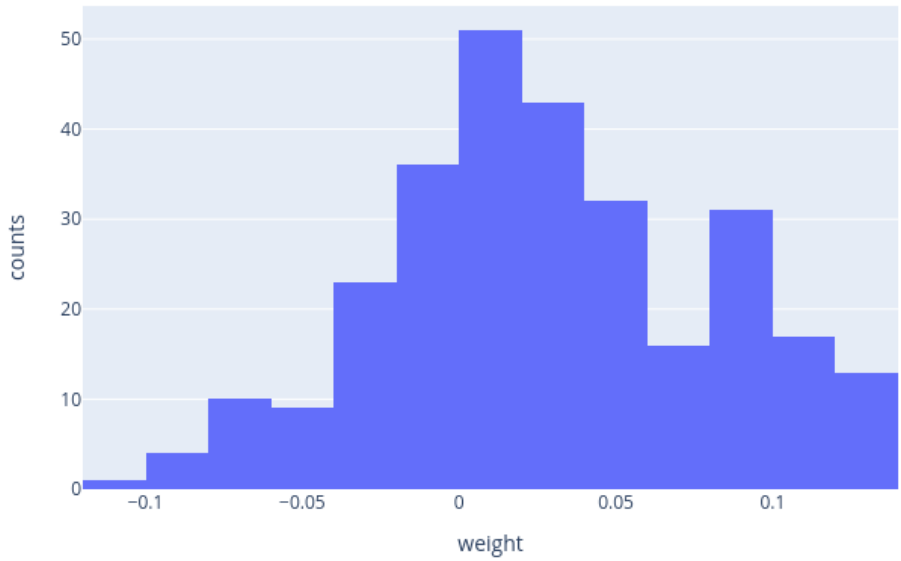

Figure 6: Histogram of entries in the first right left singular vector. Generated with this script using its default parameters. Click on the image to see its interactive version.

The weight of the first left singular vector on the z-scored binned spikes of the neurons near the top of Figure 4 is large and positive. We see vertical red stripes on the z-scores of these neurons, indicating their strong synchronization with the response times of the subject. Before the time of the last response of the subject (black vertical line) z-scores tend to be positive (i.e., binned spikes larger than their mean), but after the last response of the subject z-scores tend to be negative. Moving the mouse over the top of the plot shows that most of these neurons belong to the primary motor cortex[1] and striatum[2].

The oposite happens to neurons near the bottom of Figure 4. For these neurons the weight of the first left singular vector on their z-scored binned spikes is large and negative. We don't see vertical stripes on their z-scores. Before the time of the last response of the subject (black vertical line) z-scores tend to be negative (i.e., binned spikes lower than their mean), but after the last response of the subject z-scores tend to be positive. Moving the mouse over the top of the plot shows that most neurons belong to the pallidum[3].

[1] areas: MOp5 (layer 5), MOp6a (layer 6a), MOp6b (layer 6b)
[2] areas: CP (caudoputamen), STR (striatum)
[3] area BST (bed nuclei of the stria terminalis)