Problem set 7

Analysis for Neuroscientists

1. This problem uses the dataset from the last problem set, from Churchland et al. [1].

   (a) Modify your code from last time to, instead of computing the Fano factor, compute the firing rate of each neuron (in spikes per second) in the interval 500 ms to 600 ms (averaged over recorded trials for each neuron). Make a histogram of these firing rates.

   (b) Under the assumption that these firing rates are normally distributed, find a 95% confidence interval for the mean of the distribution of firing rates.

   (c) Make a q-q plot for the firing rate distribution. Can you find a transformation of the data (logarithm, exponential, raising to a power, etc.) that makes it closer to normal?

   (d) Now let's find confidence intervals using bootstrapping. Generate 10,000 bootstrapped samples, and compute the median for each of them. Store these medians in an array.

   (e) Calculate a 95% confidence interval for the median firing rate using the bootstrapped samples.

2. Compute the effect size (Cohen's D) for the Fano factor comparison from the previous problem set.

3. Read the documentation of MATLAB's `sampsizepwr` command.

   (a) Suppose we're doing a two-sample t test where sample 1 has mean $\mu_1 = 1.5$ and standard deviation $\sigma_1 = 0.8$. Make a plot of the power as a function of number of samples N, for N from 10 to 200. Do this for three different possible values of the mean of sample 2, μ_2, under the alternative hypothesis: 1.75, 2, and 2.25.

   (b) How many samples are needed to get a power of 0.8 for each of these three cases?

References

[1] Churchland, M.M., et al. Stimulus onset quenches neural variability: a widespread cortical phenomenon. *Nature Neuroscience* **13**, 369–378 (2010).