**NUIN 408 – Homework #2 – Spring 2020**

Due: 4/22/20 by 11:59 pm

**Problem 1**

You are measuring calcium signals from the dendrite of a neuron while you inject a fixed amount of current. The Ca2+ concentration is noisy, so you measure it by averaging over 1 second. You repeat that same experiment 15 times. The average of the measured concentration was 6.3 μM, with a standard deviation of 1.9 μM.

**a)** What is the standard error of the mean?

**b)** What is the 95% confidence interval of the mean? (hint: you need 2 numbers to define an interval)

**c)** What is the probability that the true mean is 9 uM?

**d)** What assumption(s) need to be true for your answers to the previous questions to be valid?

**Problem 2**

You perform an experiment to determine how pulse trains of different frequencies affect long-term potentiation at a particular synapse. You stimulate the presynaptic cell with brief pulse trains at 8 different frequencies (in Hz) and then you measure the strength of the synapse following stimulation by the current (in pA) in the postsynaptic cell to a fixed pulse amplitude. You perform the experiment many times and get the data set in the file ‘SynapseStengths\_HW2’.

**a)** Plot all the data with a scatter plot.

**b)** Fit the data with a 1st degree polynomial, then with a second degree polynomial, … all the way up to a 6th degree. (Ignore the warning message Matlab gives you when you do some of these fits). Plot the 6 different fits on the same graph with subplot.

**c)** Collect the sum-squared error, the R2 value (coefficient of determination), and the adjusted R2 for each of the fits.

**d)** Plot each of the quantities you collected in **c** vs. the number of degrees of the polynomial.

**e)** Which fit has the highest R2 value? Which fit is the most appropriate for the data? Explain your answers.

**Problem 3**

You wish to determine whether sugar makes neurons in your target region of the hypothalamus fire at a different rate. You take two groups of rats. One of them eats Kellogg’s special-K cereal all day; the other eats rolled oats each day. You measure average firing rates (in Hz) from 10 rats from each group, to obtain the following data:

Special-K (low sugar): 13 19 32 34 49 15 20 19 30 8

Rolled-oats (high sugar): 6 9 20 31 41 14 21 16 22 7

**a)** State the null and alternative hypotheses, both in words and in equations.

**b)** What kind of test would you use? What is the p value?

**c)** Is the experimental design adequate? Why or why not?

**d)** Now instead imagine that the same data came from a different experiment in which a **single** group of 10 rats was given the 2 cereals on different days (properly interleaved). How does this change the statistical test you use?

**e)** What is the new p-value? Is the experimental design adequate? Why or why not?

**Problem 4**

Your question is whether protein A is selective for inhibitory neurons over excitatory neurons. You randomly poke a needle into the brains, do electrophysiology to assess if neurons are inhibitory or excitatory, and then perform postmortem antibody staining for A.

Your findings are summarized in this table:

|  |  |  |
| --- | --- | --- |
|  | Stains for A | Does not stain for A |
| Inhibitory | 128 | 62 |
| Excitatory | 35 | 85 |

**a)** State the null and the alternative hypotheses, both in words and in equations.

**b)** What kind of test would you use to reject the null hypothesis? What is the p-value?