Statistical Methods for Neuroscience and Psychology – Homework 5

1. Return to Example 5.5 from Hecht *et al.* on perception of dim light. In Section 9.1.2 we used this example to illustrate propagation of the uncertainty in (β_0, β_1) to uncertainty about x_{50}. In this problem I would like you to (i) replicate the results reported there and then (ii) consider the similarity of these results to those obtained from a second set of trials on the same subject.

(i) Here are the data for subject SS in Figure 8.9, where the first column is intensity (not $\log_{10}$ intensity, which you should use instead) and the second column is number perceived out of 50:

```
 24.1    0
 37.6    2
 58.6    9
 91     27
141.9   47
221.3   50
```

Use logistic regression to estimate x_{50} and get a standard error by propagating uncertainty.

The following Matlab code should be of use:

```
response = [0 2 9 27 47 50]';
total = [50 50 50 50 50 50]' ;
[glmb glmdev glmstats]  = glmfit(intensity,[response total],'binomial');
b0 = glmb(1);
b1 = glmb(2);
vmatr = glmstats.covb;
x50 = -b0/b1 ;
beta = mvnrnd([b0 b1] ,vmatr,10000);
x50vec = -beta(:,1)./beta(:,2);
quantile(x50vec, [.025  .975])
sqrt(var(x50vec))
```

(ii) Here are the data for the second set of trials:

```
 23.5    0
 37.1    0
 58.5    6
 92.9   22
148.6   47
239.3   50
```

Plot the two data sets and fits from the two sets of trials together to judge their similarity by eye.

(iii) For the second set of trials use logistic regression to estimate x_{50} and get a standard error by propagating uncertainty.

(iv) Assuming two random variables U and W are independent we have $V(U - W) = V(U) + V(W)$. Find the formula in the notes that justfies this, and very briefly explain.

(v) Suppose U and W in part (iv) are the two estimated values of x_{50} found from parts (i) and (ii) and explain briefly why you think it would be reasonable to consider them to be independent.

(vi) Using all of the forgoing parts of this problem, find a 95% confidence interval for the difference between the x_{50} values for the two sets of trials, and interpret it.

2. The files **spatial.dat** and **pattern.dat** contain SEF data under the spatial and pattern conditions corresponding to the explicit and complex cues, respectively, described in Chapter 1. Each row of each data file contains spike counts in successive 10 millisecond bins, beginning 395 milliseconds before the appearance of the targeting cue (the subject must continue to fixate until a second "go" cue is given). Compare the firing rate curves under these two conditions, carrying out the following steps.

(i) Begin by using regression splines with knots at -200 and 200 milliseconds. Plot each of the two fitted firing-rate curves together with the data, then plot the two fitted firing-rate curves together on the same plot (without the data, as in the figure discussed in Section 16.1 for the IT neuron). Judge the fits and the differences by eye.

(ii) Repeat part (i) for several alternative choices of knots to see how much this affects conclusions.

(iii) Apply a normal kernel density estimator (Gaussian filter) to smooth the PSTH, using several choices of bandwidth to see how the choices affect the fitted curve, and compare briefly with the Poisson regression results by eye.

(iv) Use the interval (200,400) milliseconds to compare firing rates under the spatial and pattern conditions by formulating and testing an appropriate null hypothesis.

(v) Draw conclusions for this particular SEF neuron.

3. Return to the data in **woodMK801a** and **woodMK801b** from Homework 1 and use nonparametric density estimation for several choices of bandwidth, using (i) the original scale and (ii) a log scale. In both cases you should compare the results from the two data sets (before and after injection of M801).

(i) In the original scale, settle on a favorite bandwidth, then produce a plot that shows both your nonparametric density estimate and a gamma density. Briefly summarize your findings, commenting also on the gamma Q-Q plot.

(ii) In the log scale, settle on a favorite bandwidth, then produce a plot that shows both your nonparametric density estimate and a normal density. Briefly summarize your findings, commenting also on the normal Q-Q plot.

(iii) Formulate an appropriate null hypothesis and test it. Draw conclusions, discussing parts (i) and (ii) however they may be appropriate. You may, and perhaps should use multiple methods (multiple alternative versions of the hypothesis and/or test).