

MIT OpenCourseWare
<http://ocw.mit.edu>

HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Fall 2008

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

HST.583 Problem Set #4- Statistical Analysis of fMRI Data
Distributed: late on November 14, 2008
Due: December 3, 2008

1. Group GLM. Given the following table:

	Diagnosis	Age	HRF
Subject 1	Normal	42	2.87
Subject 2	Normal	43	-1.56
Subject 3	Normal	32	-1.42
Subject 4	Schizophrenic	41	1.58
Subject 5	Schizophrenic	43	0.57
Subject 6	Schizophrenic	39	-2.19

a. Write out the design matrix that models the effect of age and diagnosis. Do not assume that the slope between HRF amplitude and age is the same across diagnosis.

b. Write out the contrast matrix that tests for the effect of diagnosis on the intercept.

c. Write out the contrast matrix that tests for the effect of diagnosis on the slope.

d. Write out the design matrix that models the effect of age logarithmically instead of linearly.

2.

a) What does it mean for a design matrix to be singular?

b) What does it mean for a design matrix to be ill-conditioned?

c) What are the implications of a) and b) above on:

i) the ability of the model to fit the data?

ii) the coefficient estimates and their standard errors?

3. What is the difference between a fixed-effects and a random-effects model?

Can one have a model that includes both types of effects?

4. Is there an optimal level of spatial smoothing. If not, why? If so, what is it?

5. Sketch out a typical hemodynamic response function (HRF), give approximate values for the onset delay, delay to peak, and equilibration time.

6. You are performing an experiment in which you are manipulating a psychological variable (eg, working memory load) at levels of 1, 3, and 5 (ie, you are presenting stimuli that represent levels 1, 3, and 5). You wish to test for a linear effect of the variable. There are two possible ways: (Method 1) you can model the level directly in the design matrix, or (Method 2) you can model each level separately and test for a linear effect with a contrast. For the purposes of this exercise assume a shape to the hemodynamic response and do not worry about nuisance variables like offset and drift.

a) Describe in words how you would implement Method 1. Include a contrast matrix to test for the slope.

b) In Method 2, you would have a regressor for each level. Describe how you would create a contrast matrix to test for a non-zero slope.

8. a) What is a null hypothesis?

b) What is an alternative hypothesis?

c) Give an example of how one can have two different p-values for the same null hypothesis depending on the alternative hypothesis which is used (hint: these two p-values for a simple example of this situation will have ratio 1/2).

d) Can both the null and the alternative hypothesis be true for a valid hypothesis test?

9. What is the problem of multiple comparisons? Choose one solution to explain.

10. a) Why is it desirable to specify regions of interest in an fMRI experiment before looking at the data, to the full extent that this is possible?

b) If a region that was not of interest *a-priori* is found to have a statistically significant p-value once the data are analyzed, what can one say about the interpretation of this p-value?

c) What can be done to improve the situation in b) above?

11. Explain how Independent Component Analysis (ICA) and Principle Component Analysis (PCA) are alike and how they are different.