Bios372 Proposal for Final Exam Project
Task-induced fMRI Data Analysis

Minchun Zhou

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I agree to share this project report for Bios372 class only.

1 Description of the project

There are two type of data in fMRI analysis, task induced and resting state. In this project, I will focus on task induced type of fMRI data analysis. In task induced fMRI analysis, we are interested in testing the hypothesis that if a stimulus activates different region of interests(ROIs). Each ROI contains different number of voxels. During the fMRI scan, the brain was scaned every two seconds. A signal value was recorded for each voxel at each scan.

2 Description of the data

We have one subject. The subject was scaned six times. There are three ROIs(C=3). Each ROI contains 20 voxels(V=20). Each voxel has 128 data points(T=128). There are three stimulus during each scan(P=3). Stimulus can happen multiple times between t=0 and t=128.

3 Frequentist approach Model

$$Y_{cv}(t) = \sum_{i=1}^{P} [\beta_c^p + b_{cv}^p] X_p(t) + d_c(t) + \epsilon_{cv}(t)$$

where $c = 1, ..., C$, $v = 1, ..., V$, $t = 1, ..., T$

β_c^p is the ROI-specific activation level fixed effect due to stimulus p;
b_{cv}^p is a zero-mean voxel-specific random deviation that accounts for the local spatial covariance between voxels within an ROI.
$d_c(t)$ is a zero-mean ROI-specific signal to model connectivity across ROIs
$\epsilon_{cv}(t)$ is the noise that takes into account temporal correlation within a voxel
$X_p(t)$ is the convolution between the p impulse function and the haemodynamic response function(HRF)

Table1: Frequentist approach result

	Point estimate	SE	p-value
ROI1	0.98	0.61	0.05
ROI2	0.63	0.40	0.06
ROI3	-0.35	0.26	0.91

4 Bayesian candidate Model

$$
\begin{aligned}
Y_{cv}(t+1)|Y_{cv}(t), b_0, b_1 &\sim N(b_0 + b_1 Y_{cv}(t), \sigma_0^2) \\
Y_{c.}(t)|\beta_{c.}^p, X_p(t), \Sigma_{c.} &\sim N_c(\sum_{i=1}^{P} \beta_{c.}^p X_p(t) + \alpha_{c.}, \Sigma_{c.}) \\
\beta_{1v}^p|\mu_1, \Sigma_v &\sim N_v(\mu_1, \Sigma_v) \\
\beta_{2v}^p|\mu_2, \Sigma_v &\sim N_v(\mu_2, \Sigma_v) \\
\beta_{3v}^p|\mu_3, \Sigma_v &\sim N_v(\mu_3, \Sigma_v) \\
\alpha, b_0, b_1, \sigma_0^2, \sigma_1^2, \Sigma_v, \Sigma_{c.} &\sim non-informative-prior
\end{aligned}
$$

μ_c using frequentist result $(\mu_1, \mu_2, \mu_3) = (0.98, 0.63, 0.35)$ as prior.