Logistic Regression model to estimate voxel activation

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We let Y_{ij} be the $j-$th voxel of study i,

$$y_{ij} = \begin{cases} 1 & \text{if is } \textit{on} \text{ in the } i\text{-th study} \\ 0 & \text{if is } \textit{off} \text{ in the } i\text{-th study} \end{cases}$$

For $i = 1, 2, ..., I$. With one voxel we can assume that it follows a Bernoulli distribution,

$$Y_{ij} \sim Bernoulli(\pi_{ij})$$

$$log \frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \sum_{k=1}^{p} \beta_k X_{ijk},$$

where $X = (X_{ij1}, ..., X_{ijp})$ are possible covariates that influence the activation of the voxel j. Information about the possible covariates of each study will be needed.
After estimation π_{ij} we can build our prior based on the average values of the π_{ij}'s over studies. Our probability surface would be estimated as

$$\pi_j = \frac{1}{I} \sum_{i=1}^{I} \pi_{ij}$$

We need to assign the prior distribution of $\beta = (\beta_0, ..., \beta_p)$. It is reasonable to assume that the β_k are independend and follow a zero mean normal distribution with large and fixed variance.
For the posterior distribution we will use a Markov Chain Monte Carlo method to obtain samples from the resultant posterior distribution.