Non-human primates are frequently used as model system for studying the neural substrates of higher cognitive functions. We can design specific tasks to address particular cognitive feature. However, animals may not always adopt the strategy that researchers assumed or intended and the result could be misinterpreted. Sometimes, differences can occur between new learners and over-trained animals.

Here, imagine we have human subjects being engaged in a new task while the fMRI signals of areas of interest were collected. After doing the same task thousands times, another set of fMRI data were collected. We would like to know whether or not the task specific activities differ significantly between two stages. Namely, did the cognitive process change over time in terms of patterns of activity?

1. Sample Space(s)

We obtained each graph Gn = (V, E, Y) from one scan where V is determined by normalized voxels, E = {0, 1} by thresholding correlations between signals from different vertices or of same vertex at adjacent time points (or based on whatever appropriate criteria). Vertex labels Y could be latent. The graph is undirected and no self-loop is allowed.

1. Model

P = SBMk(rho, beta). k = 2. Since the graph is undirected and no self-loop is allowed, the two clusters can be described as likely or unlikely connected.

1. Decision Rule Class & Action Space

Begin with K-means which takes in the adjacency matrix of Gn and cluster number 2, and outputs labels for each vertices in action space A = { y = {0, 1}n }, label of clusters.

1. Loss Function

For each observation, loss l = sum(yi x L) across all n vertex labels, where L is the loss (penalty) matrix. However, I do not know how to calculate l given the “truth” Y is latent. I am also wondering how tests like permutation come into play.

1. Risk Function

R = E(l), simply the expected value of l.

1. Optimization

Minimizing R by iteratively changing the number of clusters, k, or even method of clustering.

1. Hypothesis Test

We can assume two distributions of SBMk(rho, beta), one from new learners’ and another from over-trainees’ sample space, are not significantly different, and see whether or not this hypothesis is rejected.