Project Gamma Progress Report

Nima Hejazi, Feng Lin, Luyun Zhao, Xinyue Zhou

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Background

The Paper

- "Working memory in healthy and schizophrenic individuals"
- Accession number: ds000115 (from the OpenFMRI.org website)
- The paper(s) used ANOVA to explore within/between network connectivity wrt working memory measures.
- The goal was to identify regions contributing to impaired cognitive function in schizophrenics.

The Data

- The method was fcMRI, collecting activation and connectivity (resting) fMRI data.
- 102 subjects: individuals with schizophrenia, their healthy siblings, and controls.
- A task in which subjects identified repeating letters in an interval was administered.
- The data includes anatomical (MRI) and functional (BOLD fMRI) with condition files.

The Method

- After appropriate preprocessing (e.g., Talairach transform), the paper(s) used ANOVA to compare groups.
- The main comparisons examined resting connectivity between and within network regions of interest.
- In order to assess reported analyses, we performed voxel-wise linear models (as seen in lecture).
- Going further, we attempt to define network regions based on activity patterns with machine learning.

Initial work

Scope of the analysis

- Work on single subject
- Work on 8 subjects:
    1. Subject 01 & 02 : SCZ, SCZ-SIB
    2. Subject 04 & 05 : SCZ, SCZ-SIB
    3. Subject 10 & 11 : CON-SIB, CON
    4. Subject 12 & 13: CON, CON-SIB

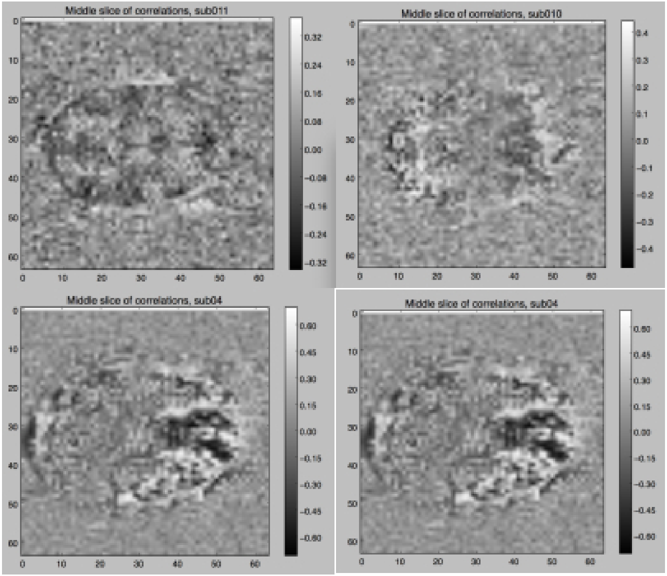
Pre-processing

- Preprocessing steps:
  1. Drop first five
  2. Remove RMS outliers
  3. Normalize the data

Statistical Analysis and Validation

- Identify activation regions by
  1. visualzing correlations between the voxel time course and neural prediction per voxel
  2. obtaining clusters from K-Means
- Validate linear model assumption by normality testing of residuals

Correlations between the voxel time course and neural prediction per voxel



Unsupervised Learning with K-Means

- Use K-means to cluster voxels into 5 groups with different feature set.
- Combine multiple clustering results via a voting algorithm.
- Features used per voxel:
  1. mean BOLD measurements over timecouse
  2. BOLD over timecourse
  3. normalized BOLD over timecourse

K-Means Results and Diagnosis

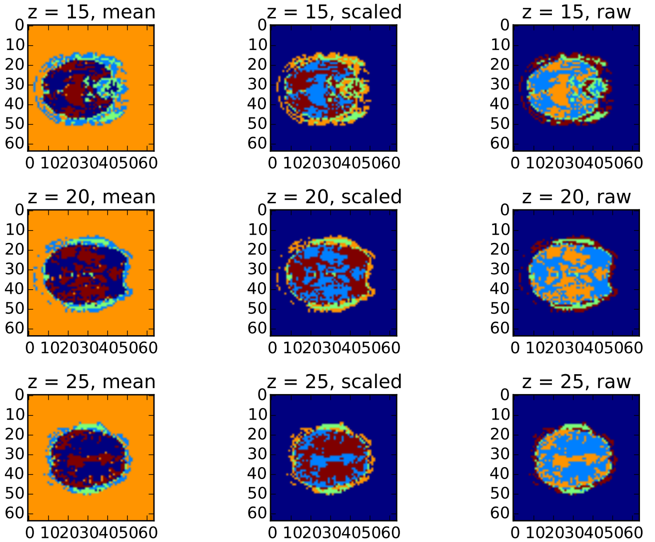


Figure 2: Comparison across feature sets for the same subject

Future

- Extend and fine-tune K-Means to focus on functional aspect of the data
    1. Improve features by inspecting and removing first principle components
    2. Improve features by
        - 2.1 fitting them to a linear models (e.g. with a drift term in the design matrix)
        - 2.2 taking the residuals
- Refine existing analysis by reducing noise
- Apply and compare existing analysis on all data sets
- Research other machine learning techniques to further explore activation regions

Future

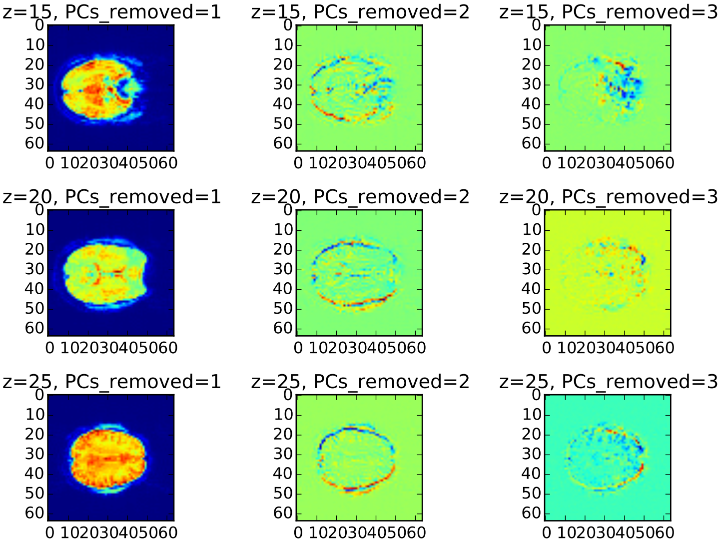


Figure 3: An example: residuals after removing the first two PCs

Process

What has been the hardest part?

- Dealing with
  1. Imperfect data: found out that the durations in condition files do not align with TRs in BOLD data
  2. Ambiguity of research: be resourceful and develop a coherent analytic plan