DAC Fall 2018
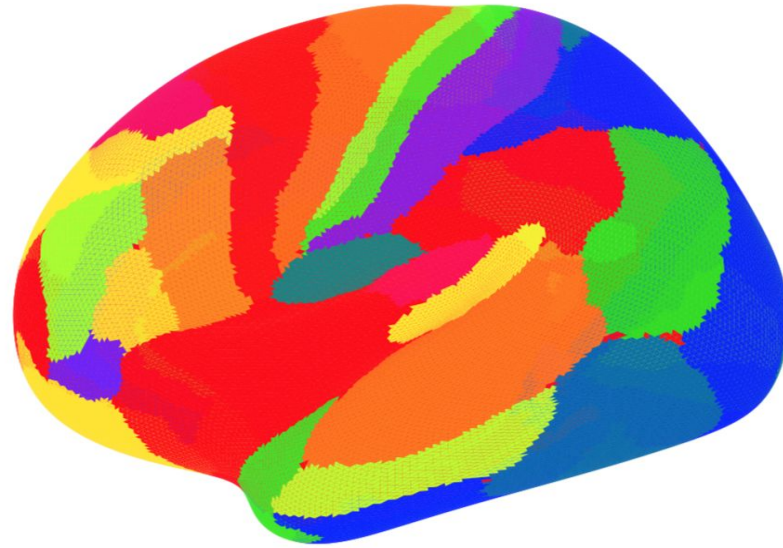
fMRI Assignments

Functional connectivity is temporal correlation between brain regions.

Parcellation of the brain (Brodmann areas)

Producing functional connectivity maps is useful but expensive

- Identifying brain disorders
  - Schizophrenia, bipolar disorder
- Better understanding functions in the brain

- State of the art parcellations (*e.g. Glasser et al. 2016*) require extensive domain knowledge

Glasser, Matthew F., et al. "A multi-modal parcellation of human cerebral cortex." *Nature* 536.7615 (2016): 171-178.

The goal of this project is to develop a data-driven method for generating functional connectivity maps.

The human-connectome project provides a suitable dataset for learning functional connectivity.

- 1200 subjects
- fMRI scanning over one hour period
- ~90000 voxels (collection of neurons)
- 30 gigabytes of data (averaged over all subjects)

Assignment 1: High level pipeline

1. Subsample dataset to allow fast prototyping
2. Perform dimensionality reduction and learn features for voxels
3. Compute connectivity using distance in learned feature space
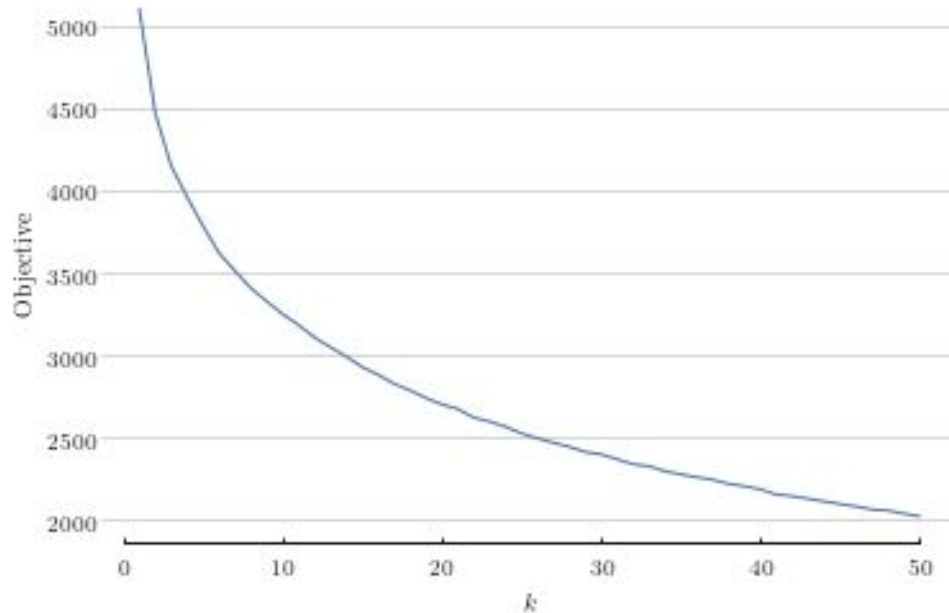4. Cluster voxels based on computed connectivity

Assignment 2: Implement baseline pipeline

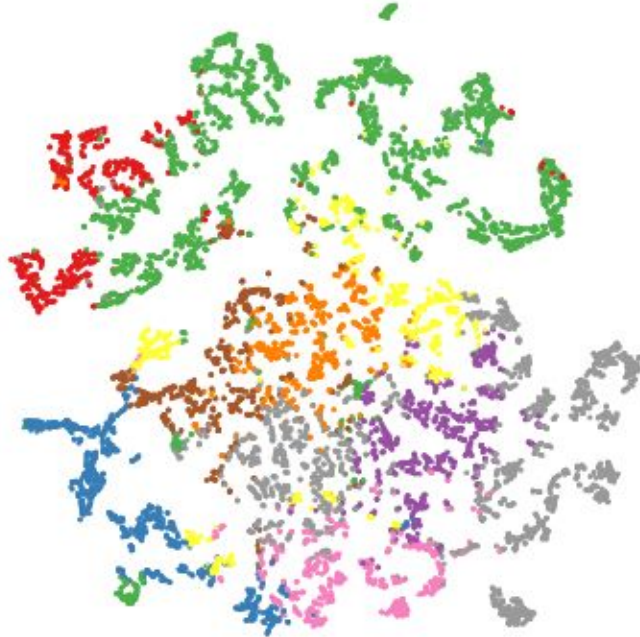1. PCA for dimensionality reduction
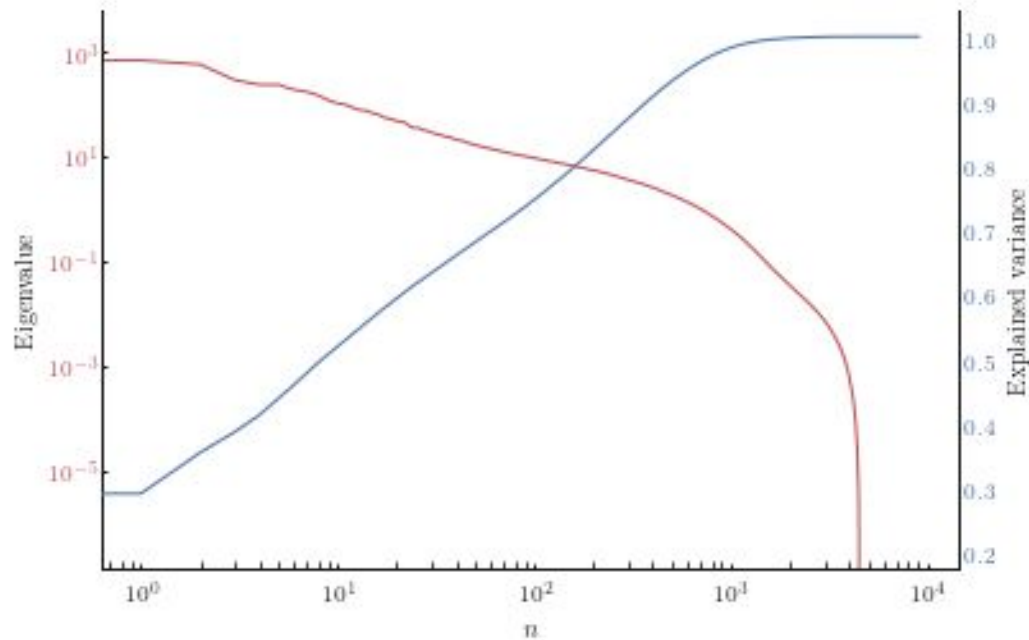
Assignment 2: Implement baseline pipeline

2. k-Means clustering using euclidean distance

Assignment 2: Implement baseline pipeline

3.   Visualization (10 clusters)

Assignment 3: Scalable pipeline and evaluation

Precision matrix estimation

- PseudoNet (*Generalized pseudolikelihood methods for inverse covariance estimation*. Ali et al.)
  - Sparse estimation without saturation
  - Computationally efficient

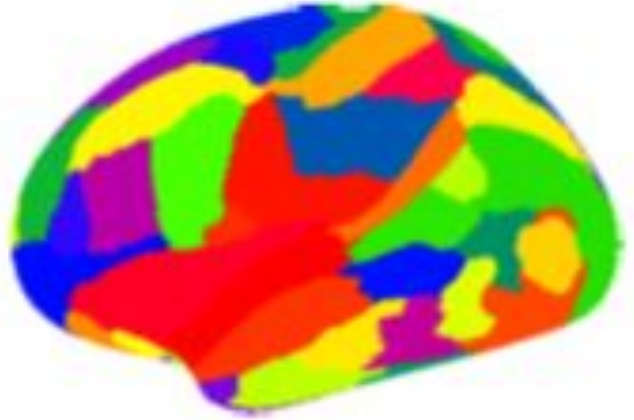# Assignment 3: Scalable pipeline and evaluation

Evaluation

- Unsupervised
  - Calinski-Harabasz index (variance ratio criterion)
    - Inter-cluster variance / intra-cluster variance
  - Silhouette coefficient
    - Mean nearest-cluster dist. (b) - mean intra-cluster dist. (a) / max(a, b)
- Supervised
  - Homogeneity
  - Jaccard score (intersection over union)
    - $J(A, B) = |A \cap B| / |A \cup B|$

Assignment 3: Scalable pipeline and evaluation

Glasser et al.

PseudoNet