BRAINHACK SCHOOL 2020

Can We Identify Sex Using fMRI?

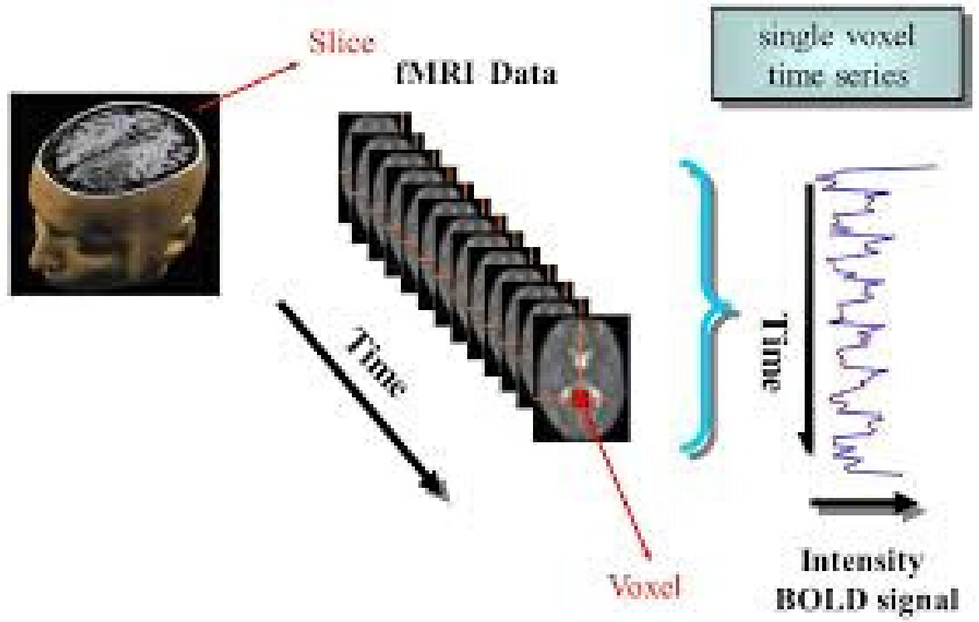
Tajwar Sultana, PhD Student
NED University of Engg. & Tech.
Karachi, Pakistan

INSPIRATION

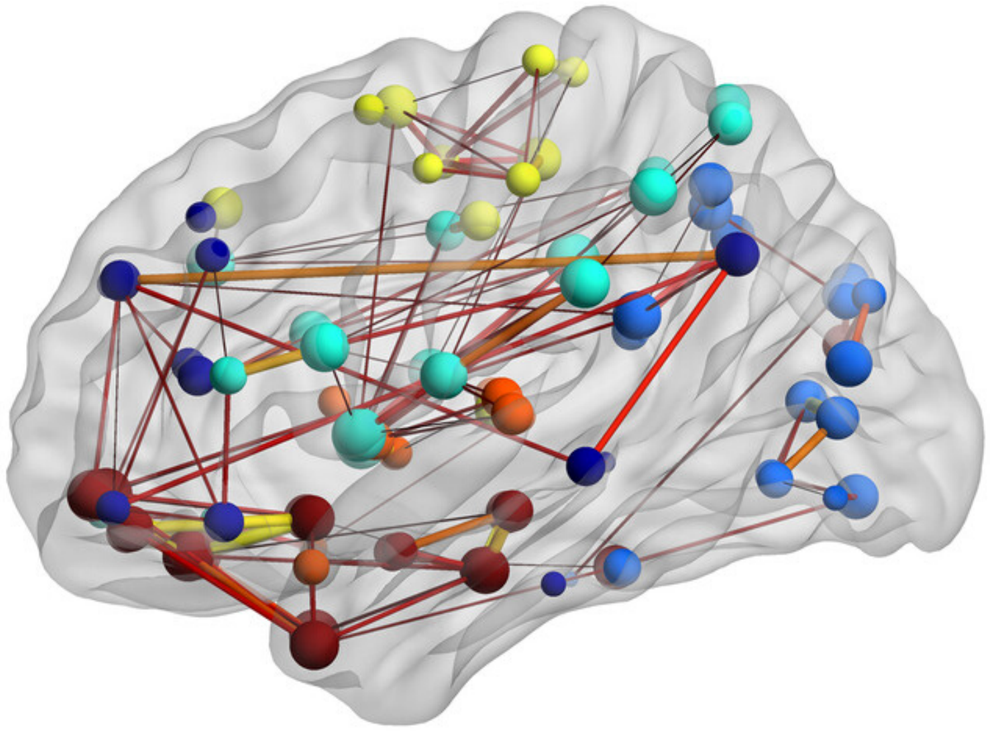
PREVIOUS RESEARCH => SEX DIFFERENCE RESULTS IN FC DIFFERENCE

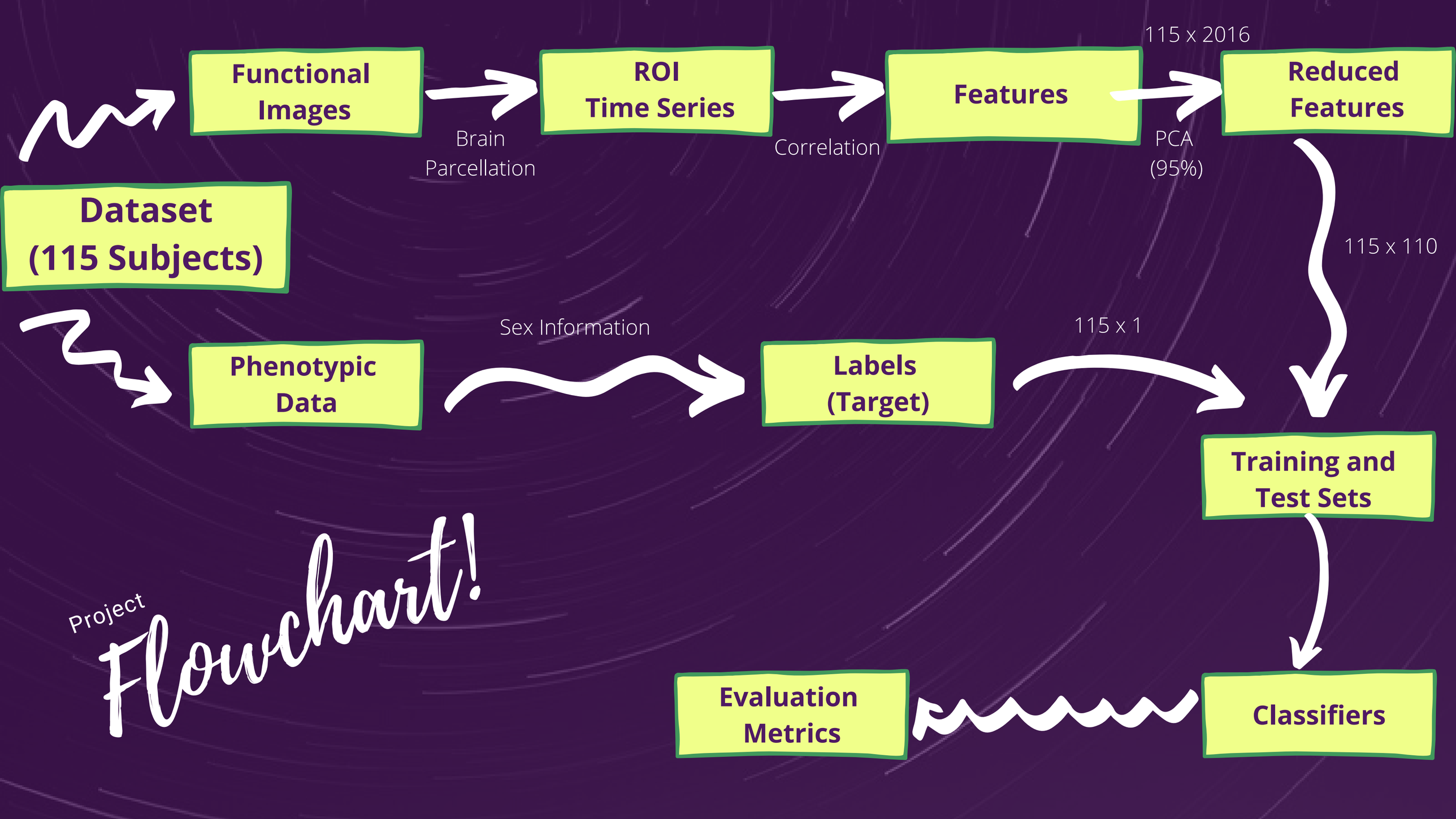
- Functional Connectivity Predicts Gender: Evidence for Gender Differences in Resting State Connectivity
- Sex Classification by Resting State Brain Connectivity

BOLD contrast and fMRI Time Series



Functional Connecitivity




Project
Flowchart!
Dataset
(115 Subjects)
Functional
Images
Brain
Parcellation
ROI
Time Series
Correlation
Features
115 x 2016
PCA
(95%)
Reduced
Features
115 x 110
Phenotypic
Data
Sex Information
Labels
(Target)
115 x 1
Training and
Test Sets
Classifiers
Evaluation
Metrics

Development Dataset

FUNCTIONAL IMAGES

- Used to determine Connectivity Matrices
- Features are built using Connectivity matrices

PHENOTYPIC DATA

- Used to determine Labels for supervised learning
- Sex Information as Target Data

DATA SIZE

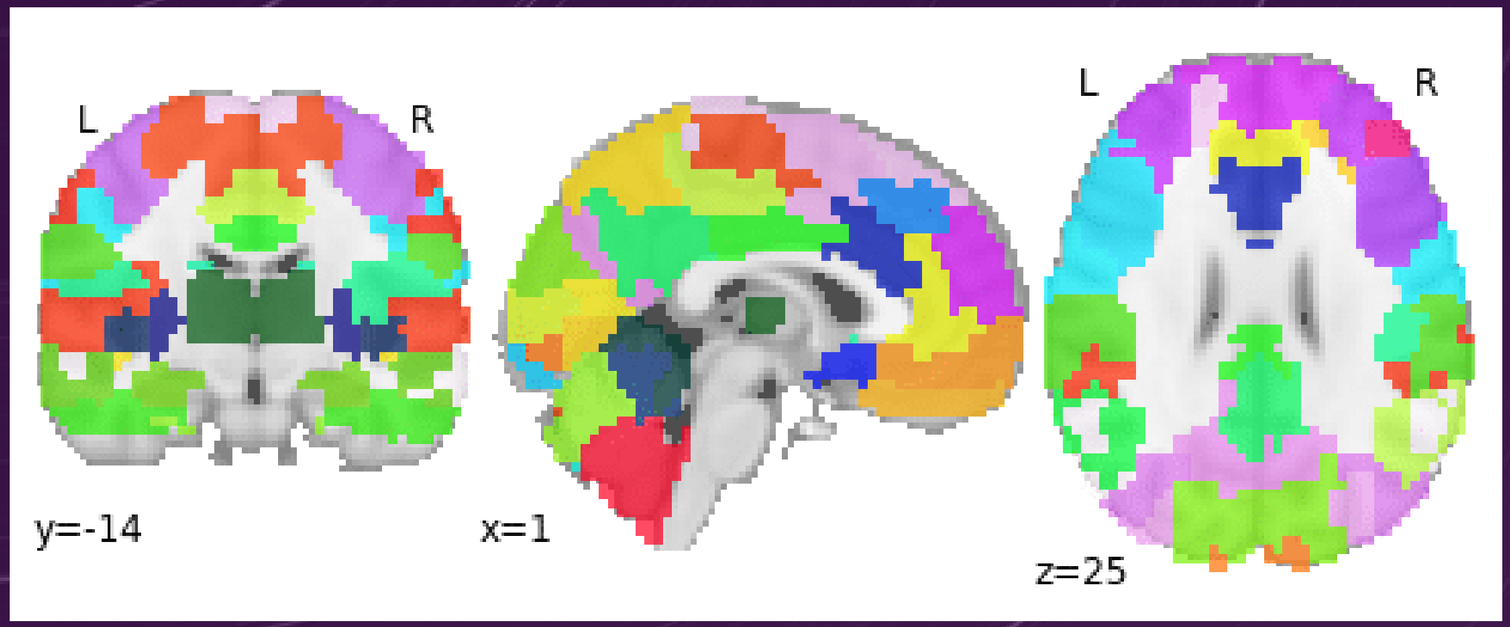
- 155 subjects
- 84 Female
- 71 Male

EXTRACTING

Region Of Interest

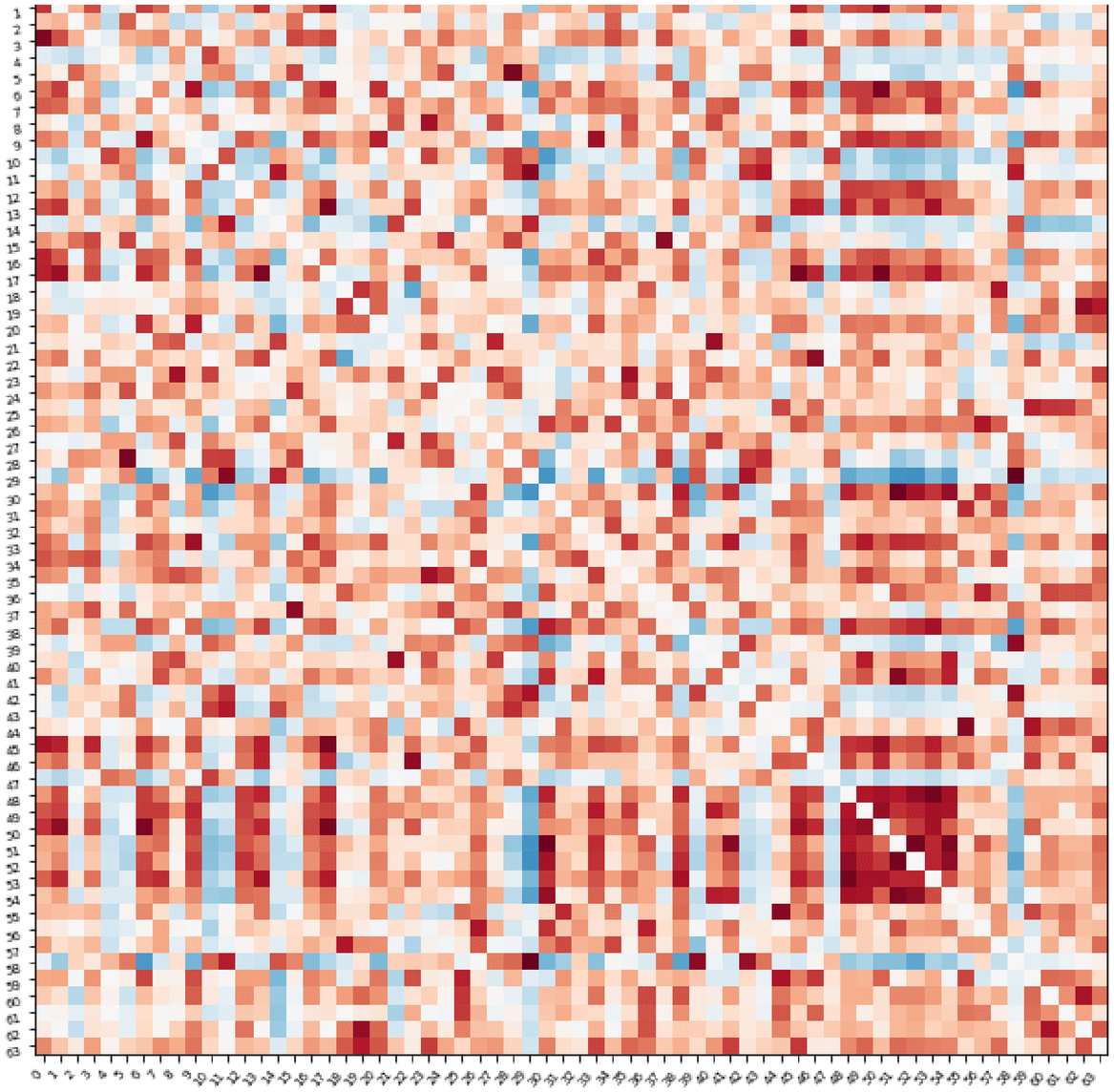
TIME SERIES

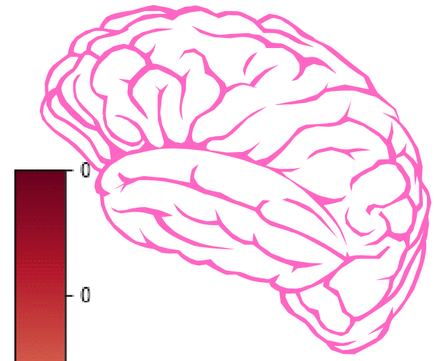
- datasets.fetch_atlas_basc_multiscale_2015
- Resolution = 64



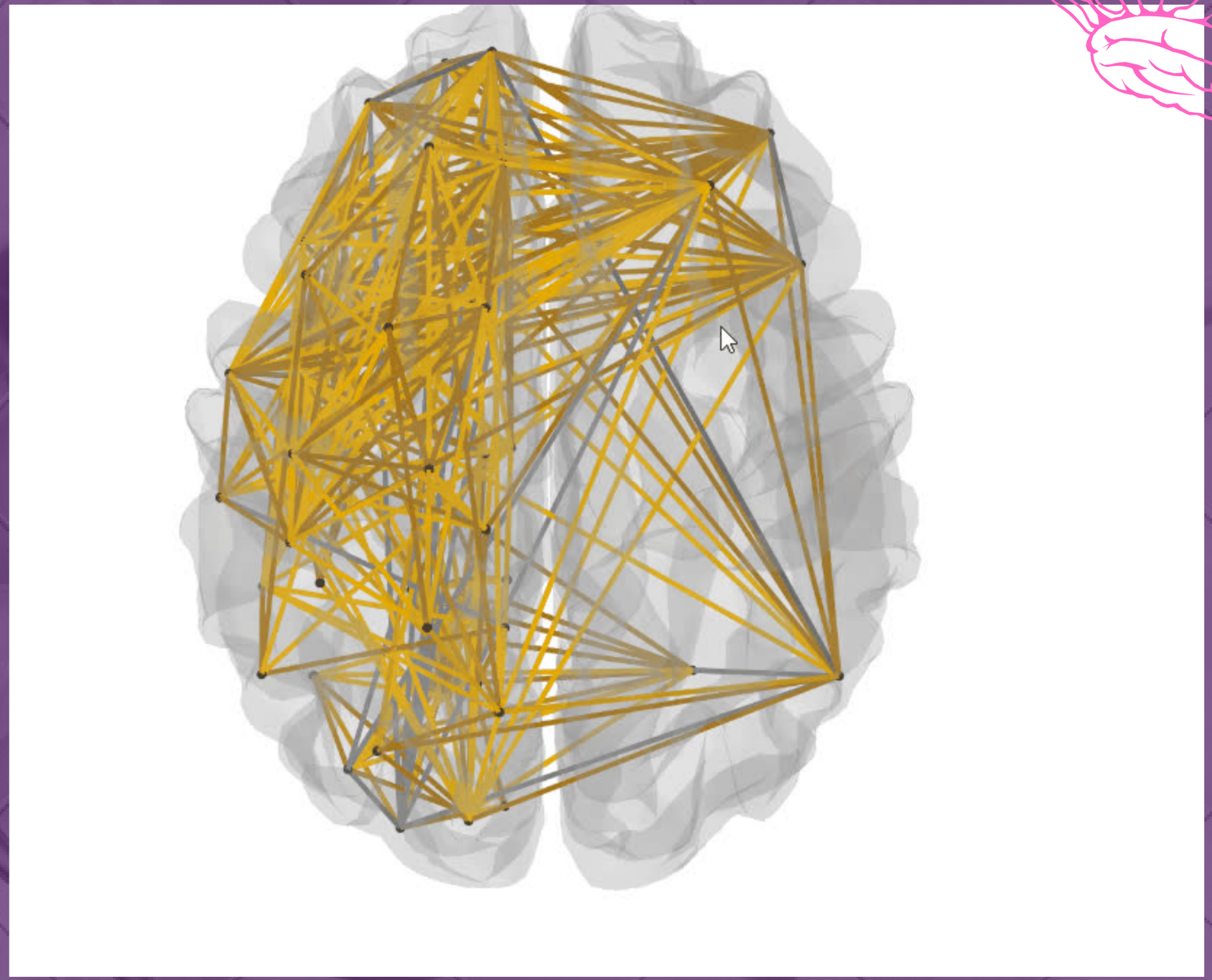
Connectivity Matrix

SINGLE SUBJECT



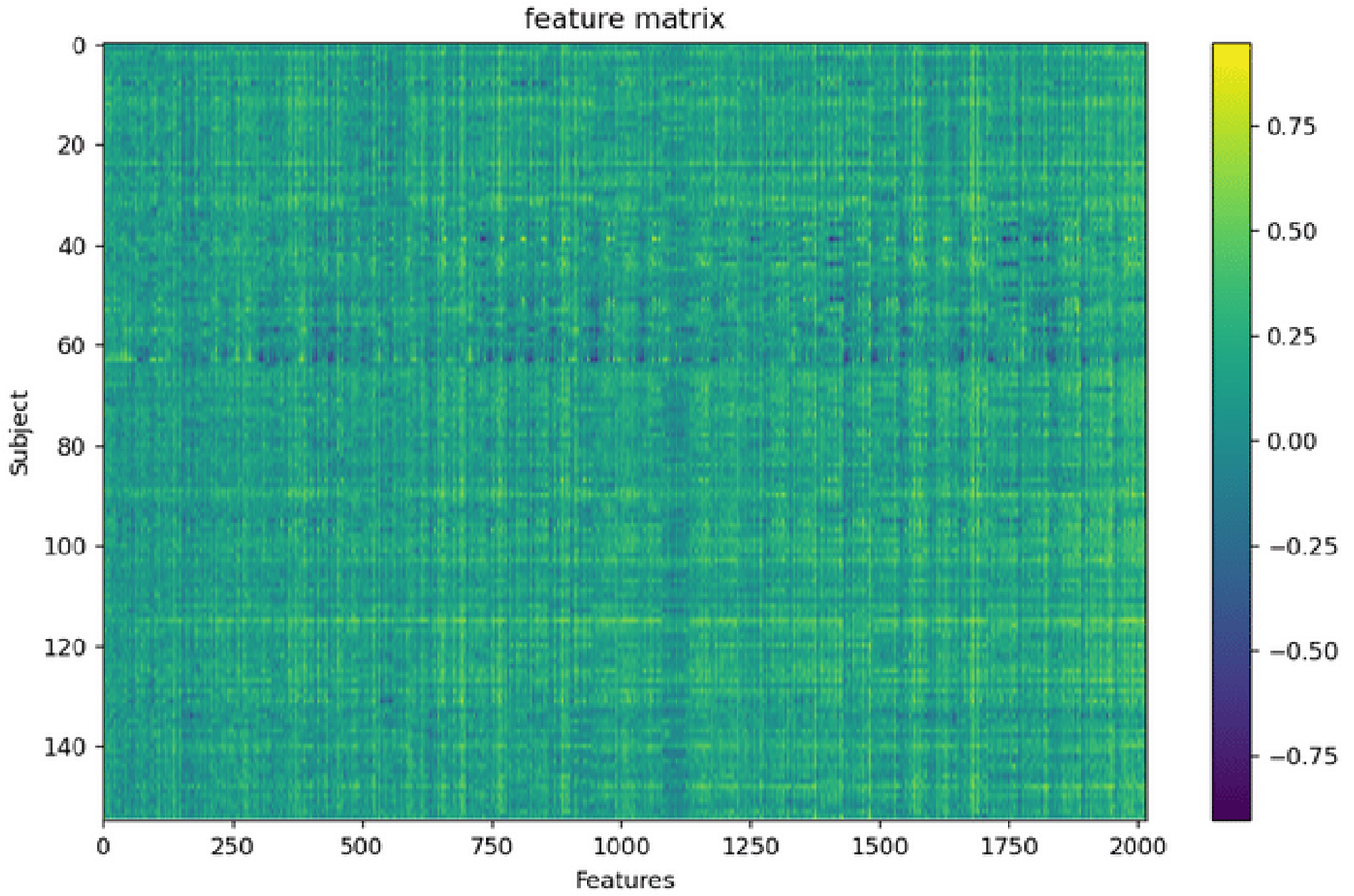


Connectome



Features

155 x
2016



LABEL ENCODING

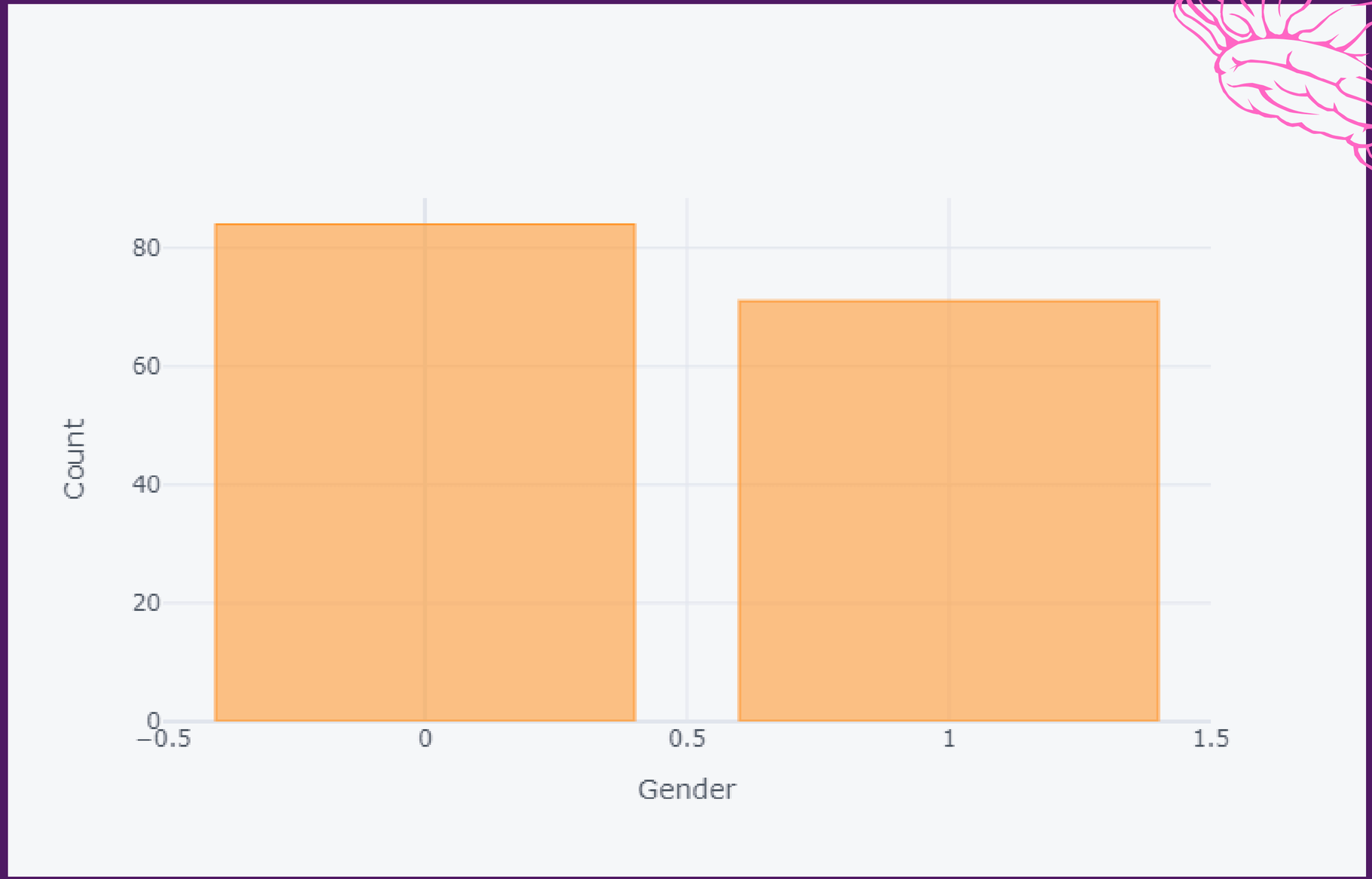
Label Encoder

Female → 0

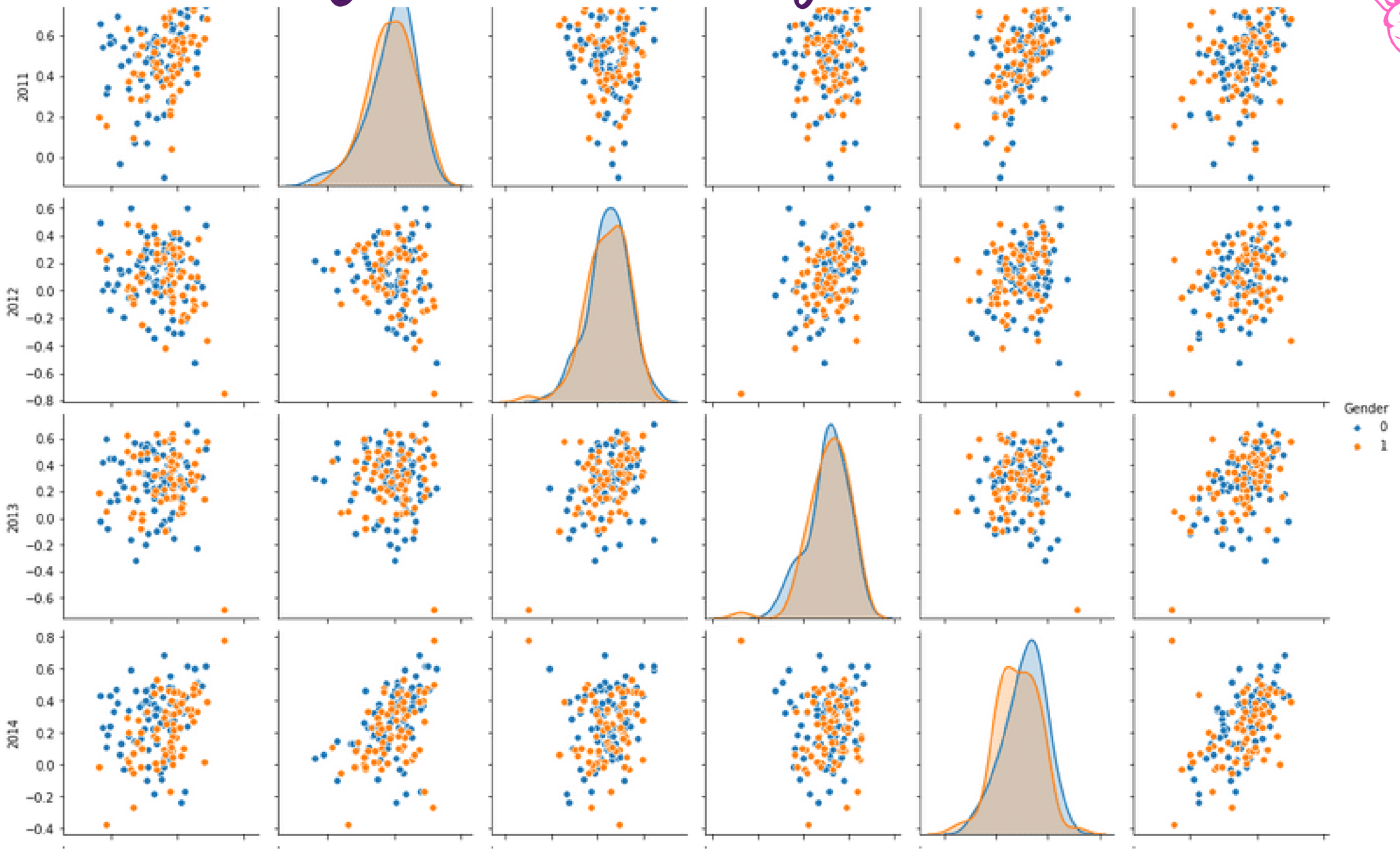
Male → 1

Label Count

MALE VS FEMALE



Matrix Plot of Features



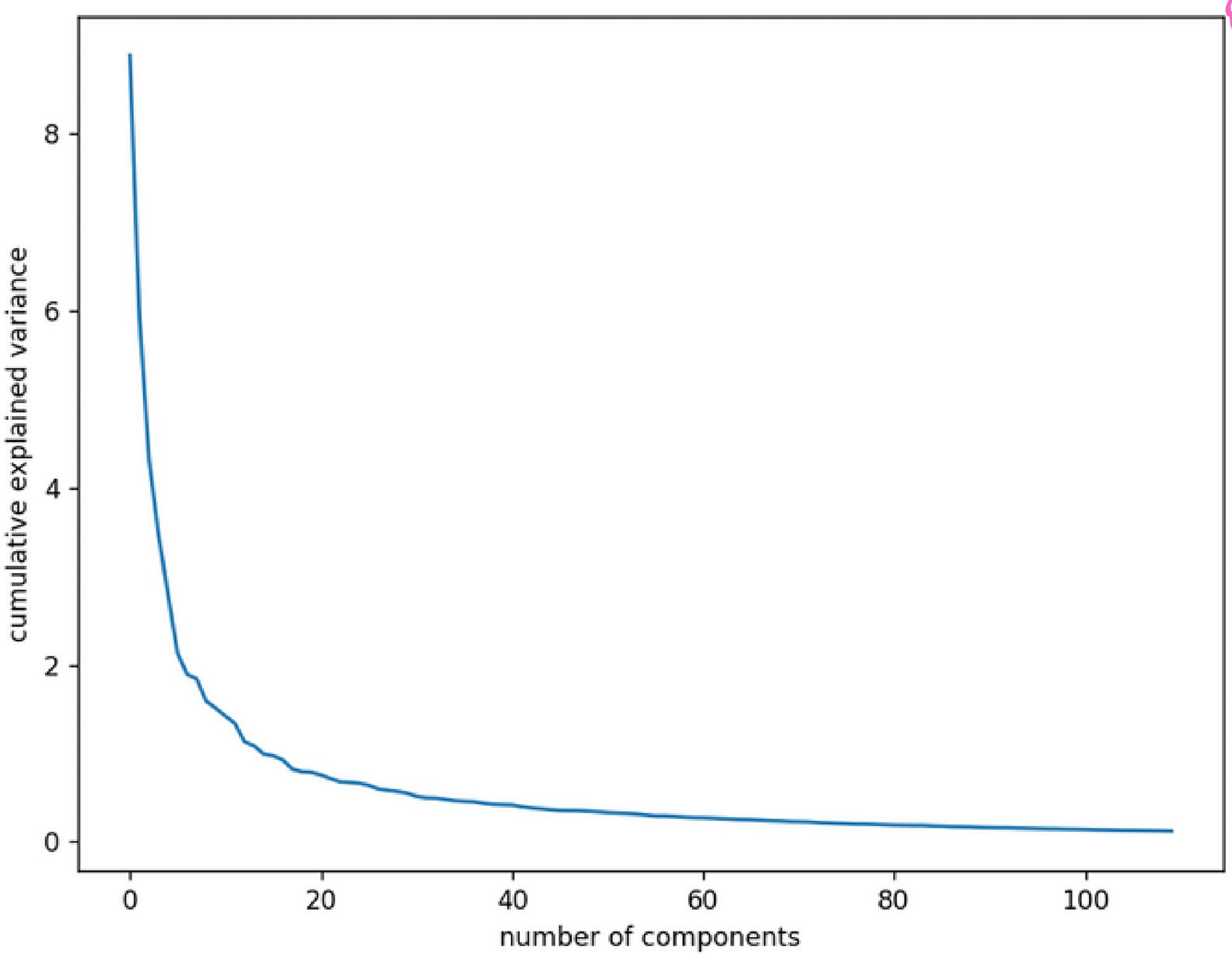
Dimensionality Reduction

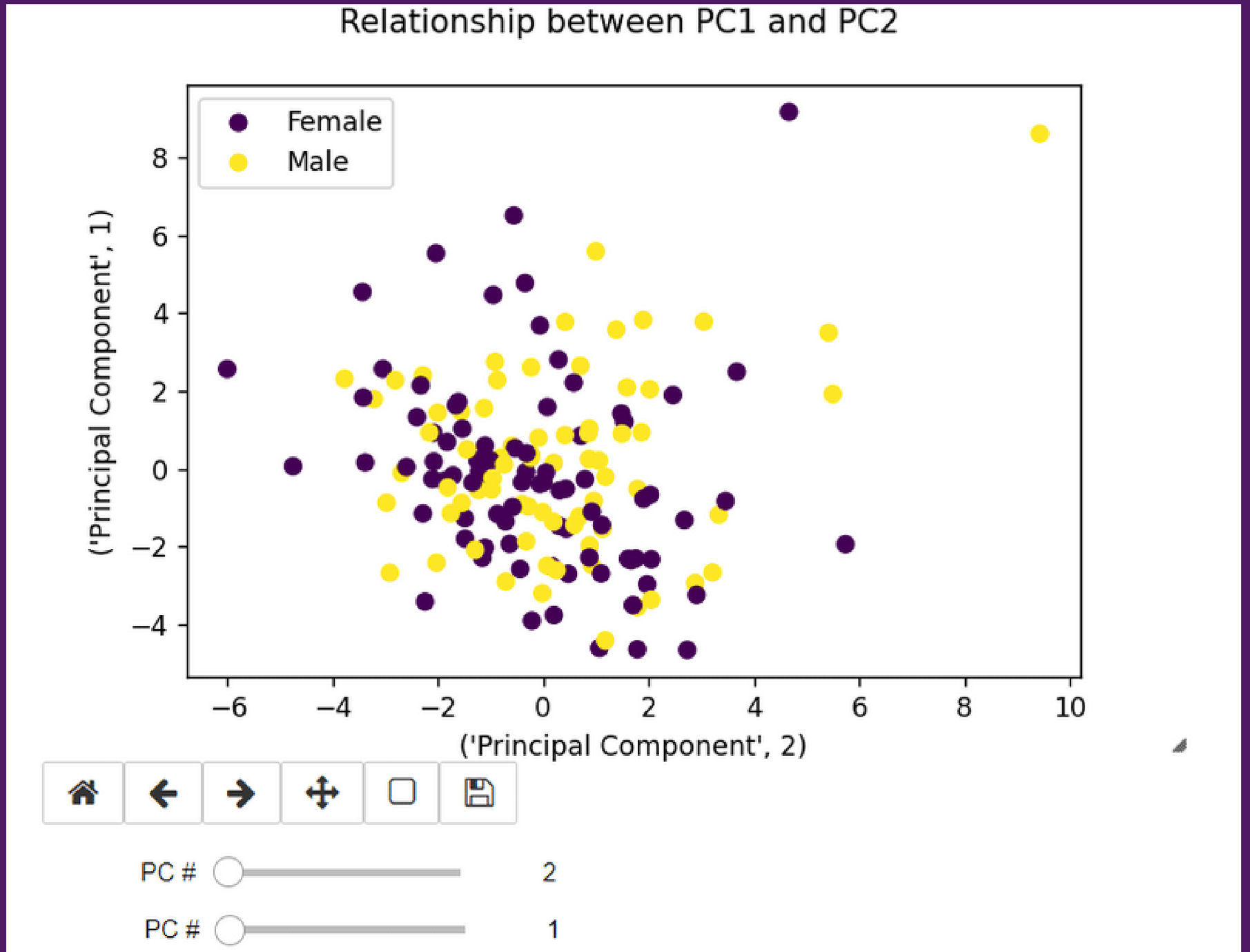
155 x 2016

Principal Component Analysis

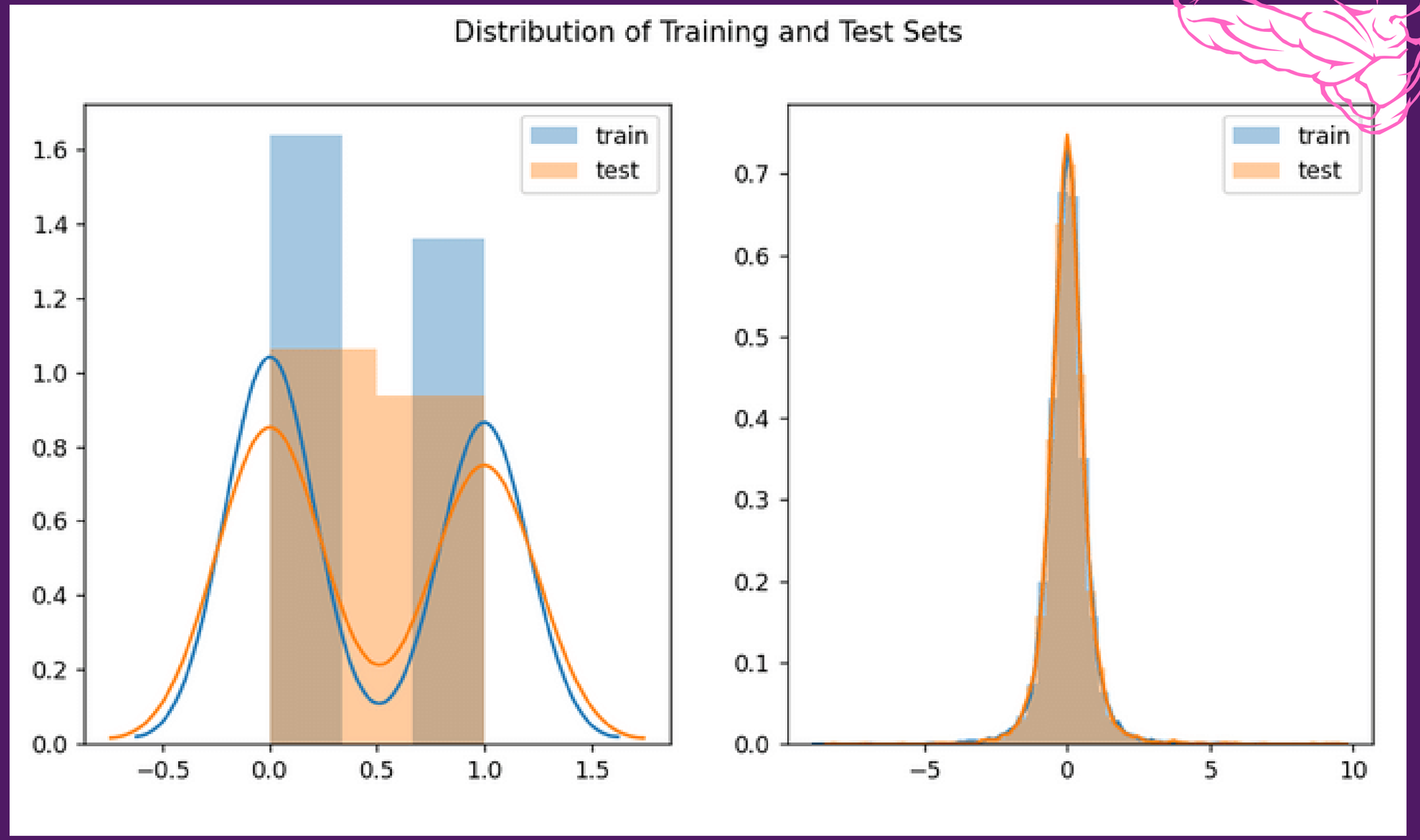
155 x 110

Scree Plot


cumulative explained variance
0
2
4
6
8
0
20
40
60
80
100
number of components


Relationship between PC1 and PC2
Female
Male
('Principal Component', 1)
('Principal Component', 2)
8
6
4
2
0
−2
−4
−6
−4
−2
0
2
4
6
8
10
PC #
2
PC #
1

Training and Test Dataset



CLASSIFICATION

CLASSIFIERS

- Logistic Regression
- K-Nearest Neighbors
- Multilayer Perceptron
- Gaussian Naive Bayes
- Decision Tree
- Random Forest

CROSS VALIDATION

10 FOLD

PERFORMANCE METRICS

- Accuracy
- ROC-AUC Curve
- F1 Score
- Confusion Matrix

Evaluation Metrics

Classification Model / Metrics	Accuracy	AUC	F1 Score	True Positive	False Positive	True Negative	False Negative
Logistic Regression	0.58	0.61	0.51	25	24	38	21
K-Nearest Neighbors	0.51	0.49	0.47	23	26	32	27
Multilayer Perceptron	0.6	0.59	0.47	20	29	45	14
Gaussian Naïve Bayes	0.47	0.48	0.32	16	33	35	24
Decision Tree	0.55	0.54	0.52	25	24	30	29
Random Forest	0.55	0.52	0.35	18	31	43	16

FUTURE GOALS

- To improve classification accuracy by:
  - Selecting those networks whose connectivity differ between male and female
  - Using advanced ML algorithms like PLS
  - Choosing different atlases
  - Using different and relevant dataset
- To explore Nilearn => RegionExtractor, Masker, plotting, atlases, seed based FC
- To implement Containerization using Docker
- More of Interactive plotting

Thank you Brainhack!