CLASSIFYING AND PREDICTING BRAIN ACTIVITY IN RESPONSE TO FACE STIMULI

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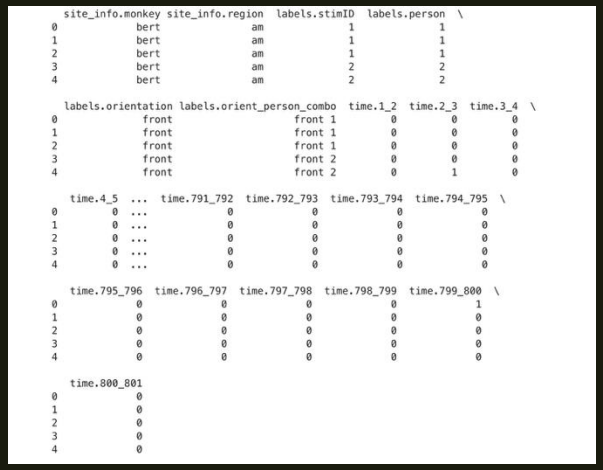
CMSE 381 – Section 001

Background and Motivation

- Study of brain responses to face stimuli
- Dataset: Freiwald_Tsao Faceviews (neural time-series)
- Goal 1: Classify which face was viewed
- Goal 2: Predict average brain activity levels
- Challenge: Extremely high-dimensional data (800 features)
- Opportunity: Find patterns in neural responses



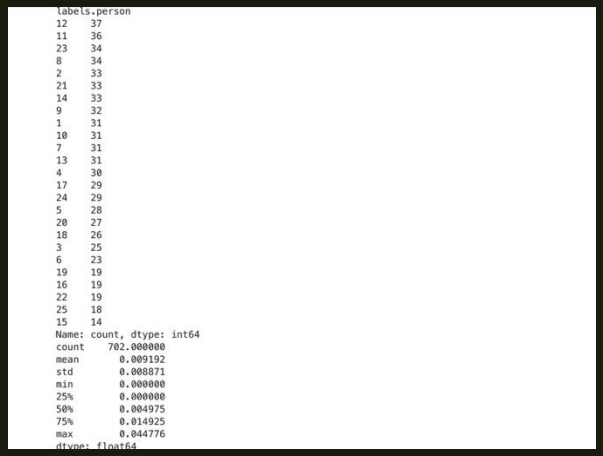
	site_info.monkey	site_info.region	labels.stimID	labels.person	\
0	bert	am	1	1	
1	bert	am	1	1	
2	bert	am	1	1	
3	bert	am	2	2	
4	bert	am	2	2	

	labels.orientation	labels.orient_person_combo	time.1_2	time.2_3	time.3_4	\
0	front	front 1	0	0	0	
1	front	front 1	0	0	0	
2	front	front 1	0	0	0	
3	front	front 2	0	0	0	
4	front	front 2	0	1	0	

	time.4_5	...	time.791_792	time.792_793	time.793_794	time.794_795	\
0	0	...	0	0	0	0	
1	0	...	0	0	0	0	
2	0	...	0	0	0	0	
3	0	...	0	0	0	0	
4	0	...	0	0	0	0	

	time.795_796	time.796_797	time.797_798	time.798_799	time.799_800	\
0	0	0	0	0	1	
1	0	0	0	0	0	
2	0	0	0	0	0	
3	0	0	0	0	0	
4	0	0	0	0	0	

	time.800_801
0	0
1	0
2	0
3	0
4	0



labels.person	
12	37
11	36
23	34
8	34
2	33
21	33
14	33
9	32
1	31
10	31
7	31
13	31
4	30
17	29
24	29
5	28
20	27
18	26
3	25
6	23
19	19
16	19
22	19
25	18
15	14

Name: count, dtype: int64

count	702.000000
mean	0.009192
std	0.008871
min	0.000000
25%	0.000000
50%	0.004975
75%	0.014925
max	0.044776

dtype: float64

Data Preprocessing

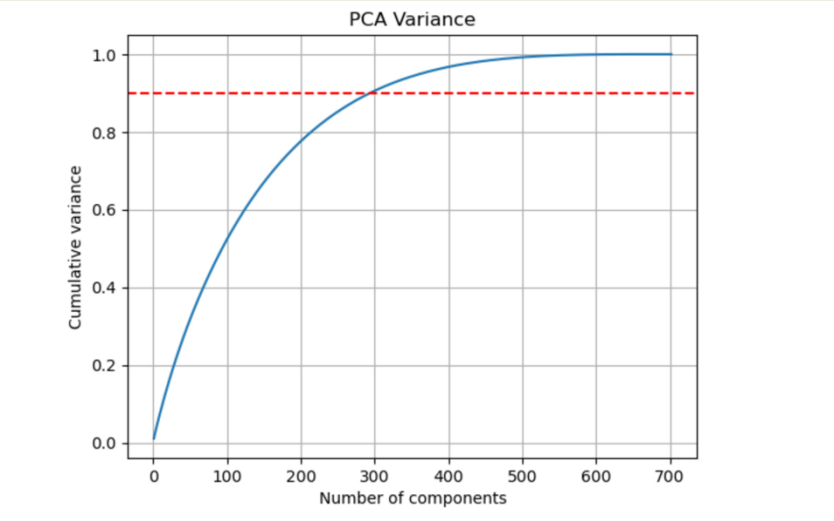
- Loaded and inspected neural time-series data
- Standardized all features to have zero mean, unit variance
- Applied Principal Component Analysis (PCA)
- Reduced features to 50 components (~95% variance retained)
- Addressed curse of dimensionality
- Prepared data for classification and regression tasks

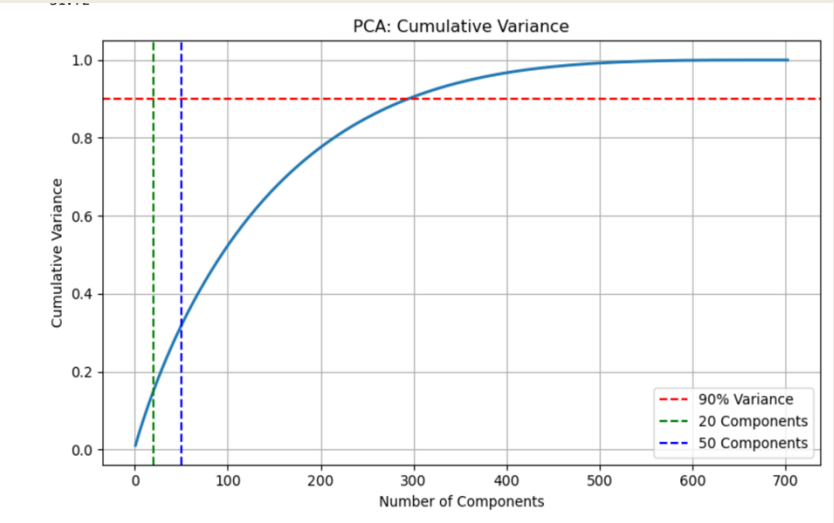
Classification Task

- Model used: Logistic Regression
- Dimensionality reduction via PCA before classification
- Hyperparameter tuning (C value) using GridSearchCV
- Validation: 5-fold cross-validation
- Target variable: Person shown in stimulus
- Goal: Achieve classification accuracy above random (33%)

Regression Task

- Model used: Linear Regression
- Response variable: Mean brain activity during stimulus
- PCA-reduced features used for regression
- Evaluation metric: R^2 score
- Objective: Positive R^2 indicates meaningful prediction
- Simplified the target to average activity per trial





Results Overview

- Classification Accuracy: ~[79.1%] (well above chance)
- Regression R^2 Score: [0.451] (positive)
- PCA captured ~95% variance with 50 components
- Reduced training time and avoided overfitting
- Clear patterns distinguish different individuals
- Models show strong potential with limited data

Synthesis and Future Work

- Brain activity patterns are distinguishable
- Classification performance above baseline
- Regression model explains meaningful variance
- Obstacle: Limited sample size, potential noise
- Future plan: Explore nonlinear models like SVM, RF
- Future plan: Use more complex features and ensemble models