Estimating Public Speaking Anxiety from bio-behavioral data

Abhishek Sinha, Apurva Purushotama, Sai Harini Voruganti , Rohan Chaudhury, Sherine Davis

PROBLEM STATEMENT

Develop a Machine Learning model to estimate the PSA levels based on the *VerBIO* dataset. The aim is to understand the effect of bio-behavioral features on the individuals' affective responses while performing public speaking tasks

METHODS

- Correlation between various bio-behavioral features with State Anxiety levels were analyzed
- *SelectKBest* filter method with *f_regression* as score function and Recursive Feature Elimination (RFE) wrapper method with Gradient Boosting regressor as optimizer were used to obtain the features that yielded the most information
- FNN model with ReLU activation and Adam optimizer was built. Further, the model was trained on the data obtained from below methods:
    - PCA was used to reduce the dimensionality of the features
    - For the HR and EDA data of each participant, coefficients were computed using linear/polynomial regression
- LSTM, RNN and GRU models were used to estimate the anxiety labels based on the temporal data
- Segregated the data based on native and non-native speakers to build group-specific models
- Visualized the significance of individual features in determining the State Anxiety of the participant through FNN & LSTM

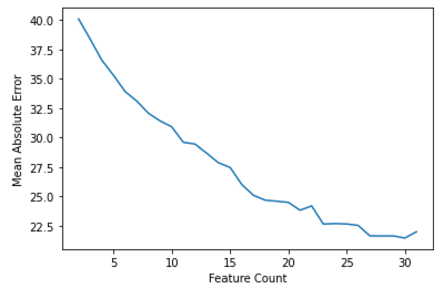
OBSERVATIONS

- RMSEnergy & BVP are the most and least correlated features with respect to State Anxiety label, based on Pearson Correlation Coefficient.
- *SelectKBest* filter method yielded the least error with 21 features.
- FNN coupled with PCA, dimensionality reduced to 2, resulted in improved mean absolute errors.
- GRU & RNN models achieved the lowest mean absolute errors using EDA & HR temporal data.
- Speech Voicing Probability, Fundamental Frequency and Pause Frequency are the most correlated features with respect to Anxiety label for non-native speakers as opposed to the Heart Rate and RMSEnergy for native speakers.

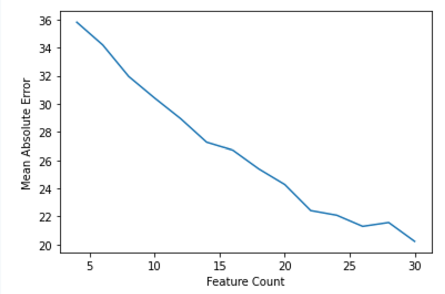
- **LSTM & GRU performs best with the temporal data**
- **Language based segregation of data, helps in devising higher accuracy models and gaining insights on correlations**

RESULTS

Filter based feature selection



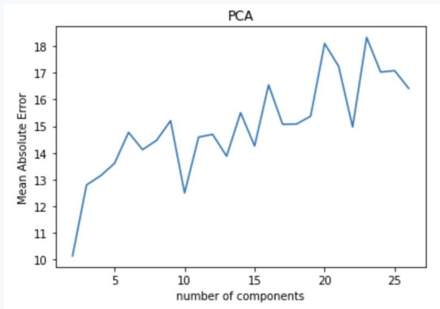
Wrapper based feature selection



Top 10 correlating features

Feature	Label	Corr	Abs
RMSenergy	StateAnxiety	-0.236090	0.236090
meanHR	StateAnxiety	-0.217042	0.217042
HR	StateAnxiety	-0.217042	0.217042
ACC	StateAnxiety	-0.216606	0.216606
IBI	StateAnxiety	0.183156	0.183156
mfcc[9]	StateAnxiety	-0.167732	0.167732
varHR	StateAnxiety	-0.165264	0.165264
mfcc[1]	StateAnxiety	-0.125903	0.125903
mfcc[10]	StateAnxiety	0.125598	0.125598
TEMP	StateAnxiety	-0.120541	0.120541

PCA based dimensionality reduction



Experimentation Results

Model	Feature Selection	Feature Count	MAE	Datatype
FNN	-	32	23.778	All
FNN	Filter Methods	30	21.471	All
FNN	Wrapper Methods	30	19.414	All
FNN	PCA	26	15.685	Non-Temporal
SimpleRNN	-	2	9.456	Temporal
GRU	-	2	9.483	Temporal
LSTM	-	2	8.454	Temporal
FNN	Native speakers	26	12.737	Non-Temporal
FNN	Non-Native speakers	26	14.307	Non-Temporal

LIME – Interpretable ML