
Classification of Emotional States with Facial Action Units

Ajani Blackwood & Atharva Manjrekar

Background

What is the FACS (Facial Action Coding System)?

- Based on a system originally developed by a Swedish anatomist named Carl-Herman Hjortsjö, later adopted by Paul Ekman, Wallace V. Friesen, and Joseph C. Hager
 - Assigns muscle movements to what are called **facial action units (AUs)**,
 - **Some combined muscle movements (AUs) denote an emotion**

Table 1: Emotions denoted by combinations of AUs

Emotion	Action Units
Happiness	6 & 12
Sadness	1, 4 & 15
Surprise	1, 2, 5B, & 26
Fear	1, 2, 4, 5, 7, 20 & 26
Anger	4, 5, 7 & 23
Disgust	9, 15 & 17
Contempt	R12A & R14A

Muscle movements denoted by **action units (AUs)**, have Intensity from 0 - 5

- 0 for no muscle contraction
- 5 for maximum muscle contraction



Figure 1: AU6 (Cheek Raiser), *Orbicularis oculi (pars orbitalis)*, IMOTIONS

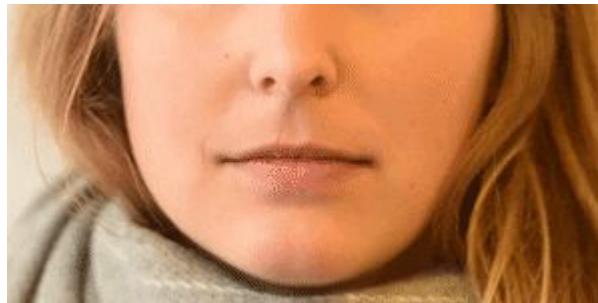


Figure 2: AU12 (Lip Corner Puller), *Zygomatic Major*, IMOTIONS

Motivation

3

Hypothesis: Facial action units that solely depict movements for the top portion of face are good predictors of emotion

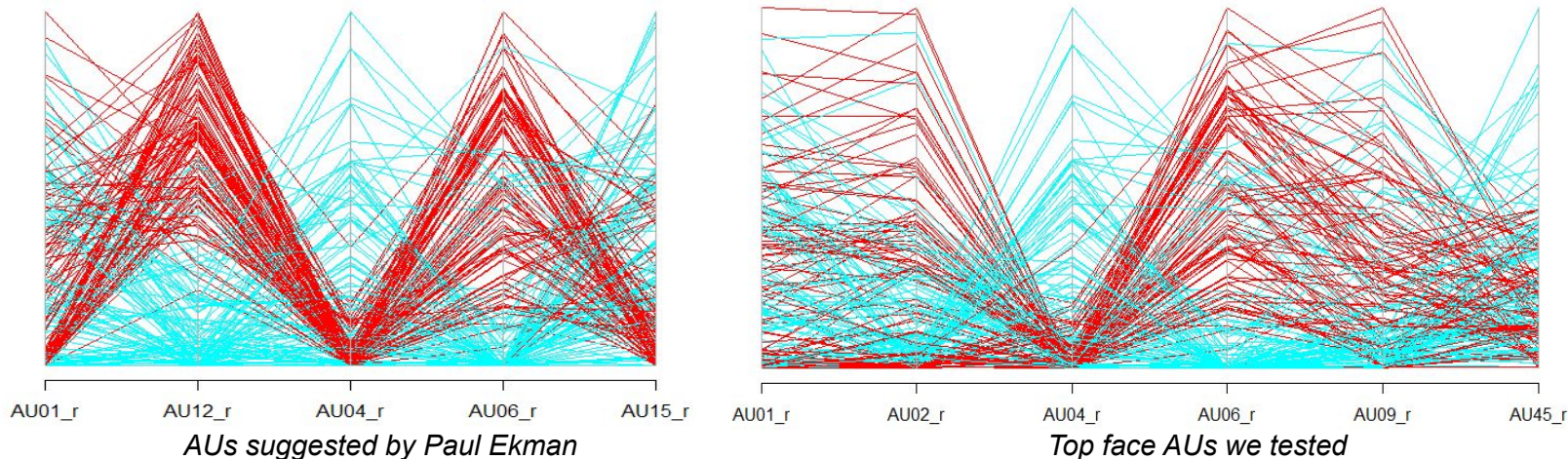
Problem: Face masks hide the bottom face. We wanted to test if top of face AUs are effective for emotional classification

- We should solve it in an attempt to mathematically reproduce the findings of Ekman, Friesen, & Hjortsjö

Our model relies on AUs of the top face to differentiate between **happiness** and **sadness**.

Parallel Coordinate Plots Showing Differentiation of Emotions by AU

Red: Happiness Blue: Sadness



Our Method

Dataset has 24 actors (12 men, 12 women) with multiple trials acting out an emotion. **Each trial is one emotion only (no transitions)**

1. Identify topface AU values having population mean of intensity ≥ 0.5
2. Take average of topface AU's per trial
3. Combine men and women with all their trials in a new dataset
4. Assign labels denoting the **known emotional state** (happy, sad)
5. Predict labels

The idea is that multiple face snapshots (observations) through time can be averaged into one image (set of AUs)

Current Methods

An HMM based Model for Prediction of Emotional Composition of a Facial Expression using both Significant and Insignificant Action Units and Associated Gender Differences

Authors: Suvashis Das, et al., 2012

Classification of Upper and Lower Face Action Units and Facial Expressions using Hybrid Tracking System and Probabilistic Neural Networks

Authors: Seyedarabi, Lee, et al., 2006

Results (Variable Importance)

5

Random Forest Accuracy Scores and Variable Importance (Red: Happiness , Blue: Sadness)

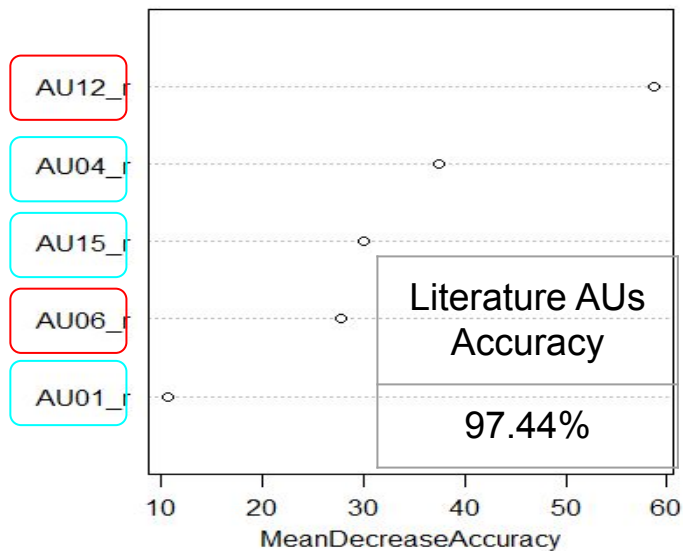


Figure 5: (Literature) Importance of AUs for Classification

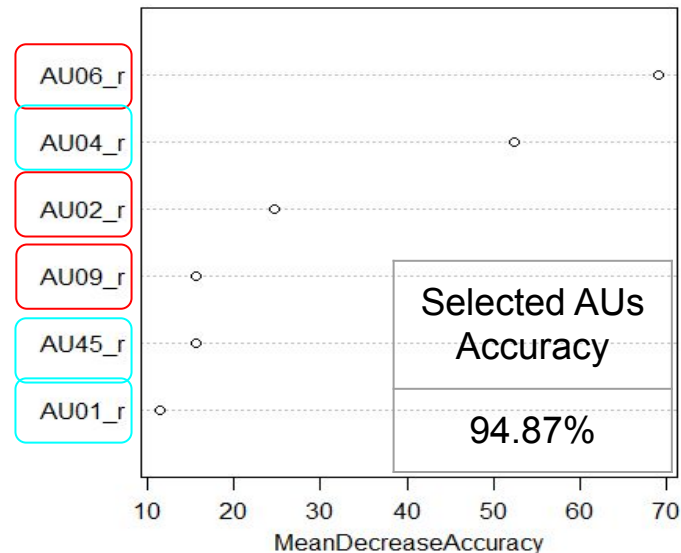


Figure 6: (Tested AUs) Importance of AUs for Classification

- Results mostly match the literature by Paul Ekman with some differences

Results (Classification)

6

192 Shuffled Observations (Happy and Sad)

Table 3: Dataframe of AU's by Literature (Sad & Happy)

	Emotion	AU01_r	AU12_r	AU04_r	AU06_r	AU15_r
180	S	0.2524218750	0.5303906250	0.6413281250	0.0132812500	0.3500000000
90	H	0.1287931034	1.4312931034	0.0000000000	0.5222413793	0.7445689655
133	S	0.4532432432	0.1419819820	1.8808108108	0.0000000000	0.0713513514
74	H	0.6558139535	1.2935658915	0.1936434109	1.9344186047	0.2046511628
141	S	1.0709677419	1.5086290323	2.4508064516	1.4654032258	0.7956451613

Table 4: Dataframe of top face AU's we choose (Sad & Happy)

	Emotion	AU01_r	AU02_r	AU04_r	AU06_r	AU09_r	AU45_r
177	S	1.5011926606	0.3458715596	0.5637614679	0.0089908257	6.146789e-03	1.011743119
132	S	2.3467424242	0.4679545455	1.3501515152	0.2606818182	8.469697e-02	0.563712121
26	H	1.4612068966	1.9327586207	0.0000000000	1.0419827586	6.823276e-01	0.261465517
162	S	0.0000000000	0.2308490566	0.0017924528	0.0000000000	4.203774e-01	0.123113208
75	H	2.6573387097	3.5749193548	0.0000000000	0.9466129032	8.548387e-03	1.306209677

Table 5: Accuracy scores for AUs by Literature (Sad & Happy)

Algorithms	Gaussian NB	Logistic Reg	SVM (rbf)	K-NN	Random Forest
Accuracy Scores	92.3%	94.87%	97.43%	92.31%	97.44%

Table 6: Accuracy scores for top face AUs we choose (Sad & Happy)

Algorithms	Gaussian NB	Logistic Reg	SVM (rbf)	K-NN (n=21)	Random Forest
Accuracy Scores	82.05%	89.74%	97.4%	89.74%	94.87%

Summary

- **Implications:** Results show AU4 and AU6 to be strong in differentiating happiness and sadness
 - Psychotherapists, interviewers, and anyone working in communications may know what specific facial features to focus on in general
- **Interpretation:** Results show AUs representing top face muscle movement are good predictors of an emotional state.
 - Works well for both sexes
- **Further Work:** Further research may suggest using different sets of AUs



AU4 (Brow Lowerer), Depressor Glabellae, Depressor Supercilli, Currugator, IMOTIONS



AU6 (Cheek Raiser), Orbicularis oculi (pars orbitalis), IMOTIONS

Thank you, please ask any questions.

References

[untitled \(upenn.edu\)](#)




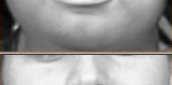






[An HMM based Model for Prediction of Emotional Composition of a Facial Expression using both Significant and Insignificant Action Units and Associated Gender Differences \(ijcaonline.org\)](#)

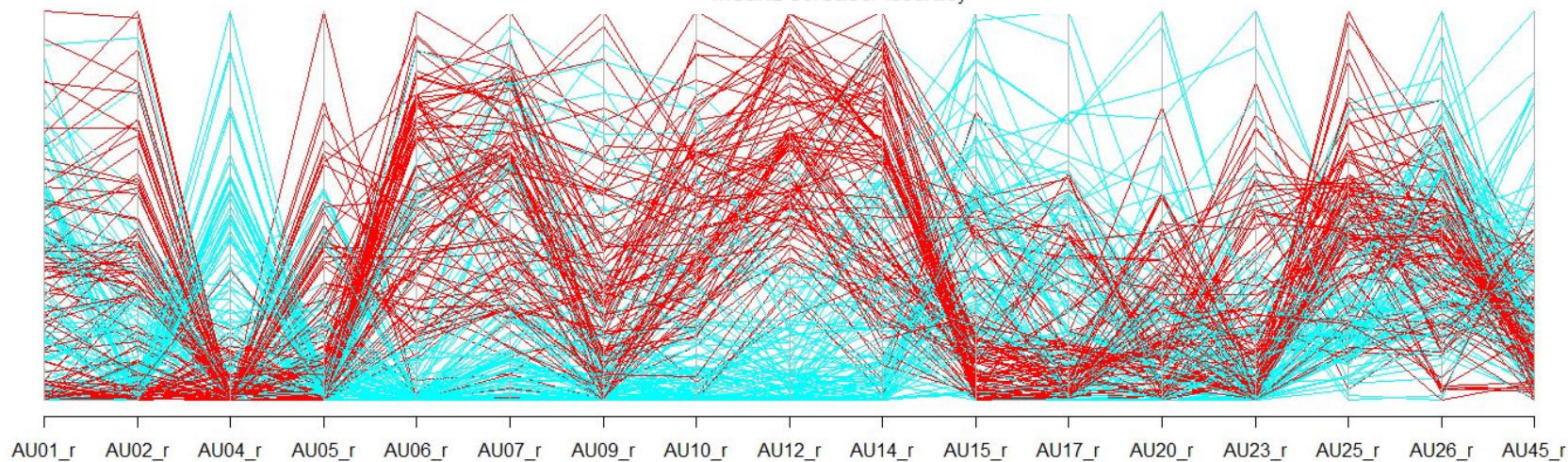
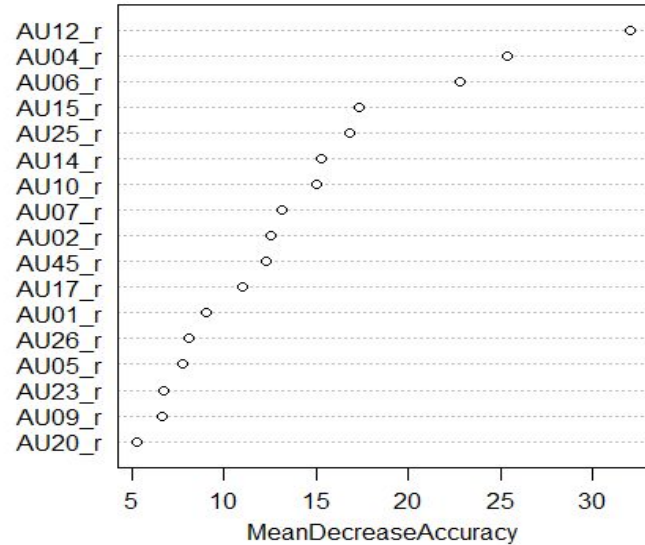
[Emotion recognition using facial expressions - ScienceDirect](#)

[\(PDF\) Automatic Lip Tracking and Action Units Classification using Two-Step Active Contours and Probabilistic Neural Networks \(researchgate.net\)](#)

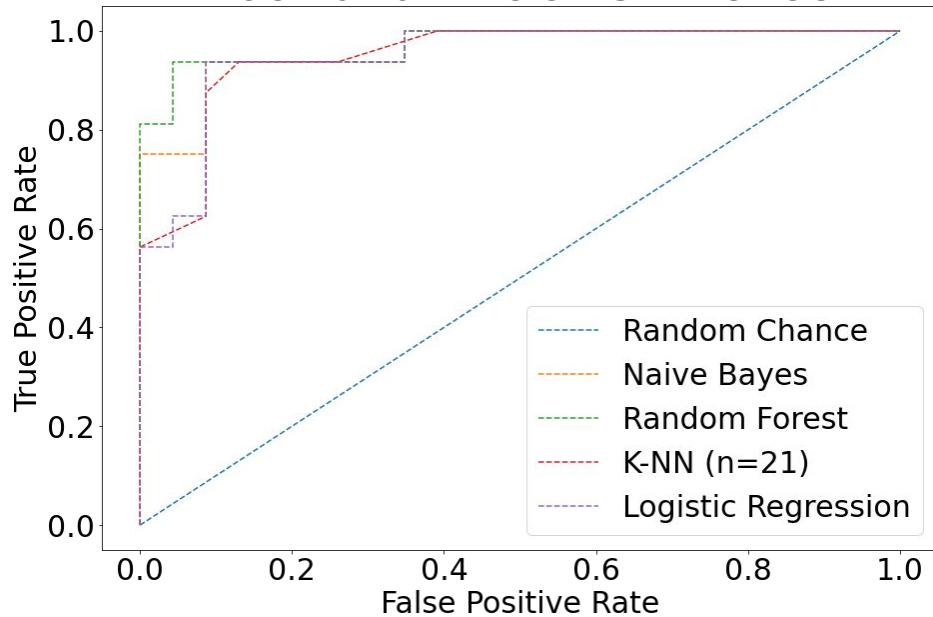
Top of Face AUs

AU	Description	Facial muscle	Example image
1	Inner Brow Raiser	<i>Frontalis, pars medialis</i>	
2	Outer Brow Raiser	<i>Frontalis, pars lateralis</i>	
4	Brow Lowerer	<i>Corrugator supercilii, Depressor supercilii</i>	
5	Upper Lid Raiser	<i>Levator palpebrae superioris</i>	
6	Cheek Raiser	<i>Orbicularis oculi, pars orbitalis</i>	
7	Lid Tightener	<i>Orbicularis oculi, pars palpebralis</i>	
9	Nose Wrinkler	<i>Levator labii superioris alaeque nasi</i>	
10	Upper Lip Raiser	<i>Levator labii superioris</i>	

<u>10</u>	Upper Lip Raiser	<i>Levator labii superioris</i>			
11	Nasolabial Deepener	<i>Zygomaticus minor</i>			
<u>12</u>	Lip Corner Puller	<i>Zygomaticus major</i>			
13	Cheek Puffer	<i>Levator anguli oris (a.k.a. Caninus)</i>			
14	Dimpler	<i>Buccinator</i>			
<u>15</u>	Lip Corner Depressor	<i>Depressor anguli oris (a.k.a. Triangularis)</i>			
16	Lower Lip Depressor	<i>Depressor labii inferioris</i>			
<u>17</u>	Chin Raiser	<i>Mentalis</i>			
18	Lip Pucker	<i>Incisivii labii superioris and Incisivii labii inferioris</i>			
<u>20</u>	Lip stretcher	<i>Risorius w/ platysma</i>			



ROC Plot for Different SVM Kernels



ROC Plot for Different SVM Kernels

