Facial Expression Recognition

Group 7   Bao, Weijia   Guo, Xudong   Liu, Jiyuan

Liu, Yanyan   Lu, Haotian (Presenter)

Workflow

Initial Assessment (1)

- **2500** Samples

- **22** Balanced Emotion Categories

- Suggested Features:
  - Fiducial points
  - Euclidean distances

Angrily disgusted	Angrily surprised	Angry	Appalled
123	122	118	112
Awed	Disgusted	Disgustedly surprised	Fearful
106	104	113	114
Fearfully angry	Fearfully disgusted	Fearfully surprised	Happily disgusted
117	115	127	109
Happily surprised	Happy	Hatred	Neutral
120	114	107	112
Sad	Sadly angry	Sadly disgusted	Sadly fearful
135	107	110	111
Sadly surprised	Surprised		
95	109		

Initial Assessment (2)

- Number of Features
  - *< 100*

- Complexity of the Model

KNN	LDA	k SVM	GBM	RF	CNN
✔	✔	✔	?	?	✘

COMPLEXITY

- Evaluation Metric
  - Sensitivity vs. Specificity

	Reference	
Predicted	Event	No Event
Event	A	B
No Event	C	D

The formulas used here are:

$$Sensitivity = \frac{A}{A + C}$$

$$Specificity = \frac{D}{B + D}$$

Round 1 Feature Engineering

- Euclidean distances
  - 3003 Distinctive pairs, $\binom{78}{2} = 3003$
  - Standardize distances
    - Comparable
    - Note: *standardize after train-test split*

$$z(X) = \frac{X - \overline{X}}{std(X)}$$

$$Xtr_s = \frac{Xtr - \overline{Xtr}}{std(Xtr)}$$

$$Xte_s = \frac{Xte - \overline{Xtr}}{std(Xtr)}$$

Round 1 Feature Selection

1. **Greedy** algorithm - *quick!*
2. **Forward** > backward - ❌ *curse of dimensionality*
3. **SFFS** > SFS - *allowing removing selected features*

10 Extracted Distance Features

Point 7 & 21 (Inner corner of right eye to right brow ridge)   Point 11 & 49

Point 10 & 33 (Left pupil to left brow ridge)   Point 12 & 55
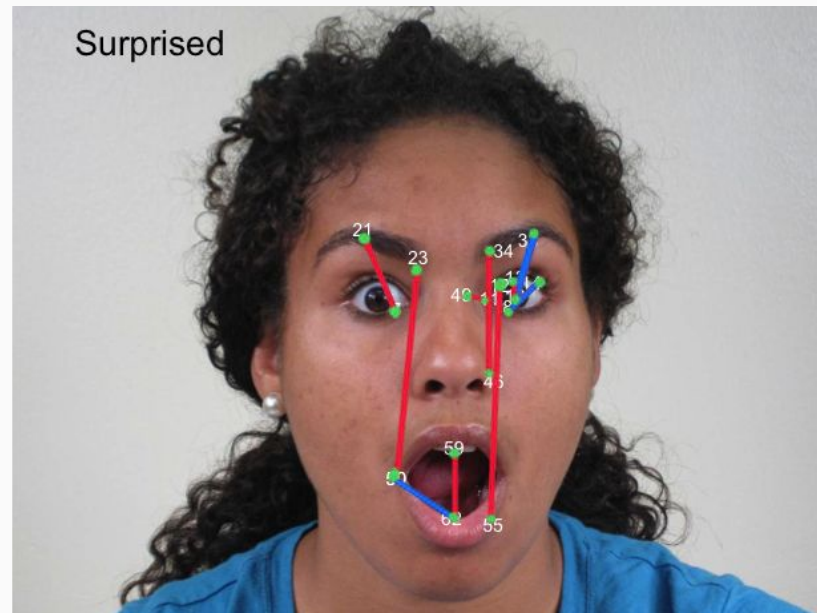
Point 10 & 13 (Radius of left pupil)   Point 14 & 18

Point 23 & 50 (Right eyebrow to right lip corner)   Point 34 & 46

Point 50 & 62 (Mouse open extend)   Point 59 & 62

Surprised

Round 1 Model 10

Goal: Solve underfit

Employ diverse complexity models to optimize our model

	KNN	LDA	(k) SVM
Train accuracy (%)	44.3	44	47.8
Training time	<1 sec	<1 sec	120 sec
Test accuracy (%)	37	41.6	43.8
Bad performance classes (*sensitivity <30% or balanced accuracy < 60%*)	10, 12, 13, 19, 20, 22	12, 13, 19, 20, 22	10, 11, 13, 19, 20, 22

- We also applied **GBM** and **Random Forest** models, but they both delivered similar results to SVM and consumed more time.

Round 1 Inference

6 Worst Emotion Classes
10(Sadly Angry)
12(Appalled)
13(Hatred)
19(Sadly fearful)
20(Fearfully disgusted)
22(Sadly disgusted)

- All <u>compound</u> emotions

- Mostly associated with sad and fear

- Linear distances are <u>not enough</u>

Round 2 Feature Engineering

Goal: Solve 6 worst emotions' underfit

Add nonlinear feature[1] (Area)

- Why: ***Extreme muscle contraction/extraction(s) in 6 worst emotions***

- How to: $\binom{10}{2} = 45$ # ***10*** extracted features from round 1

Round 2 Model 55

|	KNN	LDA	(k) SVM
Train accuracy (%)	43	48	57.4
Training time	<1 min	< 1 min	305 sec
Test accuracy (%)	36.4	38	41.8
*Relative bad performance (*sensitivity <30% or balanced accuracy < 60%*)	10, 12, 13, 19, 20, 21, 22	11, 13, 19, 20, 22	13, 17, 19, 20, 22

Round 3 Feature Selection

Goal: Further improve round 2 (3 worst emotion classes left)

Add nonlinear feature[2] (Slope)

- Why:
  - Visually checked the worst 3 classes
  - Slope cannot be approximated by either distance/area
- How to:
  - Manually add 14 slopes
    - Eyebrow: 8
    - Nose: 2
    - Mouth: 4

Final Model Performance
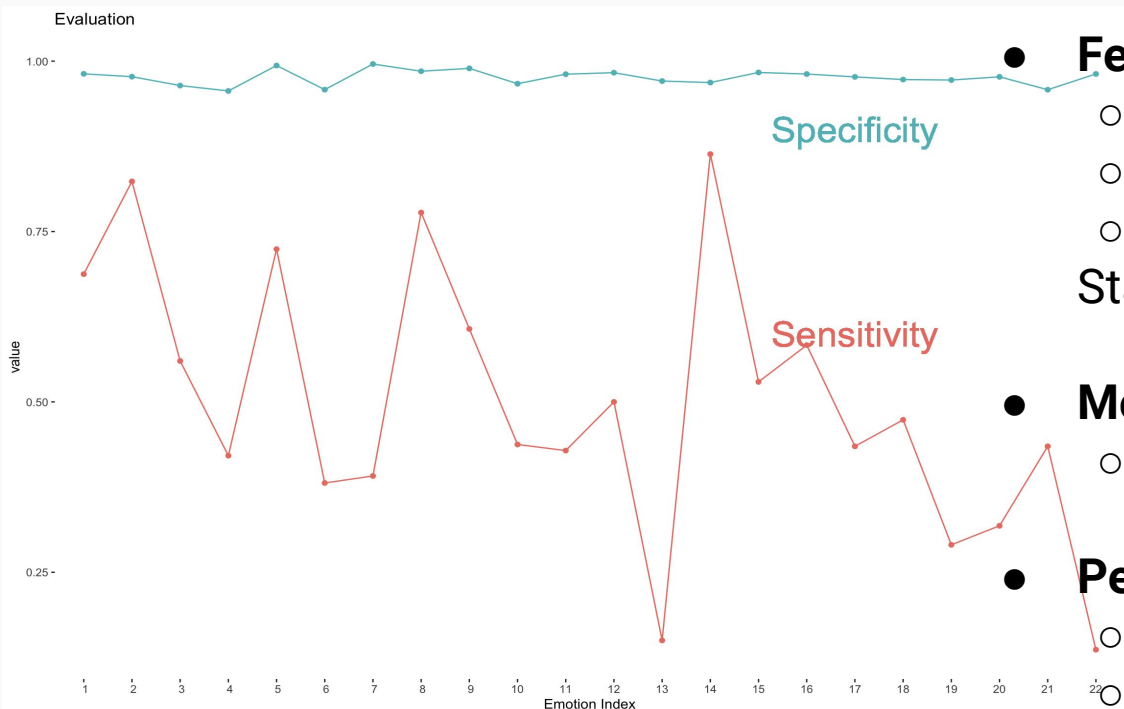
- **Features**(# 69)
  - 10 distance
  - 45 areas
  - 14 slopes

  Standardized distances, area & slope

- **Model**: **Kernel-Based SVM model**
  - Radio kernel

- **Performance**
  - 2 worst classes (<0.20 sensitivity)
  - **Neither** underfit nor overfit
  - Test accuracy: around 49.8%

Thank You
谢谢
ありがとう
Dunke
阿牛哦