Facial Emotion Recognition

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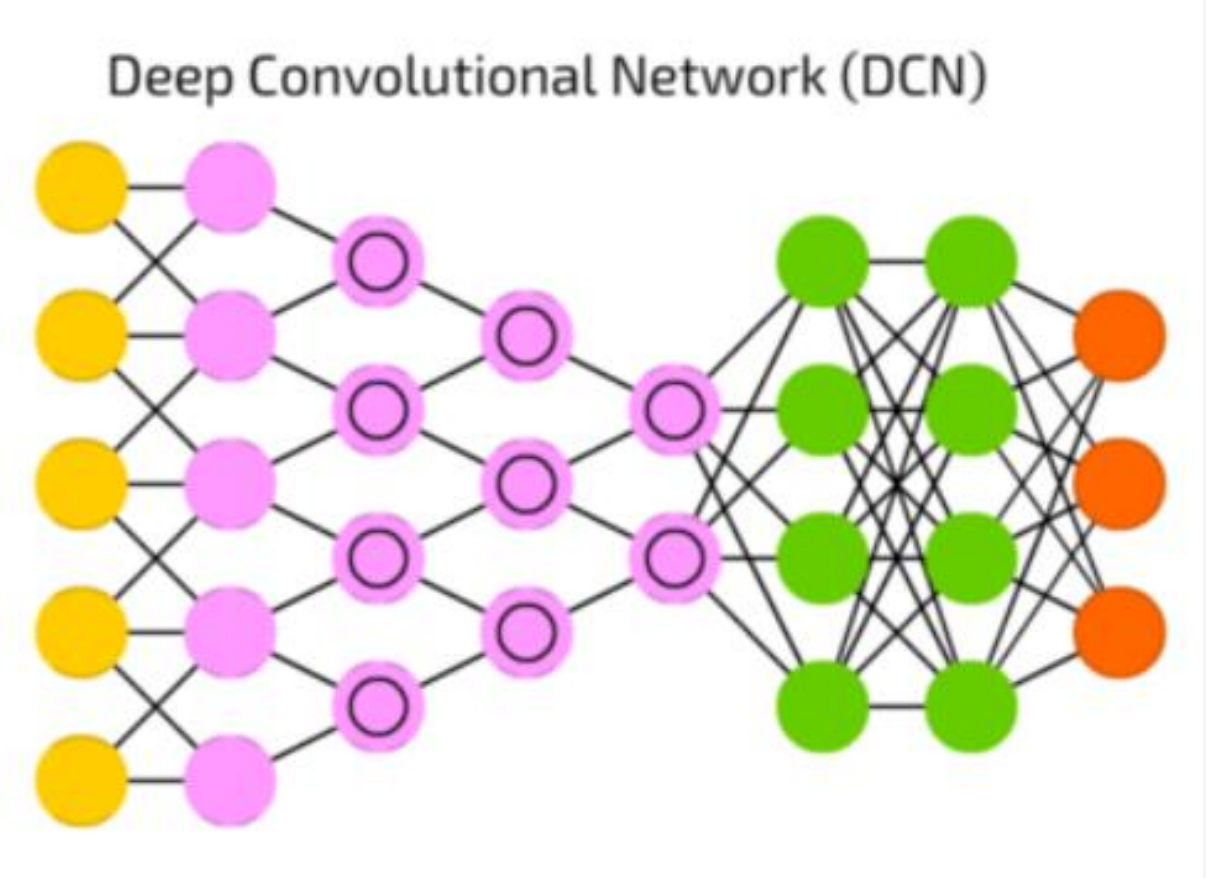
INTRODUCTION

Facial emotion recognition holds significant importance in various business contexts due to its potential impact on customer experience, employee well-being, and overall business performance.

- **Gauge customer reactions to products, services, or advertisements.**
- **Facial emotion recognition can help businesses assess customer satisfaction levels in real time.**
- **Businesses that prioritize employee well-being often leverage facial emotion recognition to monitor and assess the emotional states of their workforce.**

OBJECTIVE

1. **Train traditional machine learning models to classify facial emotions**
2. **Train a convolutional neural network to classify facial emotions**
3. **Compare results**



DATA

Fer2013 Dataset:

A collection of 35887 labeled images of people's facial expressions.



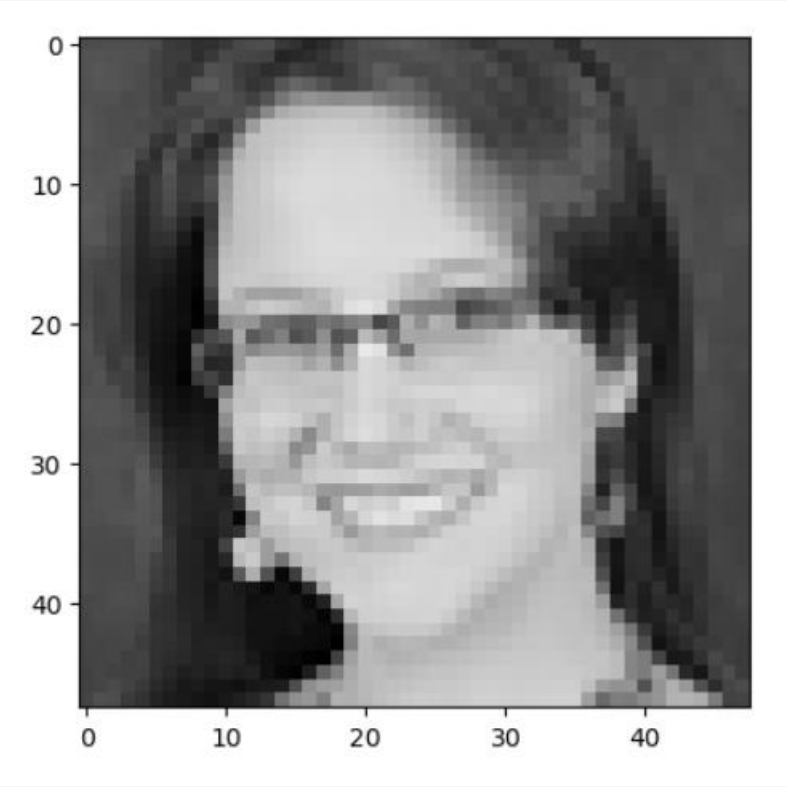



emotion	pixels	Usage
0	70 80 82 72 58 58 60 63 54 58 60 48 89 115 121 119 115 110 98 91 84 84 90 99 110 126 143 153 158 171 169 172 169 165 129 110 113 107 95 79 66 62 56 57 61 52 43 41 65 61	Training
0	151 150 147 155 148 133 111 140 170 174 182 154 153 164 173 178 185 185 189 187 186 193 194 185 183 186 180 173 166 161 147 133 172 151 114 161 161 146 131 104 95 1	Training
2	231 212 156 164 174 138 161 173 182 200 106 38 39 74 138 161 164 179 190 201 210 216 220 224 222 218 216 213 217 220 220 218 217 212 174 160 162 160 139 135 137 131	Training
4	24 32 36 30 32 23 19 20 30 41 21 22 32 34 21 19 43 52 13 26 40 59 65 12 20 63 99 98 98 111 75 62 41 73 118 140 192 186 187 188 190 190 187 182 176 173 172 173 25 34 29 35	Training
6	4 0 0 0 0 0 0 0 0 0 0 0 3 15 23 28 48 50 58 84 115 127 137 142 151 156 155 149 153 152 157 160 162 159 145 121 83 58 48 38 21 17 7 5 25 27 24 25 1 0 0 0 0 0 0 0 0 0 0 6 18 26 3	Training
2	55 55 55 55 55 54 60 68 54 85 151 163 170 179 181 185 188 188 191 196 189 194 198 197 195 194 190 193 195 184 175 172 161 159 158 159 147 136 137 136 146 120 86 93 11	Training
4	20 17 19 21 25 38 42 42 46 54 56 62 63 66 82 108 118 130 139 134 132 126 113 97 126 148 157 161 155 154 154 164 189 204 194 168 180 188 214 214 214 216 208 220 205 18	Training
3	77 78 79 79 78 75 60 55 47 48 58 73 77 79 57 50 37 44 56 70 80 82 87 91 86 80 73 66 54 57 68 69 68 68 49 46 75 71 69 70 70 72 72 71 72 74 77 76 83 84 82 81 81 69 60 60 46 57	Training
3	85 84 90 121 101 102 133 153 153 169 177 189 195 199 205 207 209 216 221 225 221 220 218 222 223 217 220 217 211 196 188 173 170 133 117 131 121 88 73 73 50 27 34 32	Training

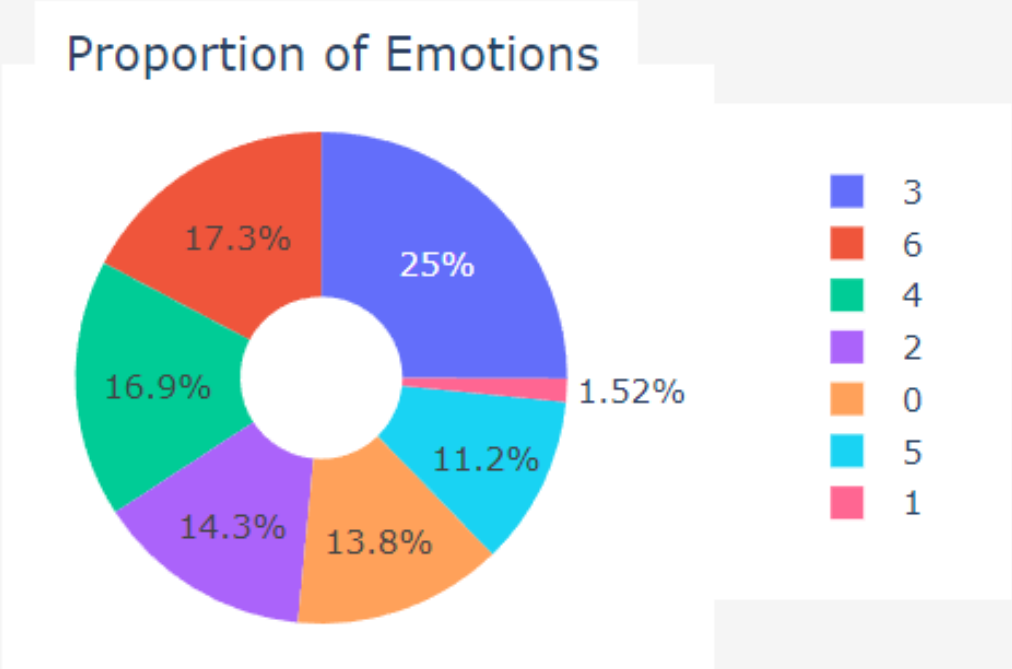
Source: https://www.kaggle.com/datasets/ashishpatel26/facial-expression-recognitionferchallenge/data

DATA

```
labels=['Angry', 'Disgust', 'Fear', 'Happy', 'Sad', 'Surprise', 'Neutral']
```



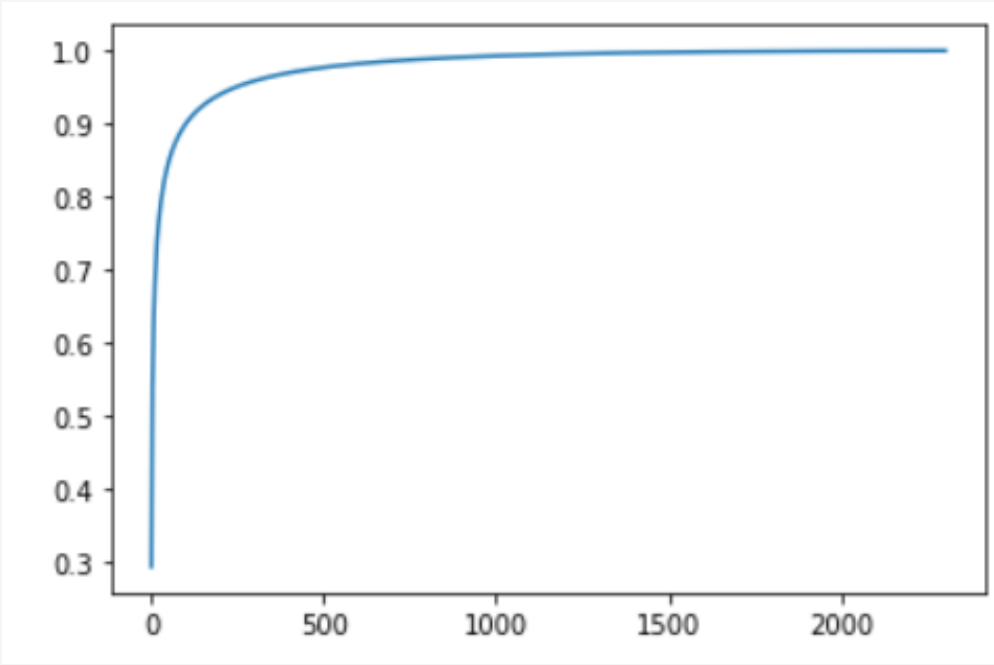
48 x 48 pixels = 2304 features

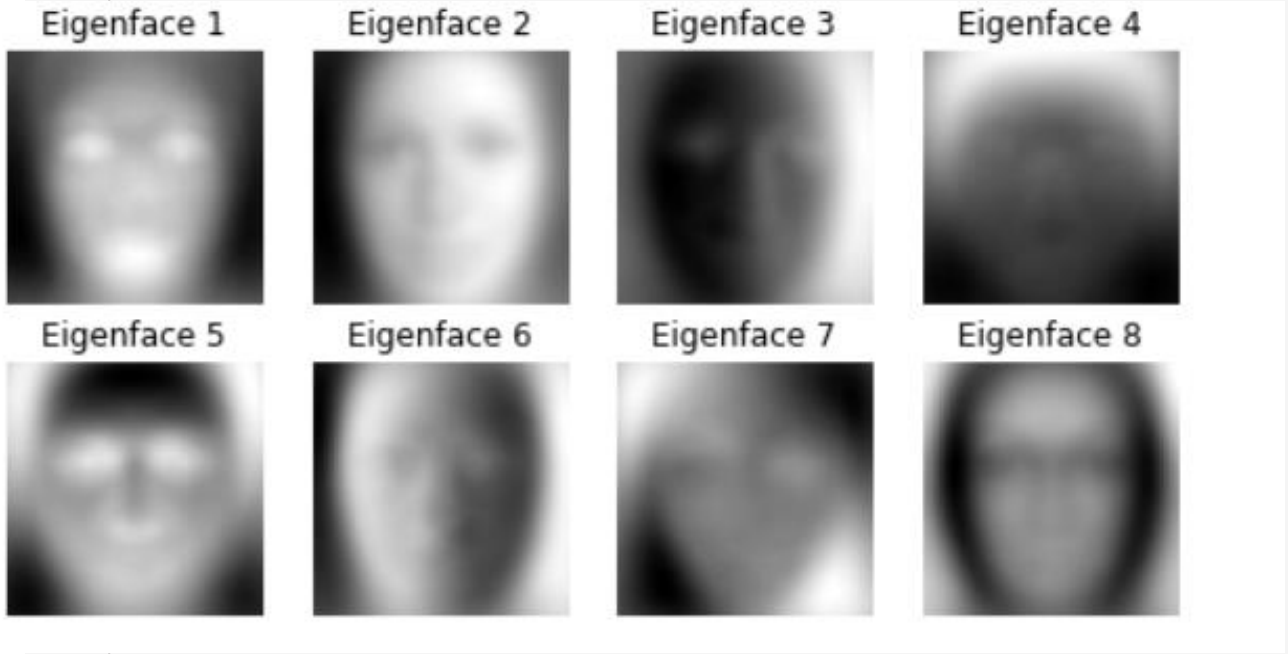


Source: https://www.kaggle.com/datasets/ashishpatel26/facial-expression-recognitionferchallenge/data

PRINCIPAL COMPONENT ANALYSIS

2304 Feature → 253 Feature





DECISION TREE CLASSIFIER

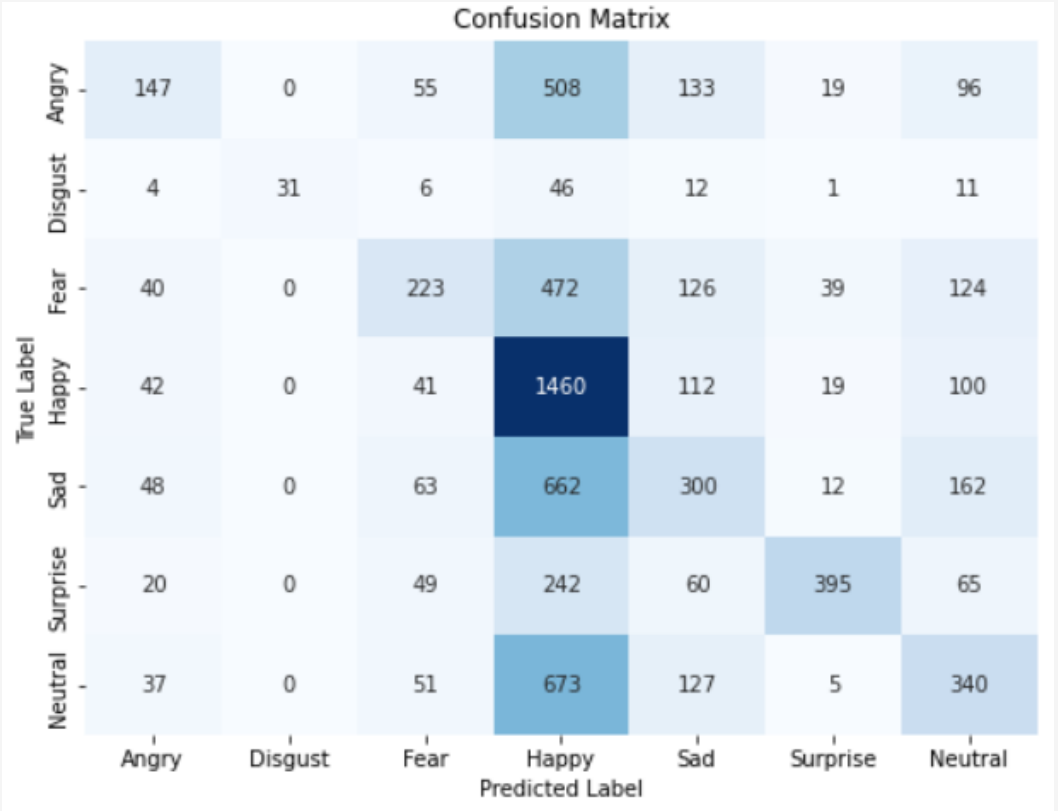
DecisionTree Classifier is choosen as base model because it can do multi-label classification.

```
accuracy: 0.29
precision: 0.29
recall: 0.29

Classification Report:
              precision    recall  f1-score   support

       Angry       0.23      0.25      0.24       958
     Disgust       0.31      0.31      0.31       111
        Fear       0.27      0.28      0.28      1024
       Happy       0.37      0.35      0.36      1774
         Sad       0.22      0.20      0.21      1247
    Surprise       0.42      0.46      0.44       831
     Neutral       0.24      0.24      0.24      1233

    accuracy                           0.29      7178
   macro avg       0.29      0.30      0.30      7178
weighted avg       0.29      0.29      0.29      7178
```

RANDOM FOREST CLASSIFIER

Random Forest is another machine learning algorithm that can do multi-label classification.

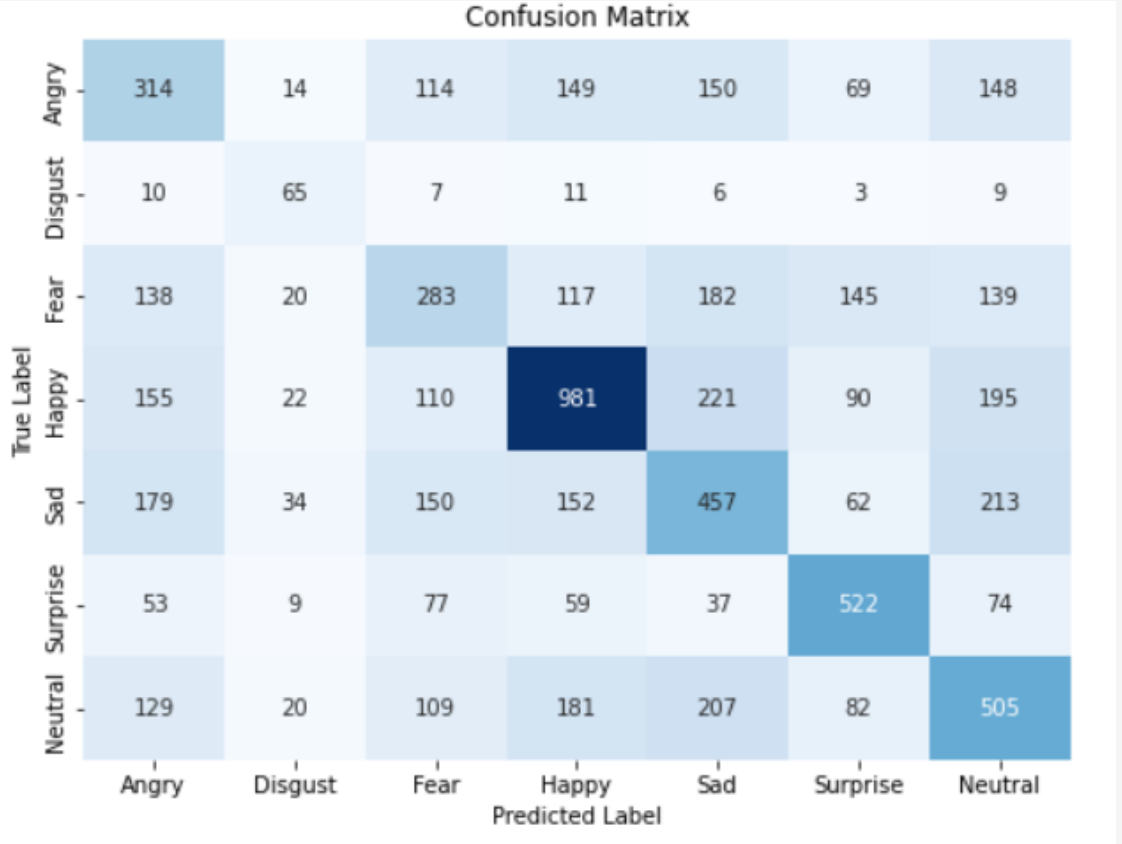
```
accuracy: 0.40
precision: 0.45
recall: 0.40

Classification Report:
              precision    recall  f1-score   support

       Angry       0.43      0.15      0.23       958
     Disgust       1.00      0.28      0.44       111
        Fear       0.46      0.22      0.29      1024
       Happy       0.36      0.82      0.50      1774
         Sad       0.34      0.24      0.28      1247
    Surprise       0.81      0.48      0.60       831
     Neutral       0.38      0.28      0.32      1233

    accuracy                           0.40      7178
   macro avg       0.54      0.35      0.38      7178
weighted avg       0.45      0.40      0.38      7178
```



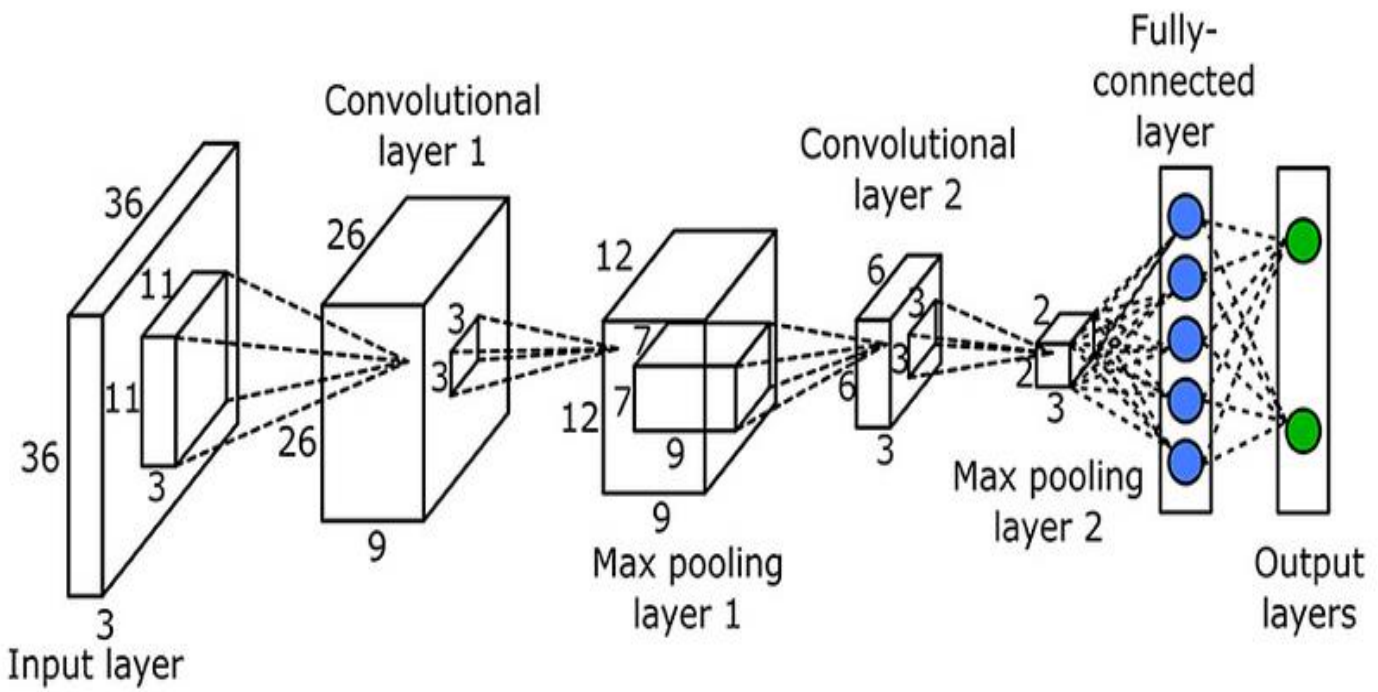
SVM CLASSIFIER

Sklearn's SVM algorithm supports multi-label classification.

```
accuracy: 0.44
precision: 0.44
recall: 0.44

Classification Report:
              precision    recall  f1-score   support

       Angry       0.32      0.33      0.32       958
     Disgust       0.35      0.59      0.44       111
        Fear       0.33      0.28      0.30      1024
       Happy       0.59      0.55      0.57      1774
         Sad       0.36      0.37      0.36      1247
    Surprise       0.54      0.63      0.58       831
     Neutral       0.39      0.41      0.40      1233

    accuracy                           0.44      7178
   macro avg       0.41      0.45      0.43      7178
weighted avg       0.44      0.44      0.43      7178
```



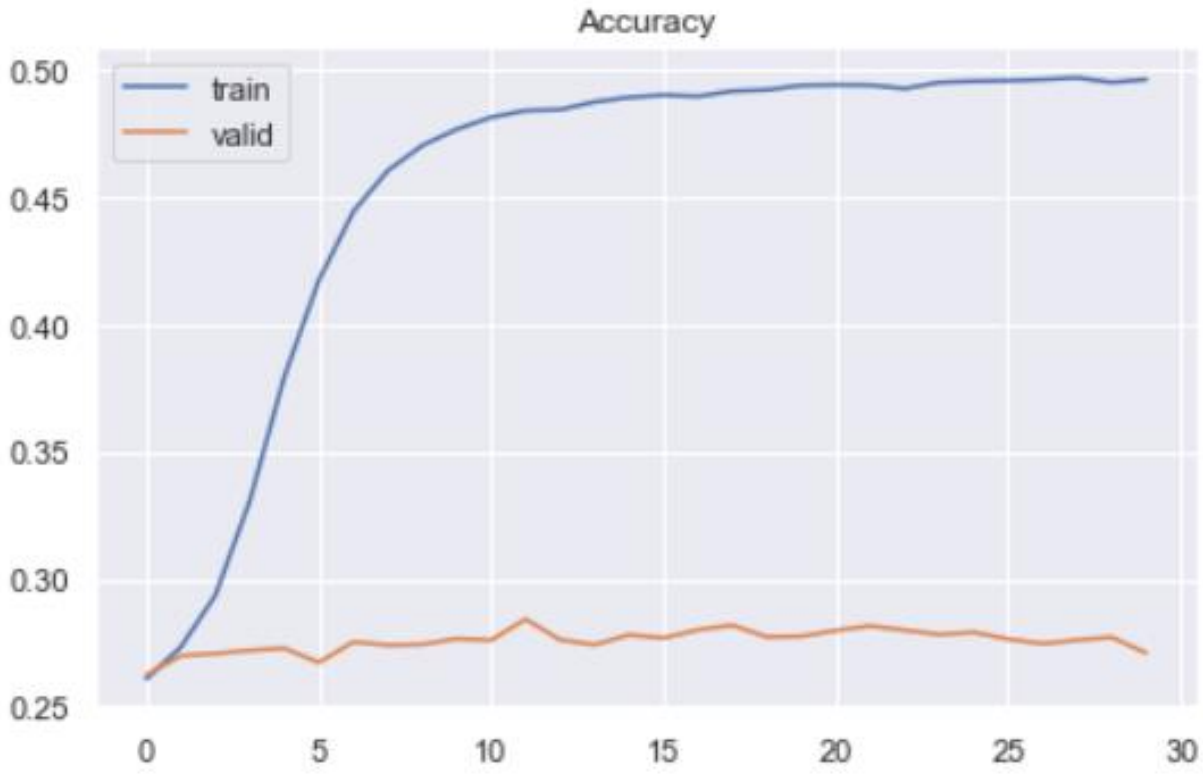
CONVOLUTIONAL NEURAL NETWORK

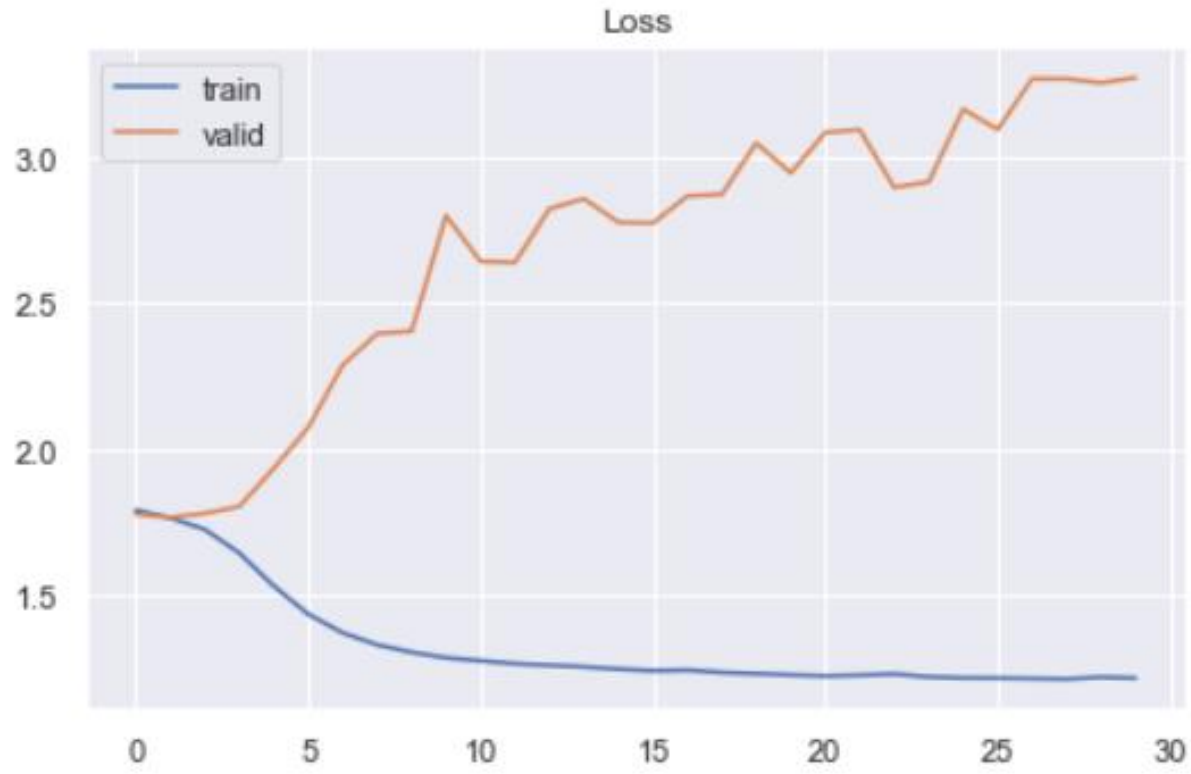


Layer (type)	Output Shape
conv2d_2 (Conv2D)	(None, 46, 46, 32)
conv2d_3 (Conv2D)	(None, 44, 44, 64)
max_pooling2d_2 (MaxPooling2D)	(None, 22, 22, 64)
conv2d_4 (Conv2D)	(None, 20, 20, 128)
max_pooling2d_3 (MaxPooling2D)	(None, 10, 10, 128)
flatten_1 (Flatten)	(None, 12800)
dense_2 (Dense)	(None, 128)
dense_3 (Dense)	(None, 7)

Total params: 1,732,103 (6.61 MB)
Trainable params: 1,732,103 (6.61 MB)
Non-trainable params: 0 (0.00 B)

CONVOLUTIONAL NEURAL NETWORK



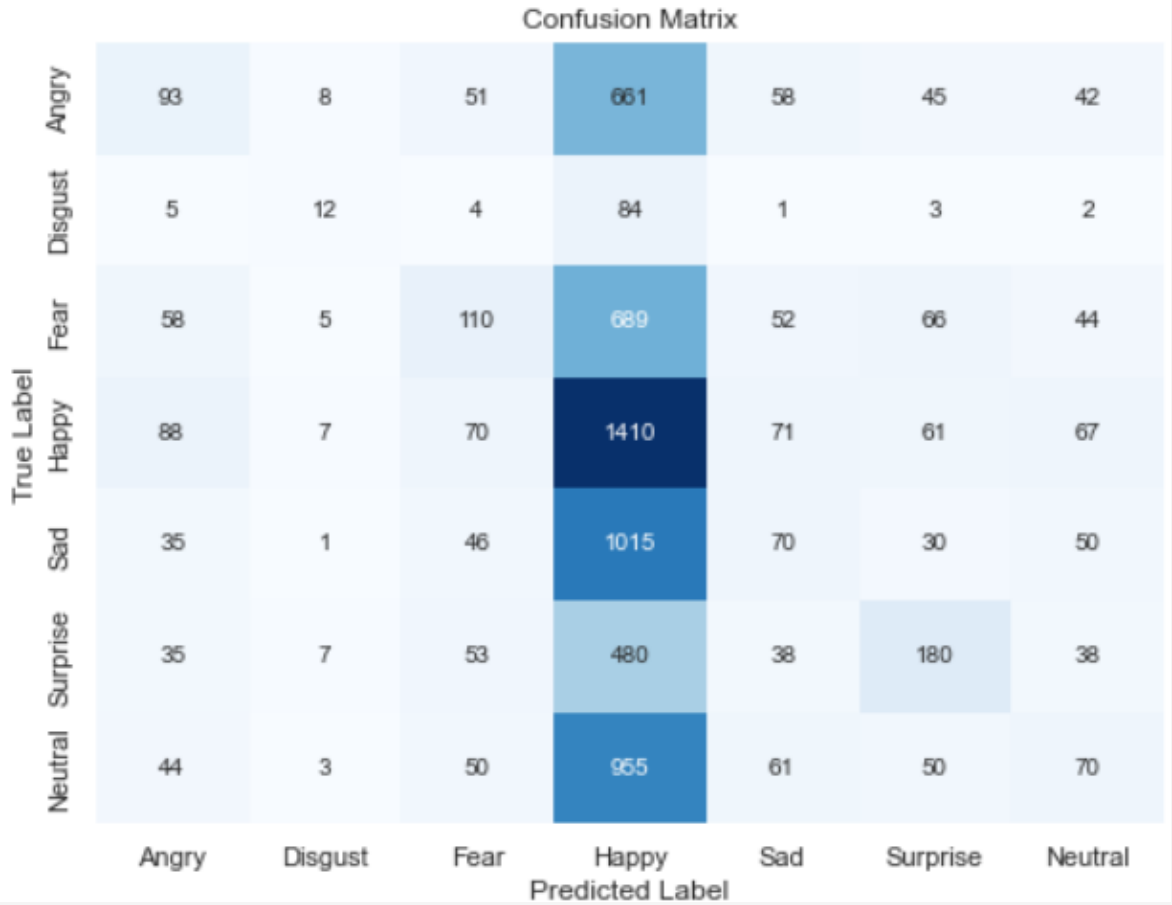



```
898/898 ━━━━━━━━━━━━━━━━━━━━ 141s 157ms/step - accuracy: 0.4985 - loss: 1.2106 - val_accuracy: 0.2771 -
Epoch 30/30
898/898 ━━━━━━━━━━━━━━━━━━━━ 141s 157ms/step - accuracy: 0.5084 - loss: 1.1945 - val_accuracy: 0.2710 -
```

CONVOLUTIONAL NEURAL NETWORK

The neural work seems to overwhelmingly predict emotion to be "happy" which happens to be the class with the highest number of samples.

	precision	recall	f1-score	support
Angry	0.26	0.10	0.14	958
Disgust	0.28	0.11	0.16	111
Fear	0.29	0.11	0.16	1024
Happy	0.27	0.79	0.40	1774
Sad	0.20	0.06	0.09	1247
Surprise	0.41	0.22	0.28	831
Neutral	0.22	0.06	0.09	1233
accuracy			0.27	7178
macro avg	0.28	0.21	0.19	7178
weighted avg	0.27	0.27	0.21	7178



CHALLENGES

1. Dataset is imbalanced, some emotions have too little sample. Upsampling the dataset doesn't improve accuracy.

2. Increase accuracy of convolutional neural network without over-fitting.

CONCLUSIONS

Traditional machine learning algorithms like support Vector Machine achieves better result than Convolutional neural network for facial emotion recognition.

NEXT STEP

We can try other neural network architectures such as Transfer Learning, VGGnet, Residual Network to achieve more accurate predictions.

Thank You!