Face Analytics

Detecting **Face**, **Emotion**, **Gender**, **Age** from Images,

using Convolutional Neural Networks

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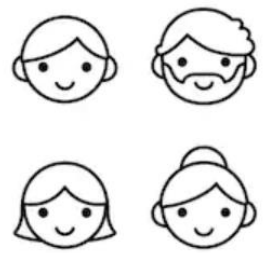
Product Features

Face Detection

Emotion Detection

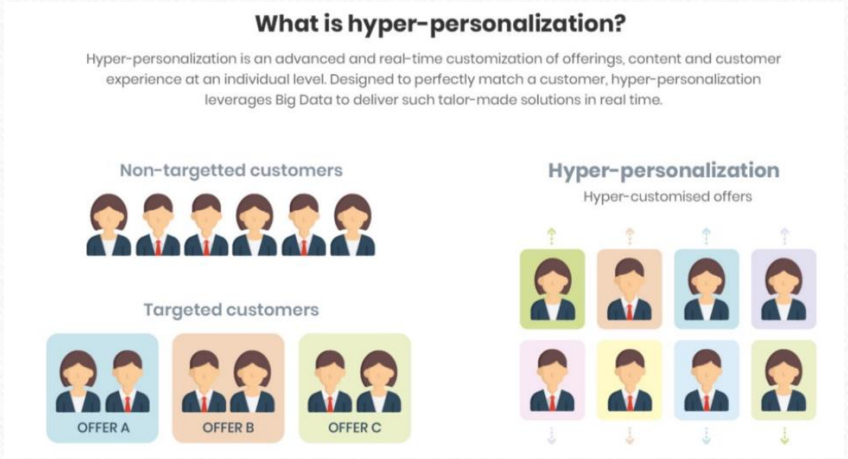
Gender Detection



Age Detection

Problem Statement

- This project aims to detect and classify human faces by emotions, gender and age, to allow companies to better **customise user experience**, improve **customer loyalty** and generate **additional sales**
- Improve understanding of **emotions induced by products** that customers interact with, and how these impact customer satisfaction and their decisions to purchase



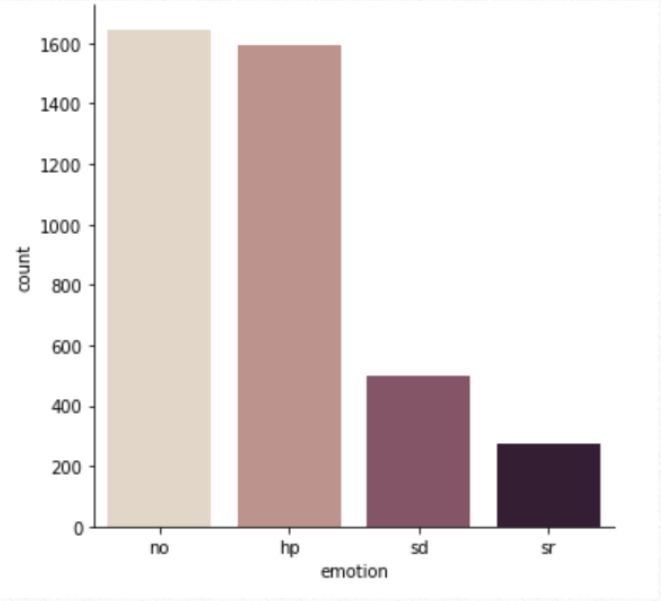
Data Collection, Pre-Processing & Exploratory Data Analysis

- The **Specs on Face (SoF) dataset** (https://sites.google.com/view/sof-dataset)
  - Collection of images for 112 persons who wear glasses under different illumination conditions
  - Devoted to two main problems: **face occlusions** and **harsh illumination** environments

Data Collection, Pre-Processing & Exploratory Data Analysis

- **Four emotion labels** provided in dataset
  - No: Neutral
  - Hp: Happy
  - Sd: Sad/Angry/Disgusted
  - Sr: Surprised/Fearful

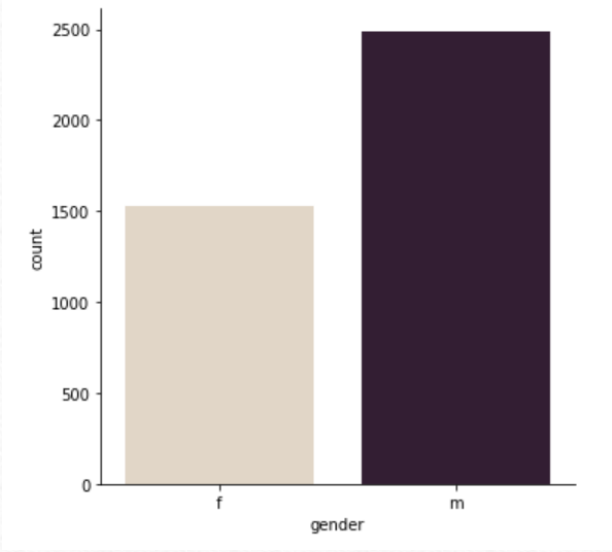
```
no    0.409771
hp    0.397807
sd    0.123629
sr    0.068794
Name: emotion, dtype: float64
```

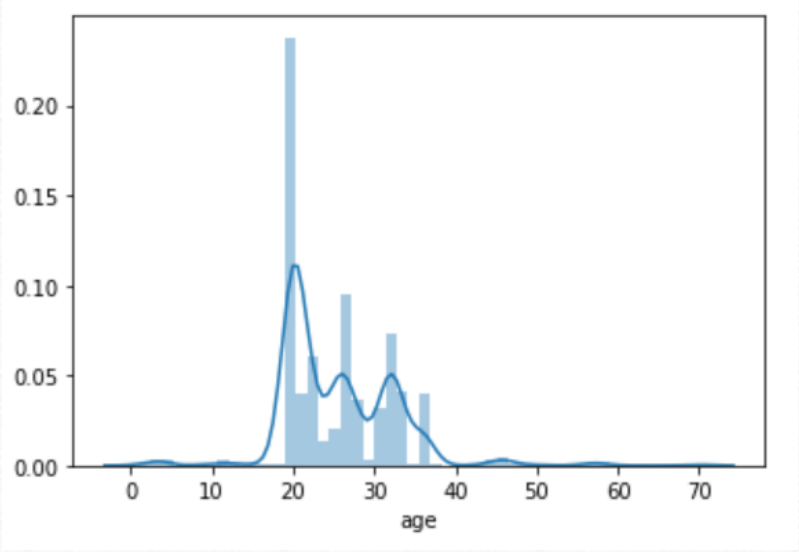


- Added **CK+48 dataset** (https://www.kaggle.com/shawon10/ckplus) to increase size of train data for hp/sd/sr emotion classes

Data Collection, Pre-Processing & Exploratory Data Analysis

- Gender and Age labels also provided in SoF dataset





Data Collection, Pre-Processing & Exploratory Data Analysis

- **Resize** to standardise all images (150x150 px)
- Convert to **greyscale** and **normalise** images to reduce effect of poor lighting
  - Tried Adaptive Thresholding, but did not improve results
- **Image augmentation** to increase size of train dataset (horizontal flipping)

CNN Models Implemented

- Face Detection – Transfer Learning using pre-trained MTCNN model
- Emotion, Gender, Age Detection – Reference from simple LeNet-5 architecture
  - Emotion classification accuracy = **60.0%**
  - Gender classification accuracy = **93.6%**
  - Age regression MAE = **3.2**

Layer (type)	Output Shape	Param #
conv2d_193 (Conv2D)	(None, 148, 148, 8)	80
max_pooling2d_193 (MaxPoolin	(None, 74, 74, 8)	0
conv2d_194 (Conv2D)	(None, 70, 70, 16)	3216
max_pooling2d_194 (MaxPoolin	(None, 35, 35, 16)	0
flatten_67 (Flatten)	(None, 19600)	0
dense_270 (Dense)	(None, 120)	2352120
dense_271 (Dense)	(None, 84)	10164
dense_272 (Dense)	(None, 4)	340

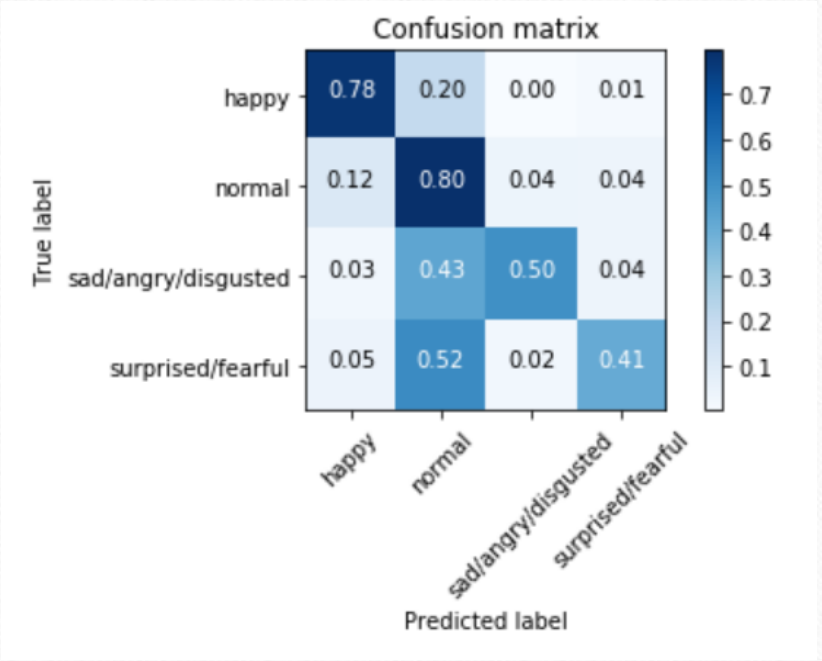
Total params: 2,365,920
Trainable params: 2,365,920
Non-trainable params: 0

Emotion Detection Model: Initial Problems and Subsequent Improvements

- Imbalanced classes
  - **Class weights** to penalise the model more for wrong predictions on images from smaller classes
- Overfitting
  - **Dropouts**, **Batch Normalization**, **Early Stopping** methods
- Difficult to tune hyperparameters manually given time and resource constraints
  - **Hyperas/Hyperopt** (Bayesian Sequential Model-based Optimisation)
  - Uses information from past trials to inform next set of hyperparameters to explore

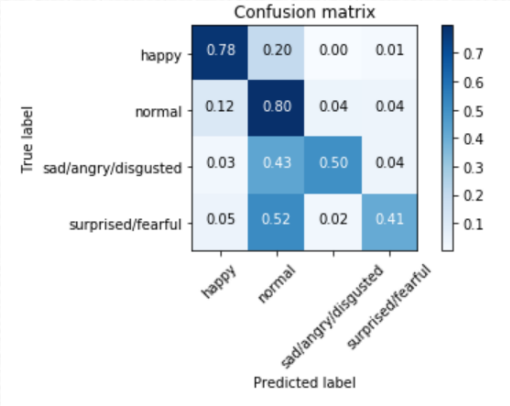
Emotion Detection Model: Further Optimisations

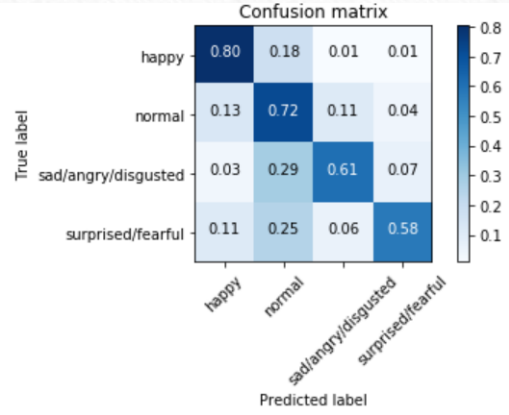
- With the above improvements, model accuracy improved to **72.8%**
- However, model still performs poorly when detecting sd/sr emotion classes
  - Tried implementing ensemble with Machine Learning models (e.g. Random Forest, Naive Bayes) but did not improve results

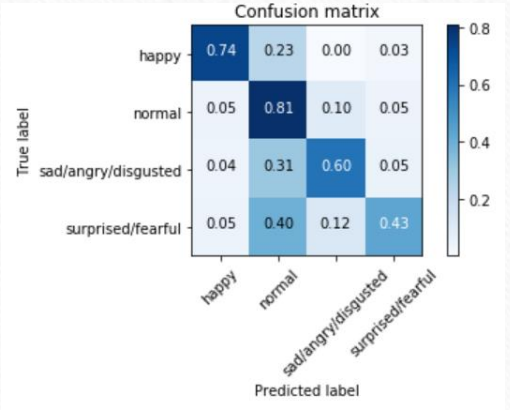


Emotion Detection Model: Further Optimisations

- Ensemble three CNN models
  - Slightly different architectures and hyperparameters (combining Hyperas top performing models)
  - Grid search model weights



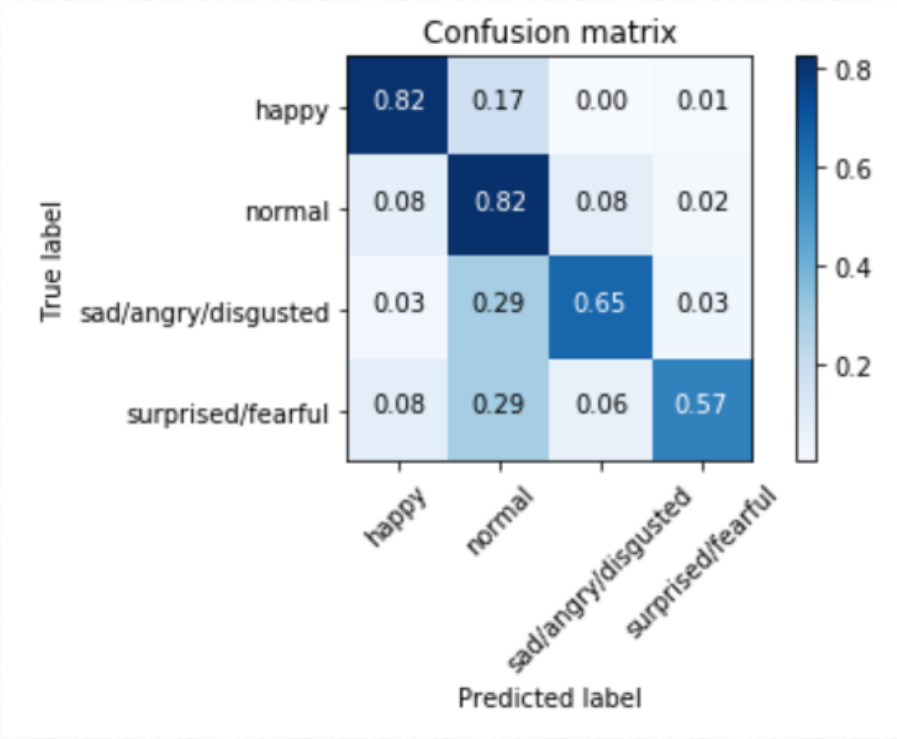




Emotion Detection Model: Ensemble Results

- Significant improvement in model accuracy for sd/sr emotions
  - ‘macro’ – calculate metrics for each class and find unweighted mean

```
Accuracy: 0.781561
Precision: 0.750502
Recall: 0.714271
F1 score: 0.729428
ROC AUC: 0.900681
```



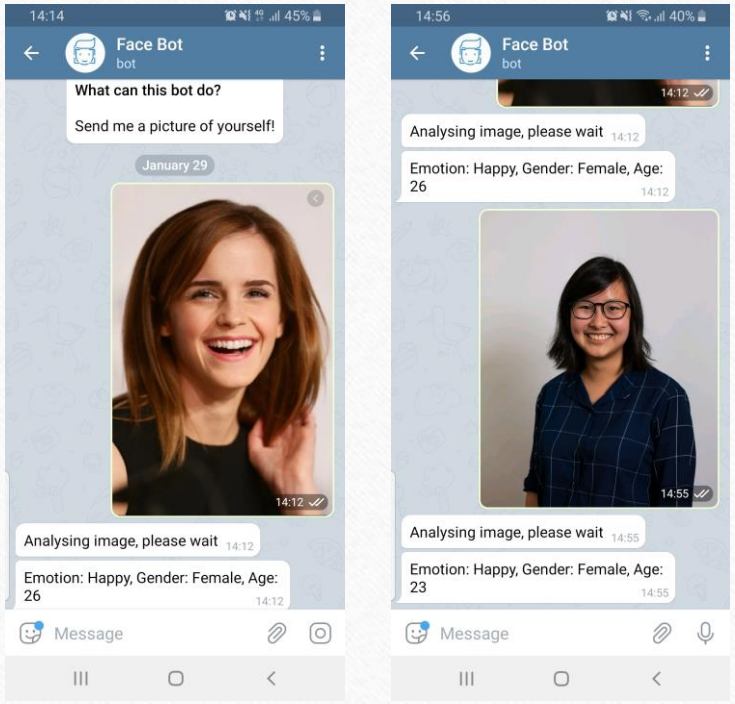
Emotion Detector Model: Examples of Wrongly Classified Emotions

```
name           AbdA
gender            m
age              31
emotion          sr
emotionCat        3
Name: 917, dtype: object
Predicted Emotion: sd
[0.0511867  0.25644809 0.67576977 0.0165955 ]
```

```
name           KhaS
gender            m
age              35
emotion          sd
emotionCat        2
Name: 3474, dtype: object
Predicted Emotion: no
[0.10623834 0.4575055  0.11356587 0.32269028]
```

Deployment to Telegram App using Heroku

- Telegram bot **@FaceClassificationBot**
- Real time prediction of a person's emotions, gender and age based on the image provided by the user



Project Limitations

- Models trained on SoF dataset, which is **not representative of population**
  - Most volunteers were from Egypt, very few Asians
  - Age range mostly from 20-35 years old – model performs poorly on very young (e.g. babies) or very old people
- Emotions are **complex**, even humans get it wrong sometimes
- Challenging to judge someone's emotions just by their facial expressions
  - Consider body language, choice of words, tone of voice