



Facial Attribute Classification

**Image Processing, CNN with
Transfer Learning, and Evaluation
Methods**

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Data Processing

200.000 images cropped to 109 x 89 of celebrity faces.

Initially:

- Loaded each image
- Standardized around training mean
- Reshaped to 1D array

Final model:

- Used three ImageDataGenerators for train, validation, and test
- Rescaled from 255 to 0-1
- These generated batches of images with specified attributes and labels



Building the Model

Model from Scratch

- Conv2D, Flatten, Dense, and Dropout Layers
- Fully trained: test accuracy of 0.0257, weighted average precision of 0.40, recall of 0.34, and f-1 score of 0.36.

Pros: More customizable, predictions centered around a similar threshold for each attribute

Transfer Learning

- Transfer Learning using ResNet50
- Froze the ResNet50 layers
- Ran for five epochs, fine-tuned for five epochs
- test accuracy of 0.009, weighted average precision of 0.63, recall of 0.30, and f-1 score of 0.39 (however, not descriptive because of variety in thresholds)

Pros: Less training time, higher accuracy, less data necessary

Evaluating the Models

Sklearn.classification_report

- We were able to see and compare the precision, f-1, and recall, as well as the difference between the weighted and unweighted averages – pretrained had more 0s.

Mustache	0.03	0.01	0.01	772
Narrow_Eyes	0.00	0.00	0.00	2968
No_Beard	0.85	0.81	0.83	17041
Oval_Face	0.28	0.02	0.04	5901
Pale_Skin	0.00	0.00	0.00	840
Pointy_Nose	0.26	0.03	0.05	5704
Receding_Hairline	0.00	0.00	0.00	1694
Rosy_Cheeks	0.06	0.00	0.00	1432
Sideburns	0.04	0.01	0.02	926
Smiling	0.51	0.44	0.47	9987
Straight_Hair	0.00	0.00	0.00	4190
Wavy_Hair	0.36	0.17	0.24	7267
Wearing_Earrings	0.22	0.06	0.09	4125
Wearing_Hat	0.03	0.00	0.01	839
Wearing_Lipstick	0.52	0.46	0.49	10418
Wearing_Necklace	1.00	0.00	0.00	2753
Wearing_Necktie	0.07	0.02	0.03	1399
Young	0.76	0.84	0.80	15114
micro avg	0.52	0.32	0.40	184653
macro avg	0.26	0.14	0.16	184653
weighted avg	0.41	0.32	0.34	184653
samples avg	0.54	0.33	0.38	184653

Confusion matrices

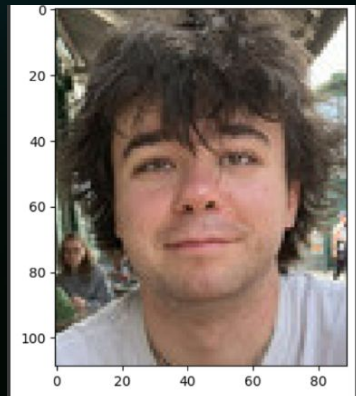
- We generated confusion matrices for each of the 40 attributes being looked at by our model. This allowed us to determine one of the issues with our accuracy was a tendency to predict all positive or all negative based on the attribute's threshold

Mustache	0.00	0.00	0.00	39
Narrow_Eyes	0.00	0.00	0.00	146
No_Beard	0.87	1.00	0.93	867
Oval_Face	0.00	0.00	0.00	286
Pale_Skin	0.00	0.00	0.00	36
Pointy_Nose	0.28	1.00	0.43	277
Receding_Hairline	0.00	0.00	0.00	83
Rosy_Cheeks	0.00	0.00	0.00	83
Sideburns	0.00	0.00	0.00	39
Smiling	0.52	0.95	0.67	512
Straight_Hair	0.12	0.00	0.01	213
Wavy_Hair	0.00	0.00	0.00	362
Wearing_Earrings	0.00	0.00	0.00	214
Wearing_Hat	0.00	0.00	0.00	42
Wearing_Lipstick	0.51	1.00	0.67	506
Wearing_Necklace	0.00	0.00	0.00	131
Wearing_Necktie	0.00	0.00	0.00	61
Young	0.74	0.45	0.56	761
micro avg	0.35	0.32	0.33	9328
macro avg	0.12	0.21	0.10	9328
weighted avg	0.29	0.32	0.24	9328
samples avg	0.35	0.34	0.33	9328

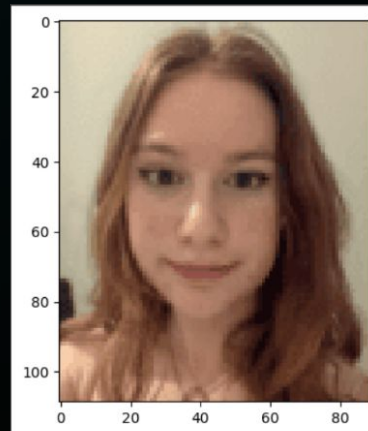
Evaluating the Model (Part 2)

Custom Images:

By using custom images, we were able to get a better visual sense of how our model was performing, as well as the different thresholds. For example, aspects such as hair color always had low probability, whereas aspects like male always had high probability.



```
1/1 [=====] - 0s 22ms/step
Probability of 5_o_Clock_Shadow: 0.1488
Probability of Arched_Eyebrows: 0.0289
Probability of Attractive: 0.1067
Probability of Bags_Under_Eyes: 0.1949
Probability of Bald: 0.0317
Probability of Bangs: 0.2567
Probability of Big_Lips: 0.1308
Probability of Big_Nose: 0.2999
Probability of Black_Hair: 0.0905
Probability of Blond_Hair: 0.0083
Probability of Blurry: 0.1874
Probability of Brown_Hair: 0.1113
Probability of Bushy_Eyebrows: 0.0716
Probability of Chubby: 0.1009
Probability of Double_Chin: 0.0845
Probability of Eyeglasses: 0.1330
Probability of Goatee: 0.2729
Probability of Gray_Hair: 0.0344
Probability of Heavy_Makeup: 0.0143
Probability of High_Cheekbones: 0.0742
Probability of Male: 0.7424
Probability of Mouth_Slightly_Open: 0.1935
Probability of Mustache: 0.1341
Probability of Narrow_Eyes: 0.1074
```



```
1/1 [=====] - 0s 317ms/step
Probability of 5_o_Clock_Shadow: 0.1109
Probability of Arched_Eyebrows: 0.0796
Probability of Attractive: 0.2918
Probability of Bags_Under_Eyes: 0.1873
Probability of Bald: 0.0209
Probability of Bangs: 0.4066
Probability of Big_Lips: 0.2044
Probability of Big_Nose: 0.2176
Probability of Black_Hair: 0.1227
Probability of Blond_Hair: 0.0780
Probability of Blurry: 0.1584
Probability of Brown_Hair: 0.2199
Probability of Bushy_Eyebrows: 0.0914
Probability of Chubby: 0.0661
Probability of Double_Chin: 0.0447
Probability of Eyeglasses: 0.0575
Probability of Goatee: 0.0949
Probability of Gray_Hair: 0.0347
Probability of Heavy_Makeup: 0.1121
Probability of High_Cheekbones: 0.2026
Probability of Male: 0.4909
Probability of Mouth_Slightly_Open: 0.2261
Probability of Mustache: 0.0436
Probability of Narrow_Eyes: 0.1133
```

Discussion

If we had more time and resources:

We would run each of our models to full completion and potentially increase the number of layers.

We'd fine-tune each of our thresholds for each of the attributes to get more helpful f-1 scores during evaluation.

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