

Understanding Beauty via Deep Facial Features



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Overview

- Studies on Facial Beauty from Psychology and Computer Science
- Facial Attributes Estimation from Deep Features
- Correlations between Facial Attributes and Beauty Scores
- Verifying Beauty Changing by Manipulating Facial Attributes

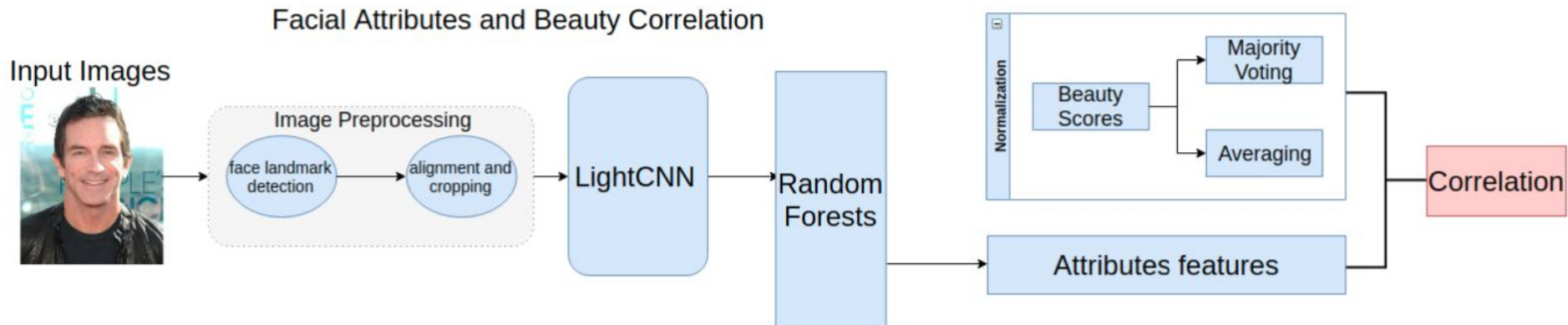
Facial Beauty Impact

- Job Hiring Decision
- Dating
- Suspect Judge Decision
- Isolation
- Depression
- Psychological Disorder

Facial Beauty Study Background

- Psychology
 - Criteria for beauty sharing by cross-cultural
 - Symmetry
 - Averageness
 - Sexual dimorphism (feminine features)
- Computation
 - Face beautification
 - Beauty prediction

Structure Pipeline

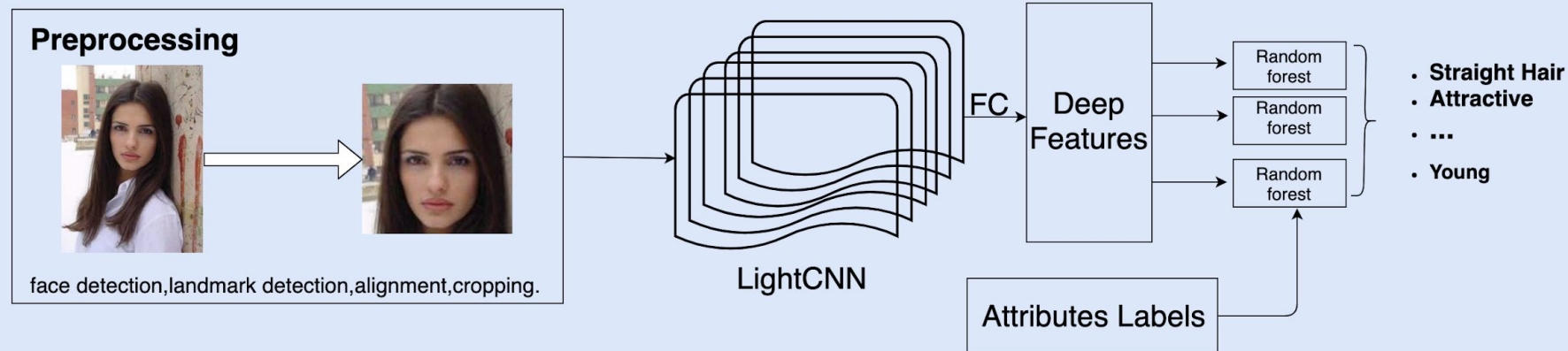


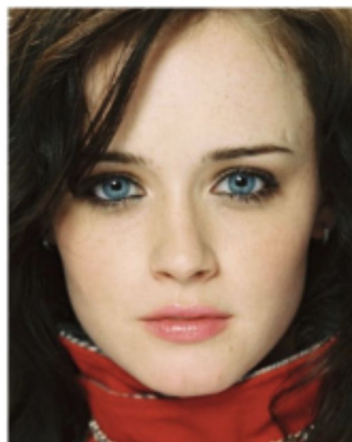
Facial Attributes Extraction

- Deep Feature Extractor -- LightCNN [Wu, He, Sun and Tan, TIFS]
 - Face recognition framework
 - Trained on millions face images
 - Off-shelf extractor
- Face Attributes Estimation
 - Dataset : CelebA [Liu, Luo, Wang, and Tang, ICCV 2015]
 - Classifier: random forest
 - Averaging accuracy over 40 facial attributes : 85%

Facial Attributes Training

Overview for Attributes Training





Attributes	result	Attributes	result	Attributes	result
5_o_Clock_Shadow	0	Black_Hair	0	Goatee	0
No_Beard	1	Straight_Hair	0	Arched_Eyebrows	0
Blond_Hair	0	Gray_Hair	0	Oval_Face	0
Wavy_Hair	0	Attractive	1	Blurry	0
Heavy_Makeup	1	Pale_Skin	0	Wearing_Earrings	0
Bags_Under_Eyes	0	Brown_Hair	1	High_Cheekbones	1
Pointy_Nose	0	Wearing_Hat	0	Bald	0
Bushy_Eyebrows	0	Male	0	Receding_Hairline	0
Wearing_Lipstick	1	Bangs	1	Chubby	0
Mouth_Slightly_Open	0	Rosy_Cheeks	0	Wearing_Necklace	0
Big_Lips	0	Double_Chin	0	Mustache	0
Sideburns	0	Wearing_Necktie	0	Big_Nose	0
Eyeglasses	0	Narrow_Eyes	0	Smiling	0
Young	1				

Beauty DataSets

- Beauty 799 [Zhang, Chen, and Yu, 2016]
 - 799 images
 - Female only
 - Diverse ethnicity
 - Three beauty score scale
 - Each Image is rated by 25 raters
- The 10k US [Bainbridge, Isola, Oliva, 2013]
 - 2222 images
 - Both female and male
 - Caucasian only
 - Five beauty score scale
 - Rated by 12 raters

Correlations between Beauty and Attributes

- PCC (Pearson's Correlation Coefficient)

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}} \quad (1)$$

where n is the sample size, x_i and y_i are sample points, and

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i, \quad \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i. \quad (2)$$

- Welch's t-test

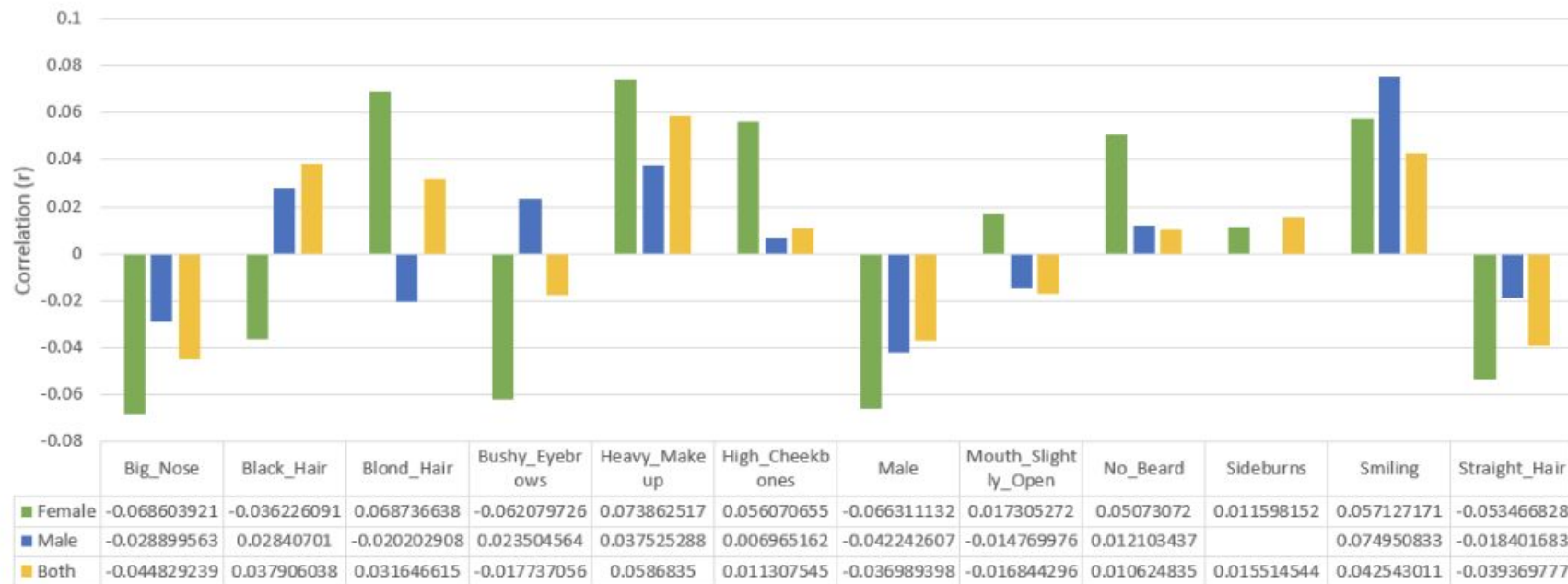
$$t = \frac{\bar{X}_0 - \bar{X}_1}{\sqrt{\frac{s_0^2}{n_0} + \frac{s_1^2}{n_1}}}$$

- s : unbiased estimator of variance.

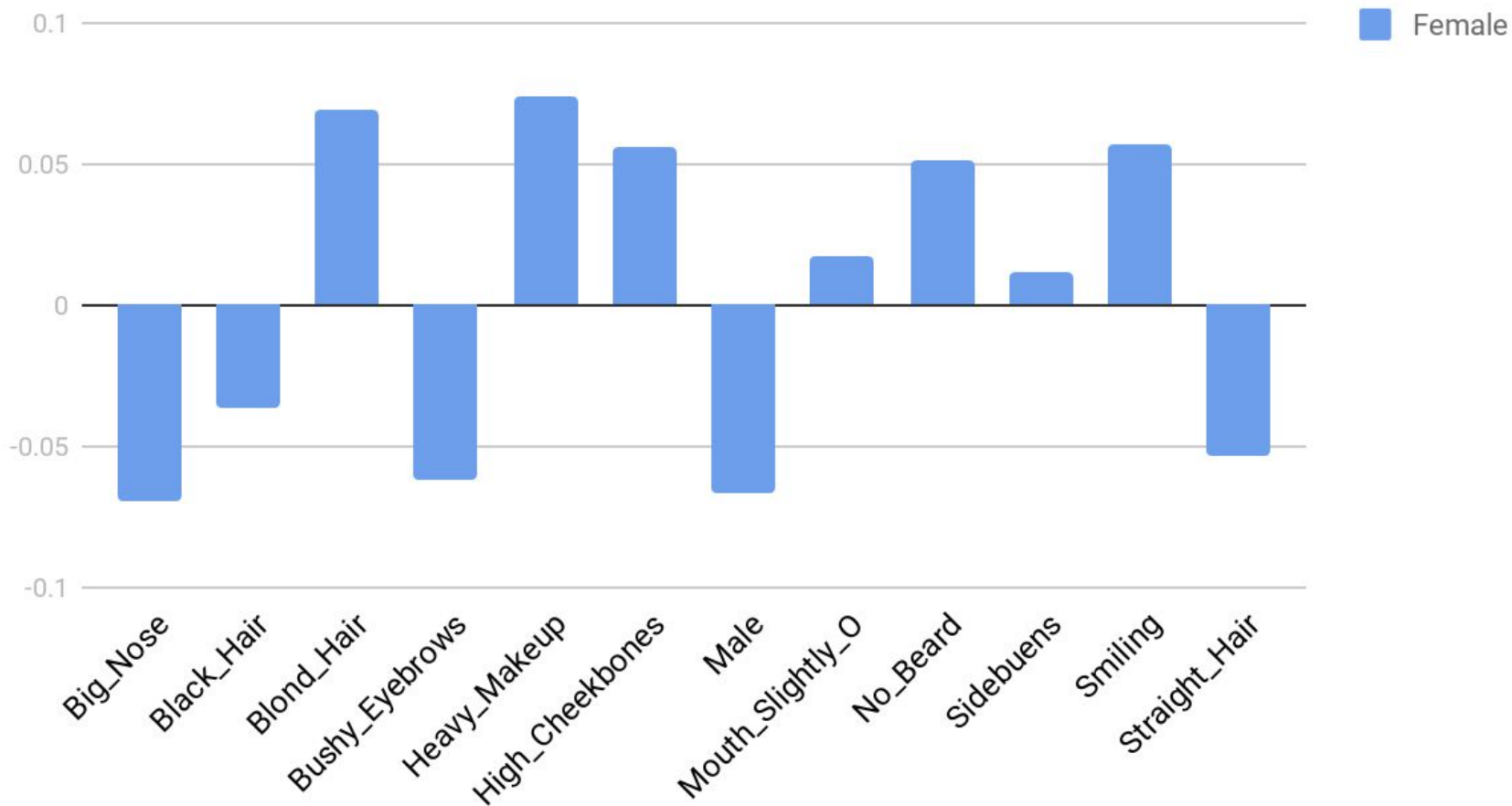
Correlations Results on Beauty 799 dataset

Attribute	PCC	p -value (PCC)	p -value (Welch)	Correlation
Arched Eyebrows	-0.109	1.93×10^{-3}	1.46×10^{-3}	Positive
Attractive	-0.208	2.71×10^{-9}	7.17×10^{-9}	Positive
Big Nose	0.054	1.28×10^{-1}	4.82×10^{-2}	Negative
Black Hair	0.062	7.97×10^{-2}	9.00×10^{-3}	Negative
Blond Hair	0.073	3.80×10^{-2}	1.94×10^{-2}	Negative
Bushy Eyebrows	0.034	3.43×10^{-1}	1.61×10^{-1}	—
Heavy Makeup	-0.203	6.77×10^{-9}	4.09×10^{-9}	Positive
High Cheekbones	-0.107	2.47×10^{-3}	1.06×10^{-3}	Positive
Male	0.206	4.28×10^{-9}	1.22×10^{-9}	Negative
Mouth Slightly Open	0.086	1.55×10^{-2}	8.25×10^{-3}	Negative
No Beard	-0.040	2.57×10^{-1}	7.21×10^{-2}	—
Smiling	0.005	8.98×10^{-1}	4.50×10^{-1}	—
Wavy Hair	-0.062	8.08×10^{-2}	5.83×10^{-2}	—
Wearing Earrings	-0.047	1.90×10^{-1}	1.90×10^{-1}	—
Wearing Lipstick	-0.245	2.43×10^{-12}	1.69×10^{-12}	Positive
Young	-0.088	1.25×10^{-2}	2.35×10^{-3}	Positive

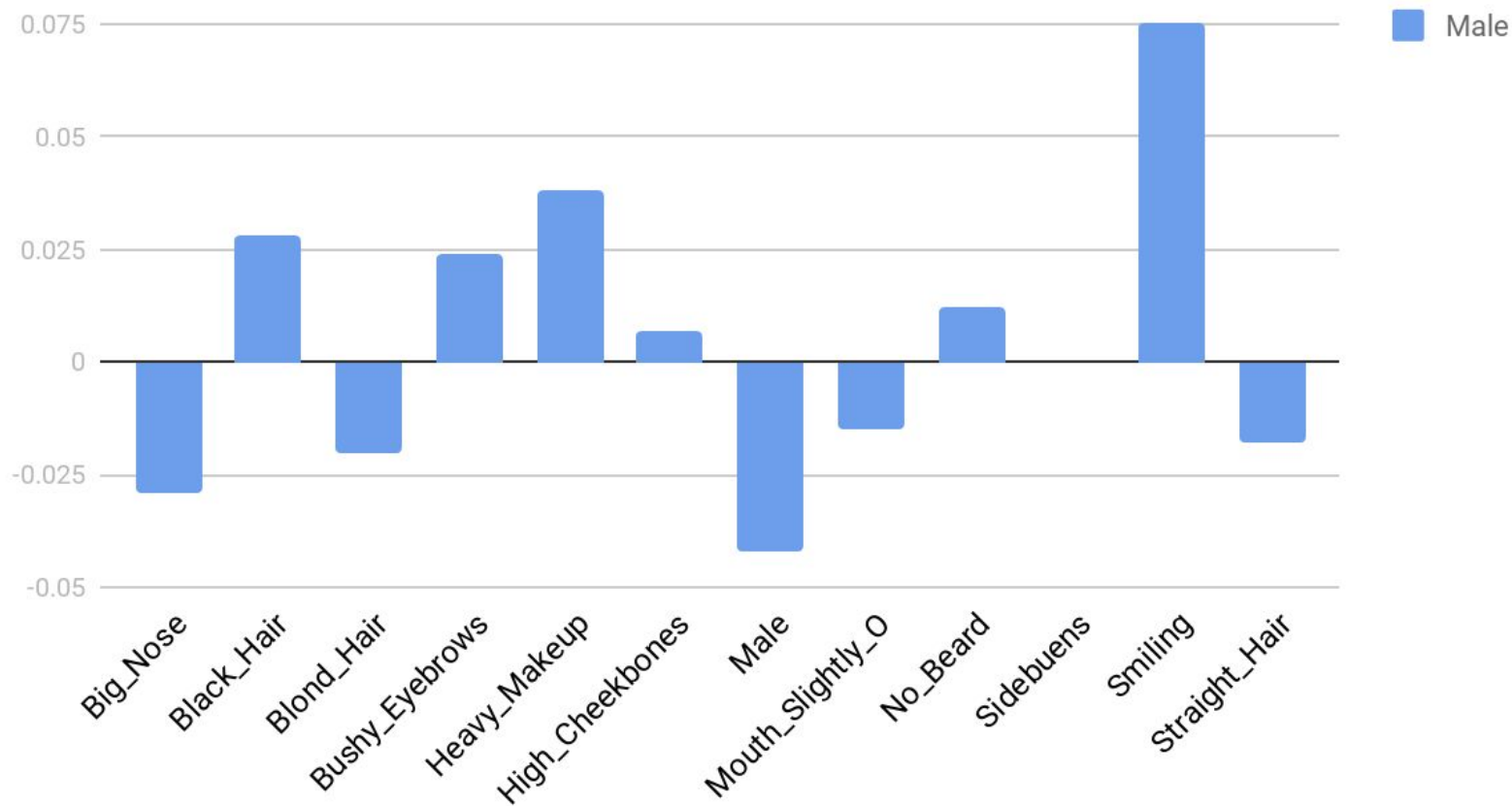
Correlations on 10k US dataset



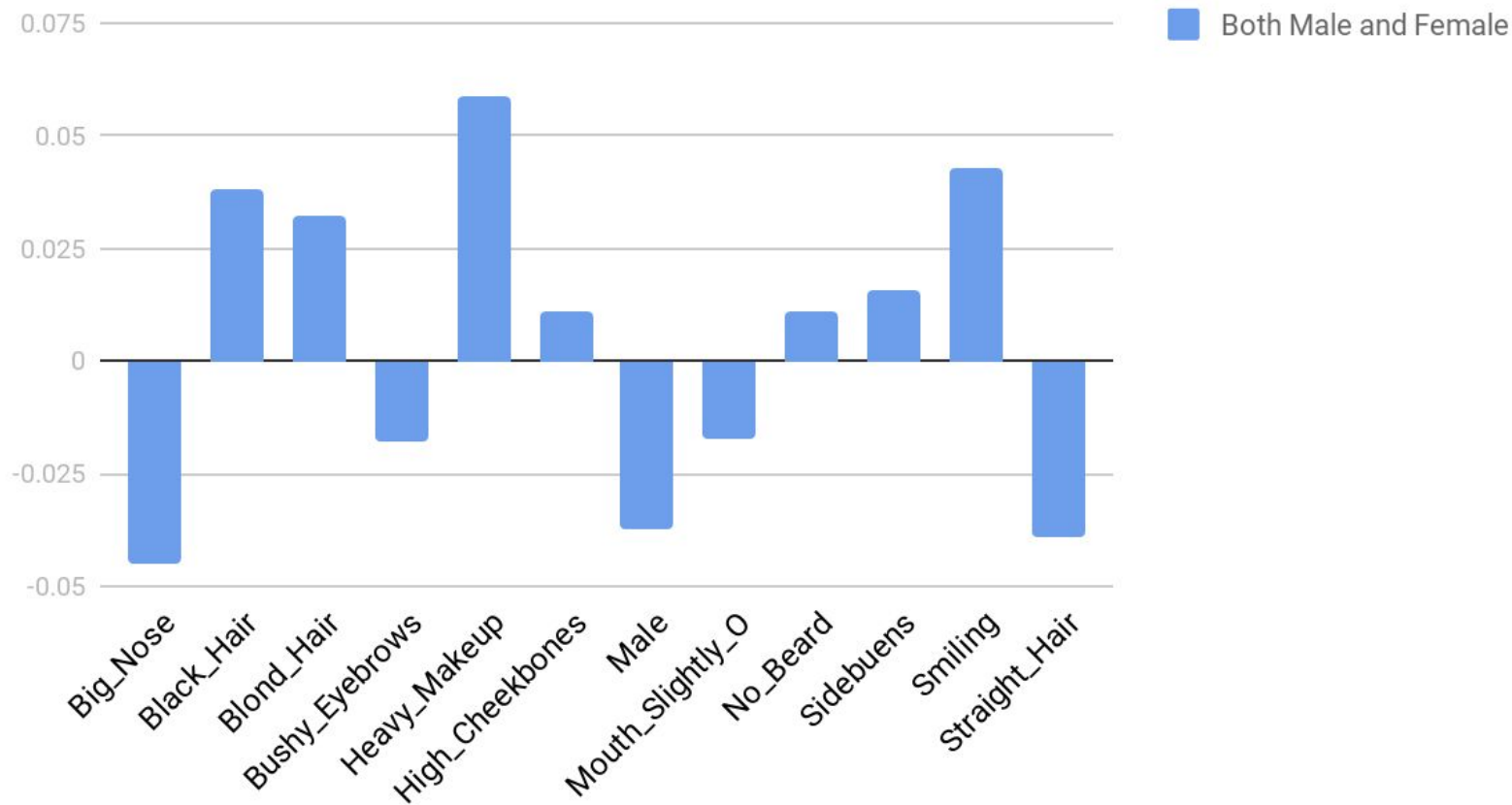
Points scored



Points scored



Points scored



Correlations Overall Consistent Results

Attribute	PCC	p -value (PCC)	p -value (Welch)	Correlation
Arched Eyebrows	0.055	2.13×10^{-3}	1.60×10^{-3}	Positive
Attractive	0.151	8.27×10^{-17}	9.82×10^{-17}	Positive
Big Nose	-0.047	9.20×10^{-3}	2.77×10^{-3}	Negative
Heavy Makeup	0.104	1.10×10^{-8}	1.17×10^{-8}	Positive
High Cheekbones	0.043	1.80×10^{-2}	9.56×10^{-3}	Positive
Male	-0.081	8.18×10^{-6}	6.03×10^{-6}	Negative
Mouth Slightly Open	-0.035	5.16×10^{-2}	2.45×10^{-2}	Negative
Wearing Lipstick	0.122	1.60×10^{-11}	3.74×10^{-11}	Positive
Young	0.042	1.97×10^{-2}	3.63×10^{-3}	Positive

Feminine Features more Attractive

Attribute	PCC	p -value (PCC)	p -value (Welch)	Correlation
<u>Arched Eyebrows</u>	0.055	2.13×10^{-3}	1.60×10^{-3}	Positive
Attractive	0.151	8.27×10^{-17}	9.82×10^{-17}	Positive
Big Nose	-0.047	9.20×10^{-3}	2.77×10^{-3}	Negative
<u>Heavy Makeup</u>	0.104	1.10×10^{-8}	1.17×10^{-8}	Positive
<u>High Cheekbones</u>	0.043	1.80×10^{-2}	9.56×10^{-3}	Positive
<u>Male</u>	-0.081	8.18×10^{-6}	6.03×10^{-6}	Negative
Mouth Slightly Open	-0.035	5.16×10^{-2}	2.45×10^{-2}	Negative
<u>Wearing Lipstick</u>	0.122	1.60×10^{-11}	3.74×10^{-11}	Positive
Young	0.042	1.97×10^{-2}	3.63×10^{-3}	Positive

Attributes Translation Using StarGAN

Original



Big Nose



Attributes Translation Using StarGAN

Original



Feminized



Attributes Translation Using StarGAN

Original

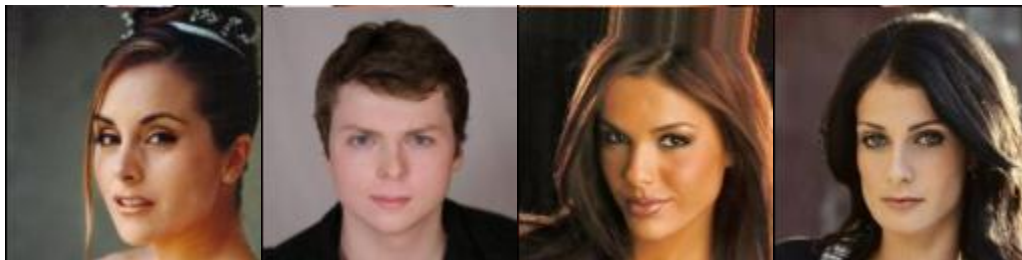


Makeup



Attributes Translation Using StarGAN

Original



Aging



Understanding Beauty via Deep Facial Features

- Facial Attributes Training and Estimation by Deep Features.
- Mining Positive/Negative Facial Attributes to Beauty from A Statistical Method.
- Manipulating Facial Attributes using A GAN Model.
- Verifying Findings by a Large-Scale User Study.

Understanding Beauty via Deep Facial Features



Thank You!
Q&A?

Attributes Translation Using StarGAN

Original



Aging





Figure 1. *In each image pair, which one (Left or Right) is more attractive?* We propose a method and a novel perspective of beauty understanding via deep facial features, which allows us to analyze which facial attributes contribute positively or negatively to beauty perception. To validate our result, we manipulate the facial attributes and synthesize new images. In each case, left corresponds to the original image, and right represents the synthesized one. The sample modified facial attributes from left to right are small nose to big nose, male to female, no-makeup to makeup, and young to aged. To see our discovery to the first question, please read remaining of the paper.