CelebHair

A New Large-Scale Dataset for Hairstyle Recommendation based on CelebA

Yutao Chen / 2021-07-31

Motivation

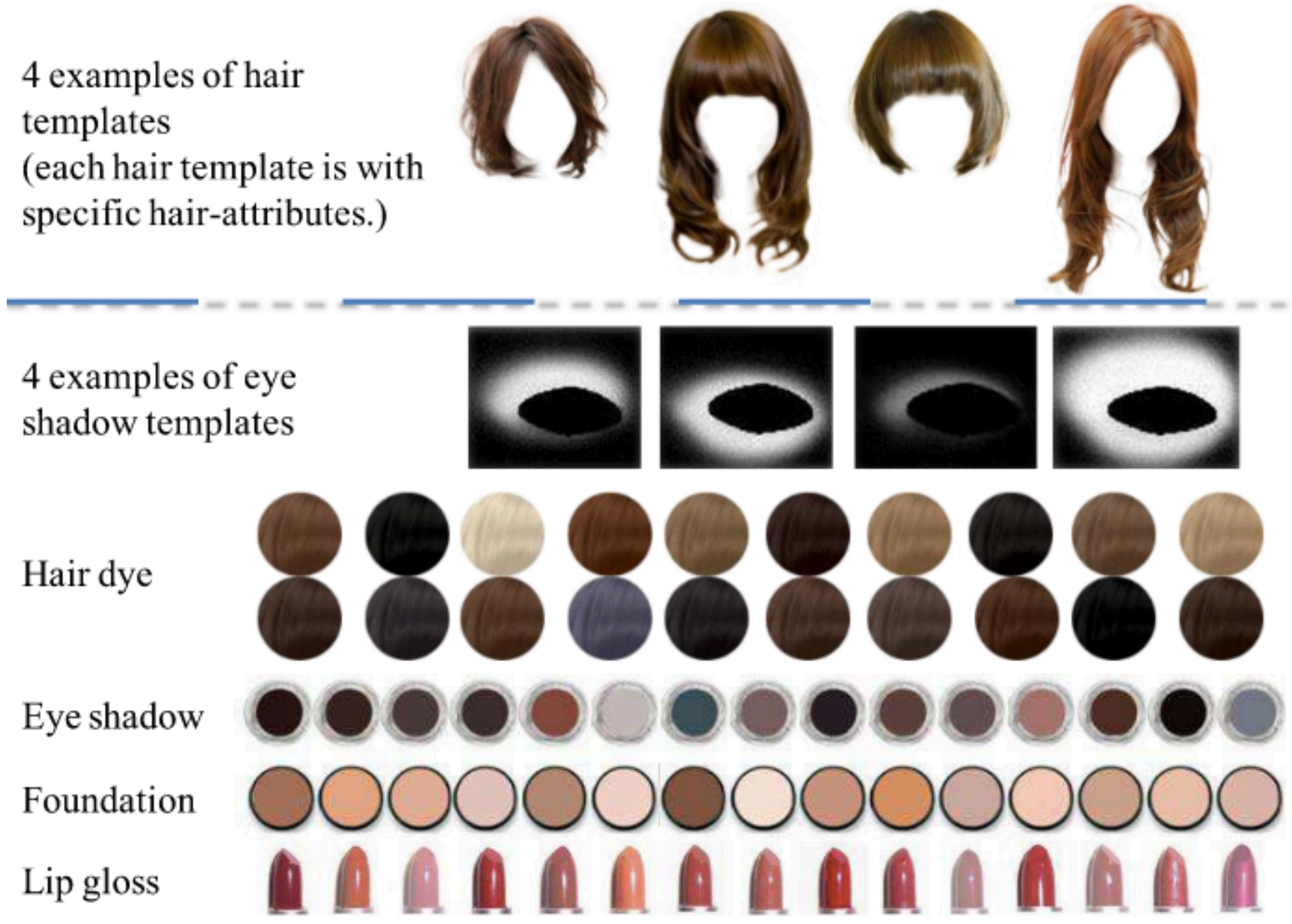
- **Task**: We are working on an application for *hairstyle recommendation* & *try-on*;
  - Therefore, we need a proper dataset for building such a recommendation system;
  - Ideally, the dataset should have abundant facial photographs & labeled features;
- **Challenge**: We found no publicly available datasets that fits our requirements;
- **Solution**: We decided to build one ourselves!

Related Works

Beauty e-Expert

Liu, L., Xing, J., Liu, S., Xu, H., Zhou, X., Yan, S.: *Wow! you are so beautiful today!* ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM) 11(1s), 1–22 (2014)

- **Pros**: Hairstyle, face shape & other beauty-related facial features;
- **Cons**: Limited volume (1505), only female figures available.



Related Works

Hairstyle30k

Yin, W., Fu, Y., Ma, Y., Jiang, Y.G., Xiang, T., Xue, X.: *Learning to generate and edit hairstyles*. In: Proceedings of the 25th ACM international conference on Multimedia. pp. 1627–1635 (2017)

- **Pros**: Larger volume (30k), various hairstyles (male & female);
- **Cons**: No any other features available.

Related Works

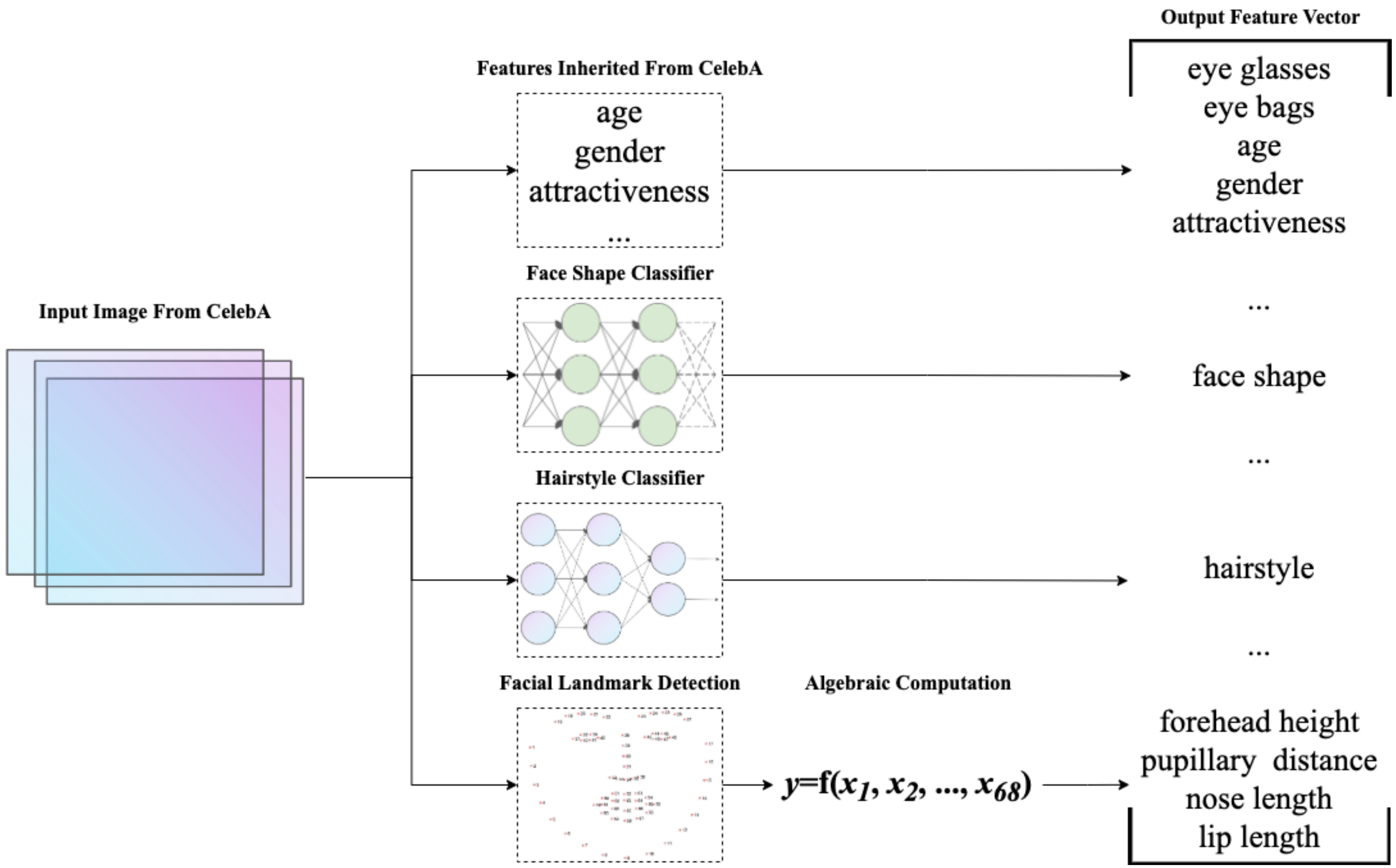
CelebA

Liu, Z., Luo, P., Wang, X., Tang, X.: *Deep learning face attributes in the wild*. In: Proceedings of the IEEE international conference on computer vision. pp. 3730– 3738 (2015)

- **Pros**: Largest volume, widely used benchmarking dataset, various facial features;
- **Cons**: Vital features missing, e.g. hairstyle & face shape.

- **Conclusion**:
  - We decided to build our hairstyle dataset *CelebHair* on top of CelebA, given that it has the largest number of facial photographs;
  - We adopted multiple approaches to extract new *facial attributes* that are previous missing in CelebA (especially *hairstyle* & *face shape*).

Data Collection

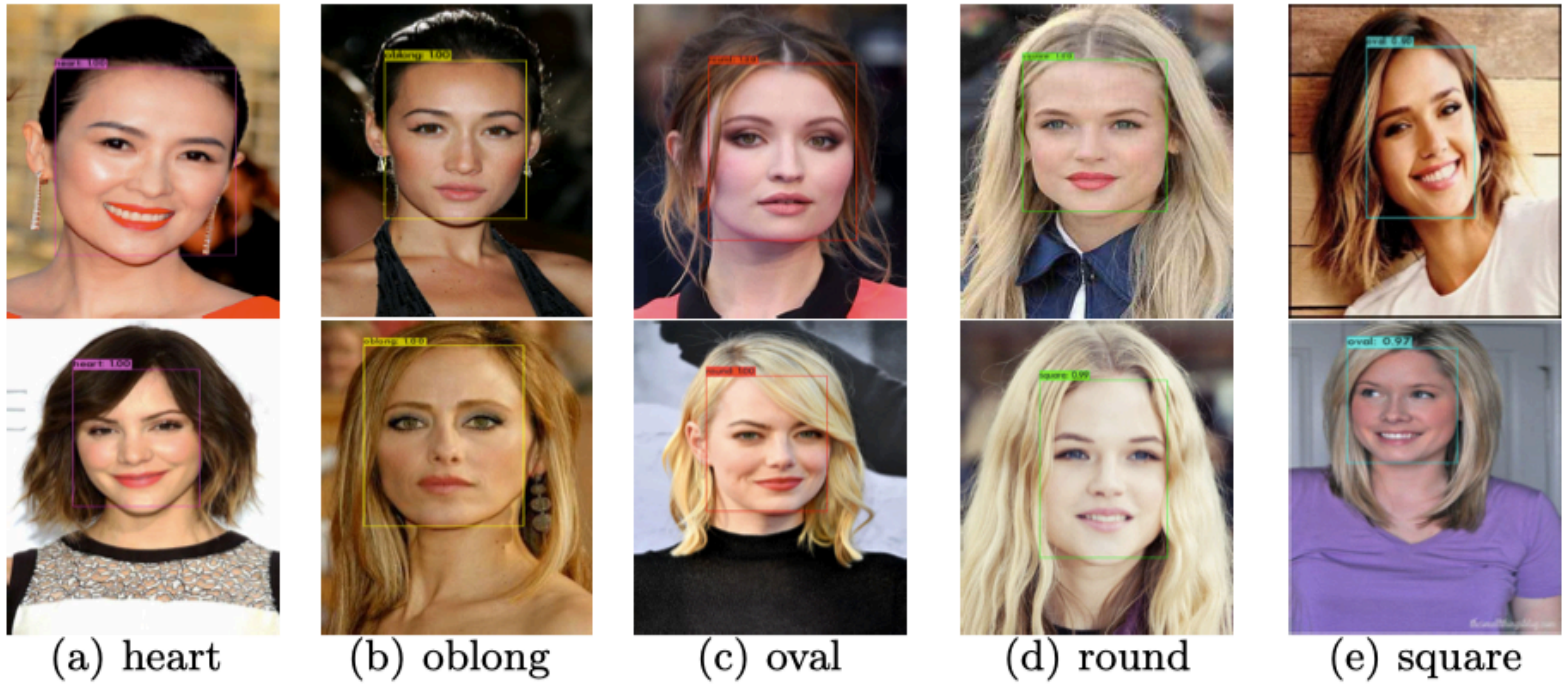


Data Collection

Face Shape

Bochkovskiy, A., Wang, C.Y., Liao, H.Y.M.: Yolov4: Optimal speed and accuracy of object detection. arXiv preprint arXiv:2004.10934 (2020)

- We trained a face shape classifier using *YOLO v4* to extract the face shape attribute;
- The classifier was first trained on a smaller dataset (https://www.kaggle.com/niten19/face-shape-dataset), then applied to the CelebA dataset.



Data Collection

Face Shape

Table 1. Face Shape Classification Results' Precision

Label	True Positives	False Positives	Average Precision[a]
overall	931	151	95.73%[b]
heart	186	17	98.16%
oblong	194	24	98.46%
oval	172	49	90.79%
round	187	41	93.62%
square	192	20	97.64%

[a] *For confidence threshold = 0.25, false negatives = 69, average IoU = 79.41%.*

[b] *IoU threshold = 50%, used area-under-curve for each unique recall.*

Table 2. Comparison with Other Approaches Towards Face Shape Classification

Approach	Training Set Size	Accuracy
SVM-Linear [11]	1,000	64.00%
SVM-RBF [11]	1,000	72.00%
MKL with Descriptors [12]	500	70.30%
Our Approach	**8,000**	**87.45%**

Data Collection

Hairstyle

Jaderberg, M., Simonyan, K., Zisserman, A., Kavukcuoglu, K.: *Spatial transformer networks*. Advances in neural information processing systems, 28. pp.2017-2025 (2015)

- We trained a hairstyle classifier using *Spatial Transformer Network* (STN);
- STN learn a *affine transformation* from the input data so that CNN could be invariant to rotation, scale etc.

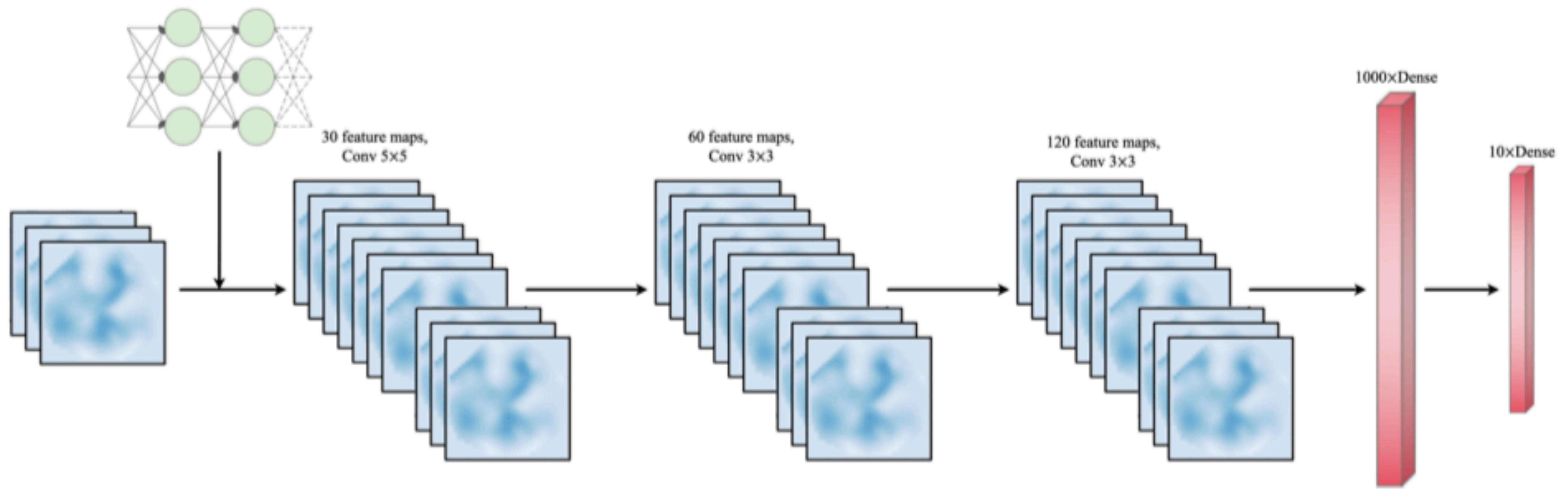


Table 3. The Accuracy of Hairstyle Classification Models

	Train Acc	Test Acc
Without STN	53.58%	42.73%
With STN	88.62%	85.45%

Data Collection

Hairstyle

Yin, W., Fu, Y., Ma, Y., Jiang, Y.G., Xiang, T., Xue, X.: *Learning to generate and edit hairstyles*. In: Proceedings of the 25th ACM international conference on Multimedia. pp. 1627–1635 (2017)

- The dataset we used to train the hairstyle classifier is *Hairstyle10k*;
- Hairstyle10k is a simplified version of Hairstyle30k, containing 10 categories.

(a) undercut (b) spikyhair (c) pompadour (d) flattop (e) crewout

(f) bald (g) trend curly (h) wave (i) curtained (j) bowlcut

Data Collection

Facial Landmarks

- We extract 68 *facial landmarks* from human faces;
- Arithmetic operations then can be performed upon these facial landmarks to determine facial attributes.

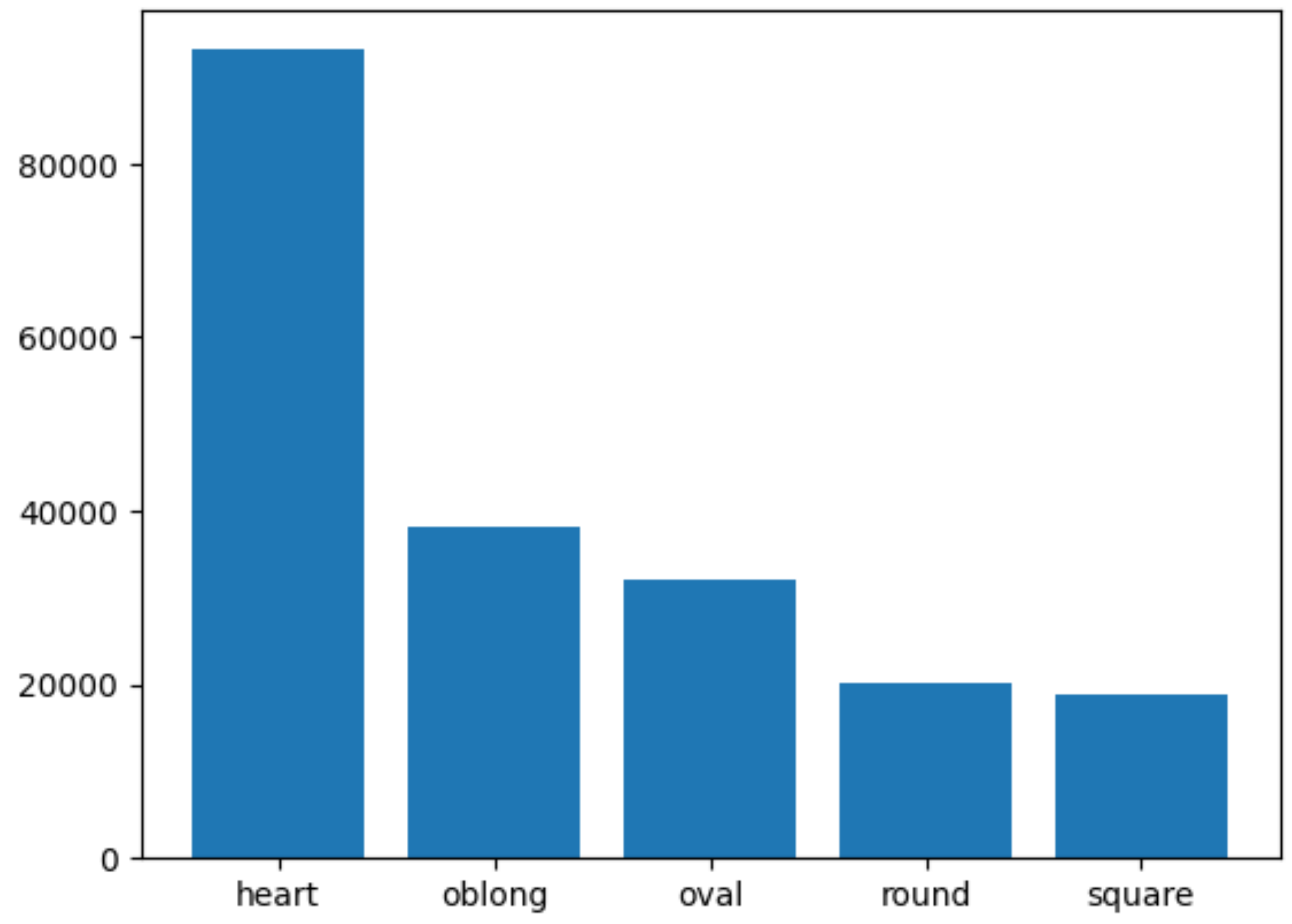
(a) (b) (c)

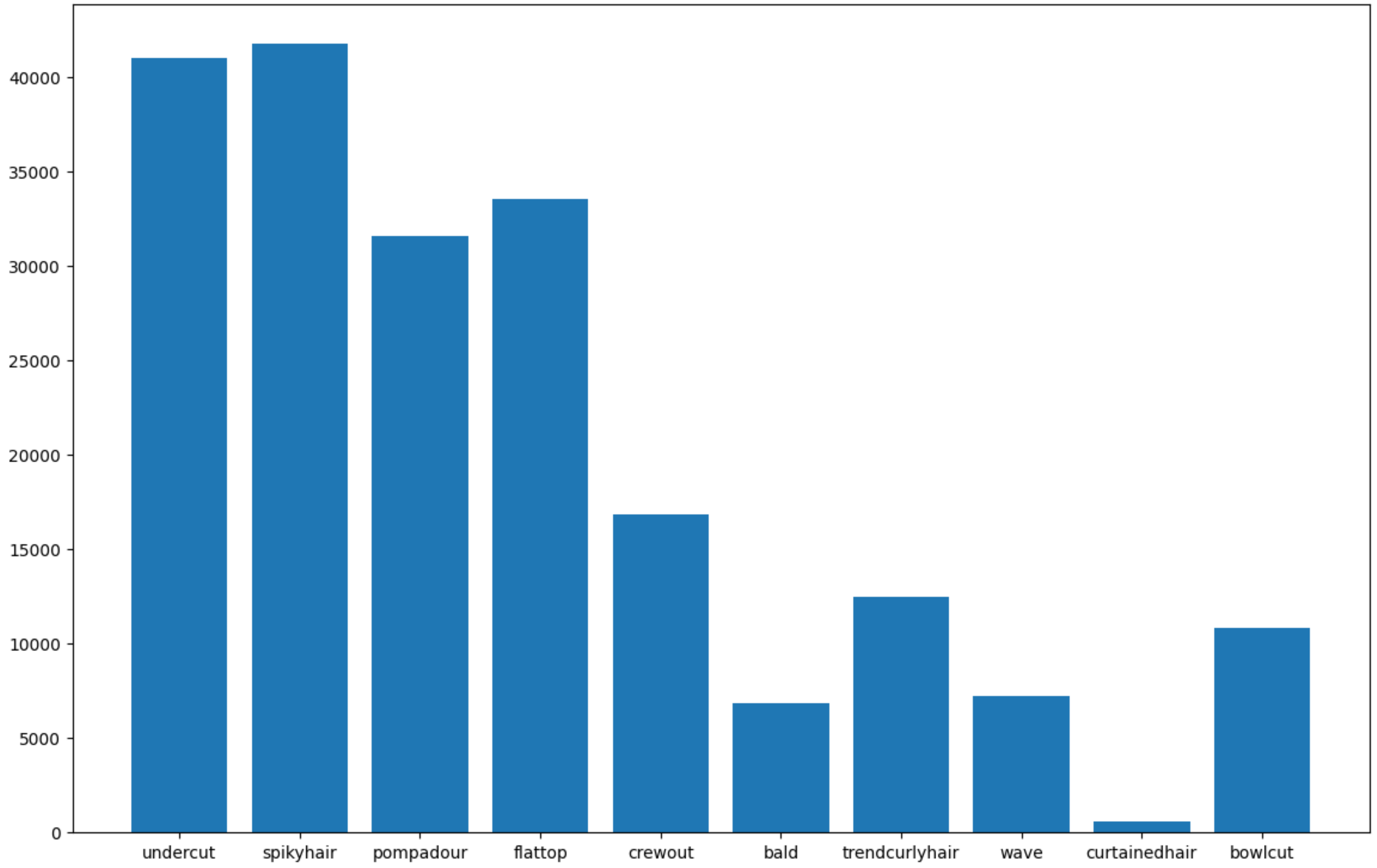
Table 4. Examples for Calculating Facial Attributes Using Facial Landmarks

Attribute	Formula
Forehead Height	$\frac{d(18,27)}{d(1,17)}$
Eye Width	$\frac{d(37,40)+d(43,46)}{2\times d(1,17)}$
Pupillary Distance	$\frac{d(42,48)}{d(1,17)}$
Nose Length	$\frac{2\times d(28,34)}{d(22,9)+d(23,9)}$
Lip Length	$\frac{d(51,53)+d(49,55)+d(59,57)}{3\times d(4,14)}$

Data Description

- The CelebHair dataset contains 202,599 facial images, and each of these images is labeled with *22 features*.





Data Description

Table 5. Attributes and their vaiable options

Attribute	Options
forehead height	short(-1), tall(1)
eyebrow curve	straight(-1), curvy(1)
eyebrow length	short(-1), long(1)
eyebrow thickness	thin(-1), thick(1)
eye width	narrow(-1), wide(1)
eye length	short(-1), long(1)
eyeglasses	none(-1), any(1)
eye bags	none(-1), any(1)
pupillary distance	short(-1), long(1)
cheekbone	low(-1), high(1)
nose length	short(-1), long(1)
nose-mouth distance	short(-1), long(1)
lip length	short(-1), long(1)
lip thickness	thin(-1), thick(1)
jaw curve	straight(-1), curvy(1)
age	young(0), medium(1), old(2)
chubby	no(-1), yes(1)
gender	female(-1), male(1)
attractiveness	no(-1), yes(1)
beard	none(-1), any(1)
face shape	1-5, see Fig. 4
hairstyle	1-10, see Fig. 2

Application

Recommendation

- By utilizing the dataset we've built, we showcased an example application in hairstyle recommendation using *Random Forests*;
- Random forests establishes a mapping from the facial features to the target hairstyle, based on the *attractiveness* feature.

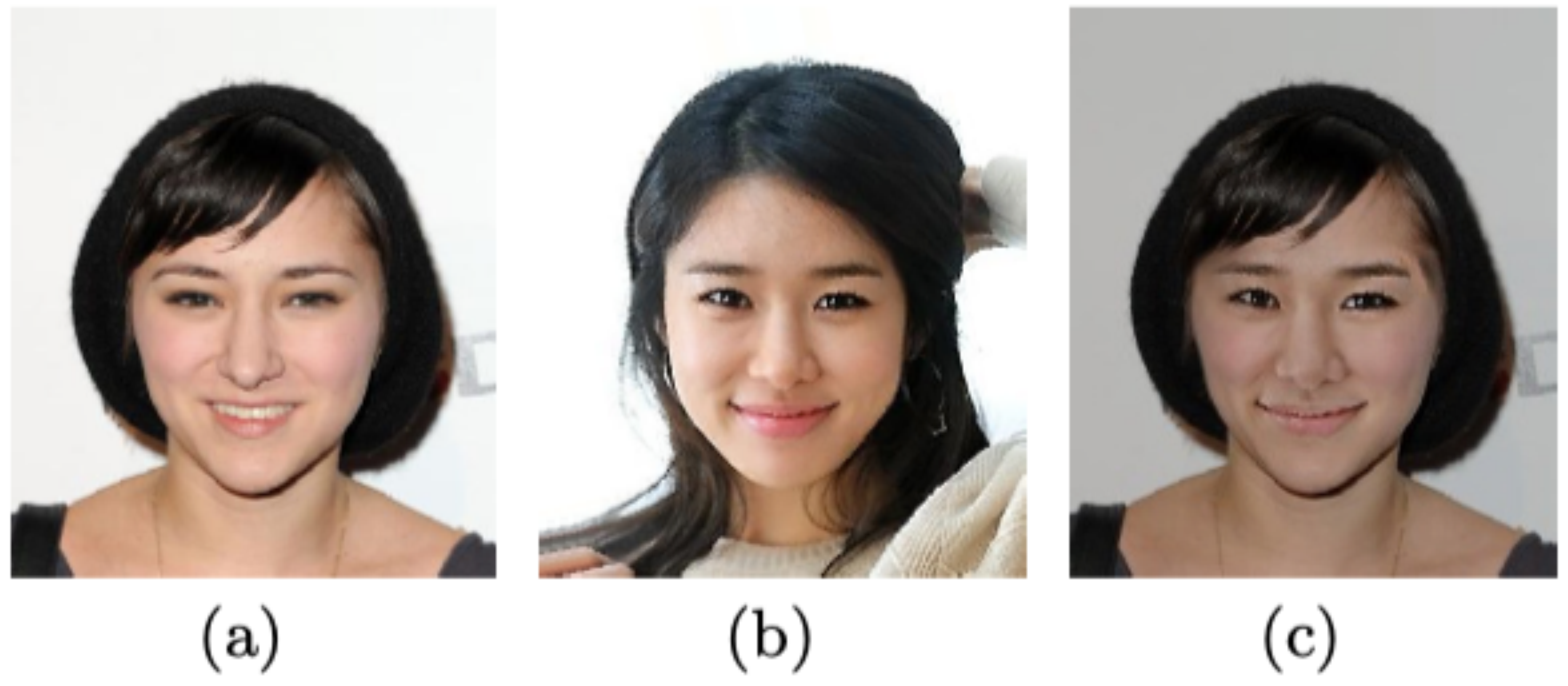
Table 6. Performance of Random Forests with Different Parameters

Hyper Parameters	Train Acc	Test Acc
n_estimators=5, max_depth=3	37.68%	24.37%
n_estimators=10, max_depth=3	40.42%	29.65%
n_estimators=10, max_depth=5	54.39%	43.71%
n_estimators=20, max_depth=5	77.62%	75.43%
n_estimators=50, max_depth=5	89.12%	87.03%
n_estimators=100, max_depth=5	91.29%	86.63%

Application

Try-On

- Currently, we use a *deepfake*-alike technique for hairstyle try-on;
- The results of such technique is unnatural. Even worse, it alters a primary factor in hairstyle choice — face shape.



Reference hairstyle + Input face —> Result

Application

Try-On

Shen, Y., Yang, C., Tang, X., Zhou, B: *Interfacegan: Interpreting the disentangled face representation learned by GANs*. IEEE transactions on pattern analysis and machine intelligence. (2020)

- **Future work**: Use InterFaceGAN to improve hairstyle try-on experience.

Thanks!