Face Shape Classifier

Akik Kothekar

University of Michigan

BSE in Computer Science

Introduction

This project was undertaken by me during my time at Lenskart.com as a Research and Development Intern, under the guidance of Nikunj Mattoo, Senior Product Manager at Lenskart.com. Lenskart.com is an ecommerce organization that offers all kinds of eyewear related products; ranging from fashionable products such as sunglasses to eyeglasses and contact lenses. The organization caters to over 100,000 customers every month and is revolutionizing the eyewear industry in India. One of the ways in which this revolution is taking place is by the use of technology. Recently, Lenskart.com has integrated certain features into its platform such as allowing users to 'try on' eyewear by generating a 3D virtual model of the user's face, and providing the user a measure of his/her frame size by just clicking a picture.

The aim of this project was to develop an algorithm that would classify an individual's face into certain face shapes and this classification can then be used to recommend/suggest sunglasses, eyewear frames and other such products that are offered by Lenskart.com. The fashion industry has been using face shape to recommend eyewear frames and hairstyles that accentuate or tone down facial features. For example, individuals with oblong faces are recommended oversized frames and to balance the long and wide features of their face and also to avoid clear rimless frames that exaggerate length and width. With the presence of a algorithm that can classify one's face into certain shapes, the possibilities that would emerge from integrating it into a recommendation engine are endless. The aforementioned example is normative but with the right recommendation engine users can gain access to new trends which take into account articles used by celebrities and their face shapes as well.

Face Shape Classification

The shapes

After traversing numerous guides that detailed how to manually determine one's face shape, I concluded that an online guide offered by Birchbox [1]provided a relatively objective way to classify one's

[1] Phillips, J. How to Determine Your Face Shape. Retrieved from https://www.birchbox.com/guide/article/how-to-determine-face-shape-men

face shape into six shapes – round, square, oblong, diamond, triangular and oval. The following are outlines of the aforementioned face shapes-

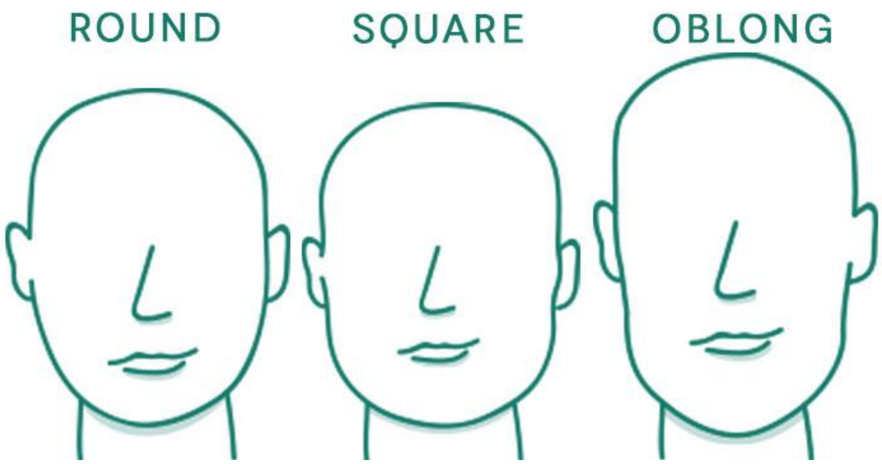

Fig 1: Round, Square and Oblong Face Shape[2]

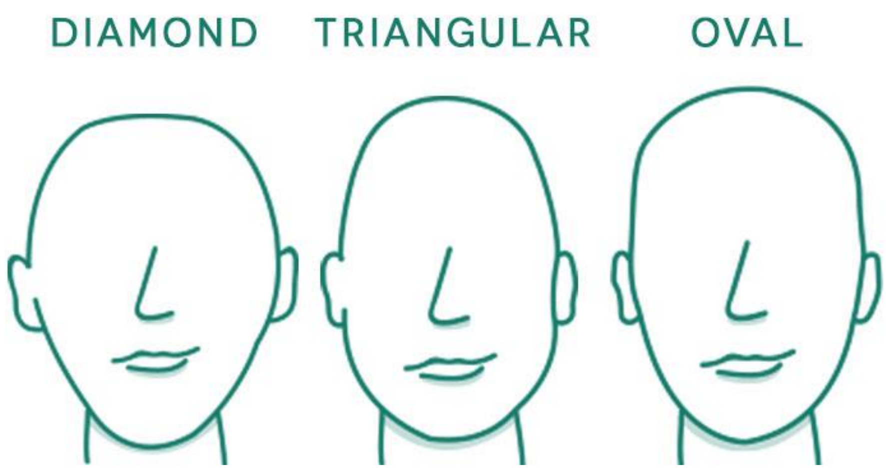

Fig 2: Diamond, Triangular and Oval Face Shape[2]

The Classification Process/Algorithm

According to the guide, there are four measurements of facial attributes that are key to classifying one's face into one of the six shapes. These are as follows –

1. **Forehead**: distance from the peak of one eyebrow to the peak of the other one
2. **Cheekbones**: across the upper cheeks; starting and ending at the outer corner of each eye

[2] Phillips, J. How to Determine Your Face Shape. Retrieved from https://www.birchbox.com/guide/article/how-to-determine-face-shape-men

3. **Jawline**: measure of the jaw across your face at its widest point
4. **Face length**: distance from the center of the hairline to the tip of the chin

In order to obtain these measurements from just the image of a face, the **Dense Facial Landmarks API by Face++** was used. This API provided cartesian coordinates for key landmarks on the face such as eyebrows, eyes nose and the outline of the face. The API outlines all these features and provides the cartesian coordinates of all the points that make up the outline of these features.

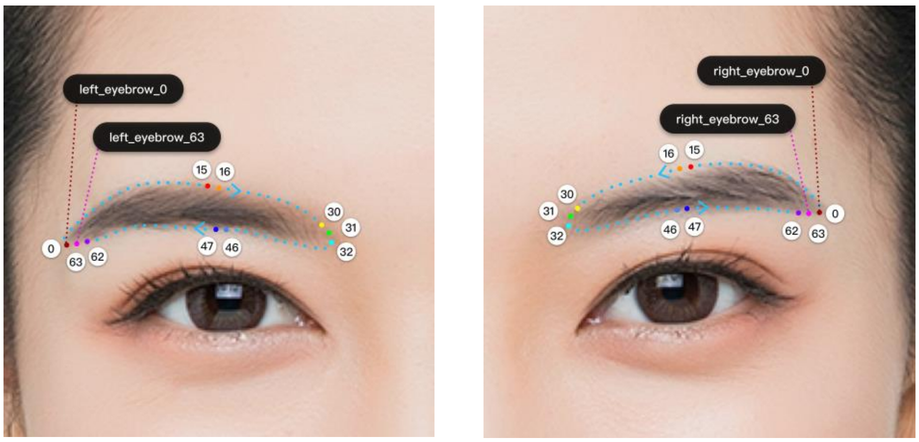

Fig 3: Eyebrow landmark coordinates from Face++[3]

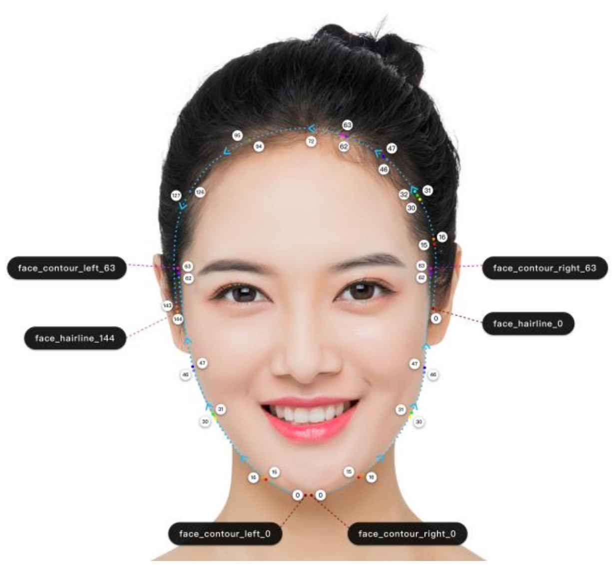

Fig 4: face outline landmark coordinates from Face++[3]

[3] Dense Facial Landmark: API Documentation. Retrieved from https://console.faceplusplus.com/documents/55107053

The coordinates depicted in Fig 3 were used to calculate the forehead length and the rest of the measurements were calculated using the coordinates depicted in Fig 4.

The algorithm to classify the face into one of the six shapes was the result of three processes. The first was to implement the steps given in the Birchbox guide. The steps in the guide are meant for a person to manually figure out their face shape and thus was a bit ambiguous to completely replicate it in code. To eliminate the ambiguity, personal assessment of Fig 1 and Fig 2 were required to spot subtle differences in face outlines that would make the classification much better and easier to implement in code. The final part of the process was to run the code on 500 labelled images and make changes in order to improve its accuracy. **Since face shape is a very subjective topic, the algorithm, in some cases, classifies the face into two shapes if the criteria for multiple shapes matches the measurements for a face**. The following is the final algorithm-

Round

For a face to be 'round' the cheekbones and the face length have a similar measurement. These two measurements are larger than the jawline and forehead which have a similar measurement as well. The angle of the jaw is supposed to be 'soft'.

After observing the measurements of 100 round faces, I concluded that the similarity in the measure of cheekbones and face length is between 53% and 65%; the ratio of cheekbones to face length for a round face is usually greater than 0.53 and less than 0.65. The similarity in the measure of forehead and jawline was found to be at least 85%, that is, the ratio of forehead to jawline for round faces was at least 0.85. The cheekbones and jawline, on examination of Fig 1, seem quite similar and the ratio of cheekbones to jawline was found to be usually between 1.1 and 1.2 thus proving that they are similar. The angle of the jaw was calculated by finding the arctan of the slope of the line obtained by joining the coordinates of the bottom tip of the chin and the corresponding end of the jawline. The angle for round faces was found to be less than 20 degrees.

Square

For a face to be 'square', all the measurements are similar, and the angle of the jaw is sharper than that of round faces.

After observing the measurements of 100 square faces, I concluded that the first condition that a square face should satisfy is that the cheekbones and face length are at least 55% similar, that is the ratio of cheekbones to face length is at least 0.55. The next condition is that the cheekbones and forehead are usually very similar, at least 90%, and the cheekbones are also very similar to the jawline, at least 80%. Thus, the ratio of cheekbones to forehead is at least 0.9 and the ratio of the cheekbones to jawline is at least 0.8 and 1.18 at most. The final condition for a face to be square is that the angle of the jaw is usually greater than 20 degrees.

Oblong

For a face to be 'oblong' the face length must be the largest of all the measurements and the forehead, cheekbones and jawline are similar.

For optimizing the algorithm, I figured that the algorithm doesn't need check if the face can be classified as oblong if the face has already been classified as round or square. After analyzing the measurements of 100 oblong faces, I concluded that the face length is considerably larger than the rest of the measurements. The forehead, cheekbones, and jawline are very similar, at least 90%. Thus, the ratio of forehead to cheekbones and forehead to jawline is usually at least 0.9 and 1.1 at most.

Diamond

For a face to be 'diamond' shaped, the face length must be the largest of all the measurements and the cheekbones, forehead and jawline are in descending order. The chin is pointed.

From the difference in the description of oblong faces and the above description of diamond faces, I concluded that a face cannot be inferred as oblong and diamond; it can only be one of them. After analyzing measurements of 100 diamond faces, I could confirm that the face length is considerably larger than the other measurements and the cheekbones, forehead and jawline are in descending order. Another observation that increased accuracy in classifying diamond faces was that the jawline is usually at most 76% the size of the cheekbones, that is, the ratio of cheekbones to jawline is at least 1.24.

Triangular

For a face to be 'triangular', the jawline, cheekbones and forehead are in descending order. The face length can be of any length. Unfortunately, I did not have access to a labelled data/input for triangular faces because of which further trends in measurements could not be identified. Thus, the only guide for classifying a face as triangular is the description offered by the Birchbox guide.

Oval

For a face to be 'oval' the face length is considerably larger than the cheekbones and the forehead is larger than the jawline. The angle of the jaw is rounded.

After analyzing the measurements of 100 oval faces, I was able to confirm that the face length is indeed very large when compared to the cheekbones and the forehead is always greater than the jawline, even by the slightest margins in some cases. The cheekbones are larger than the jawline just like in the case of diamond but the ratio of cheekbones to jawline in this is usually less than 1.24. The forehead is also larger than the jawline and the ratio of forehead to jawline is at least 1.1.

Conclusion and Future Work

I have presented in this paper the purpose behind the development of an algorithm, for Lenskart.com, that would classify an individual's face into a shape, the methods and tools used to get the data required for the process of classification and the algorithm, that is, a set of criteria for each shape type that a face can be classified into. Coming up with the algorithm was a strenuous process of trial and error and the result of having a keen eye for trends in face attribute measurements (the four measurements used for the classification process). The absence of another data set of labelled images prevented me from testing the algorithm thoroughly and thus improve it even more.

Another approach to this face shape classification problem is by using a convolutional neural network such as a retrained Inception v3 model. The model can be retrained using images of outlines such as the ones in Fig 1 and Fig 2. The input to the model can be an outline of the face which can be produced by plotting the face outline coordinates obtained from the Face++ Dense Facial Landmarks API (Fig 4) using a library in python. The accuracy of this retrained model will be definitely and significantly be better than the accuracy of the algorithm detailed in this paper. This approach was not undertaken due to time and resource constraints.