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Analysis of android application based on images in cellular phone

Abstract

The research of accuracy rates of freeware for android has been done. Smartphone applications which interest author are Face Age, Guess my Age, How Hot are you, face, and Golden Ratio Face Rater. Both Face Age and Guess my Age used artificial intelligence to predict age of people in the image. How hot you, nFace, and Golden Ratio Face Rater are used golden ratio symmetry and proportional to decide how attracting people based their images. All freeware was installed on Smartphone operating system Android KITKAT 4.4 with random access memory 0.5 gigabytes. We get 73.98% for average accuracy rates for Face Age and 71.05% for Guess my Age. How hot are you give us 21% more accurate than Golden Ratio Face Rater and nFace which each have accuracy rates about 15%.

Keywords: image, freeware, android, golden ratio, artificial intelligence

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Introduction

Cellular phone based android operating system as known as Smartphone. Nowadays, we commonly use Smartphone to communicate with other peoples. It offers many variant application and easy access social media such as whatsapp and line. There is a lot of game which you can download free or prepaid in Google play store. We focused our research in freeware nFace, how hot are you (HHAY), Guess my Age (GMA), Face Age (FA), and Golden Ratio Face Rater (GRFR). To create a machine that indistinguishable from human intelligence, a good artificial intelligence (AI) is essential. Then, we want that machine to understand that even difficult to describe by spoken language. These machines had been well known as Machine Learning (ML). With Machine Learning algorithms and exploitation of computer, we can process image data which previously required power beyond the capabilities of mobile devices. There are four major Smartphone platforms available Apple's iOs, Google's Android, Microsoft Windows Phone and RIM Blackberry. Most researcher had chosen android as platform for the mobile application because several reasons. First, it has the advantage of being free to develop for and development can be done on any platform. It also there are ports of popular computer vision libraries and the android SDK (Software Development Kit) includes APIs (Application Programming Interface) for face detection. Android SDK was used to create application that able to call phone's camera to allow the user for take photos. The native code which performs the prediction is platform independent. So it will be feasible to use on other platforms. For the users benefit, researcher chooses automatic facial analysis to avoid monotonous task.

They also mostly prefer local facial analysis. This is to remove a reliance on network connectivity. But, local facial did not feasible when the goal is to perform analysis in real time. A mobile application should able take photograph using Smartphone's camera, identify faces within photograph, calculate the beauty of selected face and have no dependency on network connectivity. The mobile application should also perform anywhere under different lighting conditions. If it a responsive application will be plus benefit so the application runs at 60 frames per second. Researcher want to create mobile application which does not need the land marking of features, able to retain accuracy without dependent of lighting conditions, angle of face, and skin tone, also be able to output a score in less 10 second on 1 gigahertz processor. There some choice of technique. Golden ratio has benefit of skin tone and lighting independent, but it needs labeling of landmark features. For Eigen faces does not need landmark but perform poorly when there is variance in lighting or pose. The dataset is color images of female faces. It has large range of different poses, under different lighting condition and different age or races. Even predictive model comes with the fact that the data only contain female images, it is does not undermine the goal to demonstrate facial attractiveness prediction on mobile devices.

Facial beauty is a quite interesting topic that can be investigated by many aspects. Most researchers study facial beauty perception for two reasons. First, facial beauty has insight to human behavior and biological benefit. It also gives practical guides for practical application such as aesthetic surgery plans and photo retouching. One important issue is whether beauty is in the eye of the beholder or has a universal standard. Some studies said that although individual and cross-cultural differences exist, people use similar standard in their judgments about facial beauty. Then, this is making a base for facial beauty research. The most important concern is to determine what feature that associated with facial beauty. Many people had believed that golden ratio is underlying beautiful faces as ancient times. Since year 2000, computer scientist has attracted to this topic and used biometric techniques to modeling facial beauty. We believed that golden ratio is an idealized description of facial beauty although they are not really accurate. It can be corrected by measurement on the target population. Beside golden ratio, vertical thirds and horizontal fifths rules was also proposed to underlying beautiful faces. The vertical thirds rules divide length of the face intro three equal length parts. First, we measure from hairline to eyebrow. Next, we measure eyebrow to nasal floor. Lastly, we also measure from nasal floor to chin. For horizontal rules, we divide the width of the face into five equal widths. If a face conforms to these rules, then that face can be considered as beautiful face. However, beautiful faces do not often conform to the vertical thirds and horizontal fifths rules.

Averageness also considered relate to facial attractiveness, but it is not only determinant. Average faces are considered as attractive but not optimally attractive. It does not mean that attractive face is average. Facial symmetry is also another trait of facial beauty. Facial beauty perception is quite complex. The methodology of facial symmetry is similar to what method that averageness hypothesis used. We generate symmetrical faces with image processing techniques, but its conclusion is controversial. Some said that perfectly symmetric

faces more attractive than slightly asymmetric faces when some said not. Even symmetry correlated with facial beauty, but it is not major determinant factor and amount of effect of symmetry on facial attractiveness is still not clear. Although like that, both golden ratio, the vertical thirds and horizontal fifths rules, facial symmetry skin smoothness, and averageness is widely used as additional feature to decide facial attractiveness calculation and modelling. Nowadays, to do some facial beauty analysis by biometrics technology, we should do as follow. We build databases for facial beauty analysis and applications, and then decide which facial features work best for facial beauty analysis. We can build computational models to map facial beauty to a facial beauty score to develop its applications. Most databases were collected by authors and it also needs beauty scores. The beauty score measured by average human rating conventionally. But it will time-consuming and labor-intensive. Many types of features have been adopted to decide perceived attractiveness. After extract the features, we can build computational models using the ratio features as dependent variables. The feature can be divided to two. First, holistic features such as shape, eigenface, averageness and symmetry. Then, local features such as Gabor filter responses and Local Binary Pattern. To understand what a local feature is, we will have a brief explanation about Gabor filter. Gabor filters give benefits such as excellent band-pass filters for unidimensional signal. A complex Gabor filter is defined as Gaussian kernel times a complex sinusoid and can be written as follow.[1]

Where

$$g(t)=ke^{j\theta}\omega(at)s(t) \tag{1.1}$$

$$\omega(at)=e^{-\pi t^2} \tag{1.2}$$

$$s(t)=e^{j(2\pi f_o t)} \tag{1.3}$$

$$e^{j\theta}s(t)e^{j(2\pi f_o t+\theta)}=(\sin(2\pi f_o t+\theta),j\cos(2\pi f_o t+\theta)) \tag{1.4}$$

With k,θ, f_o are filter parameters. Gabor filter has two parts as complex functions, the real part $g_r(t)$ and the imaginary part $g_i(t)$ that holds the filter as follow.

$$g_r(t)=\omega(t)\sin(2\pi f_o t+\theta) \tag{1.5}$$

$$g_i(t)=\omega(t)\cos(2\pi f_o t+\theta) \tag{1.6}$$

At space domain (2 dimensional), we have Gabor filter as

$$g(x,y)=s(x,y)\omega_r(x,y) \tag{1.7}$$

Where s(x,y) is a complex sinusoid and $\omega_r(x,y)$ is two dimensional Gaussian-shaped function. First term has known as the carrier and the latter as the envelope. The complex sinusoid carrier may define as,

$$s(x,y)=\exp(j(2\pi(u_0x+v_0y)+P)) \tag{1.8}$$

Where (u_0,v_0) is spatial frequency and P is phase of the sinusoid. The Gaussian envelope can be written as

$$\omega_r(x,y)=K\exp\left(-\pi\left(a^2(x-x_0)_r{}^2+b^2(y-y_0)_r{}^2\right)\right) \tag{1.9}$$

With

$$(x-x_0)_r=(x-x_0)\cos\theta+(y-y_0)\sin\theta \tag{1.10}$$

$$(y-y_0)_r=-(x-x_0)\sin\theta+(y-y_0)\cos\theta \tag{1.11}$$

Where K is scales the of Gaussian envelope, (a,b) is scale the two axis of Gaussian envelope, θ is rotation angle of the Gaussian envelope, P is phase of the sinusoid carrier, and (x_0,y_0) is location of the peak of the Gaussian envelope. Now, equation (1.7) can be written as complex Gabor function in space domain

$$g(x,y)=K\exp\left(-\pi\left(a^2(x-x_0)_r{}^2+b^2(y-y_0)_r{}^2\right)\right)\exp(j(2\pi(u_0x+v_0y)+P)) \tag{1.12}$$

This equation has two dimensional Fourier transform as follow

$$\hat{g}(u,v)=\frac{K}{ab}\exp\left(-\pi\left(\frac{(u-u_0)_r{}^2}{a^2}+\frac{(v-v_0)_r{}^2}{b^2}\right)\right)\exp(j(-2\pi(x_0(u-u_0)+y_0(v-v_0))+P)) \tag{1.13}$$

Beside holistic feature and local feature, scientists also use a combination of multiple facial features to build facial beauty models. To build a computational model, we generally prepare a training data set, including facial images and their corresponding beauty score. Then, we extract facial features from facial images. Lastly, we build a model by supervised learning technique such as multivariate linear regression and support vector regression. To also understand what linear regression is, we will have a brief explanation about it as follow. Linear regression is a learning algorithm that finds best fit of line for a given set of data. It also can to estimate the values of unseen data points. Simple linear regression models the relation between a dependent or response and one independent variable. It can define as (www.mathworks.com)

$$y=\beta_0+\beta_1x+\in \tag{1.14}$$

here y is the slope or regression coefficient and $\in$ is the error term. We begin with set of observed values (x_1,y_1), (x_2,y_2), …, (x_n,y_n) and make these values in matrix form to represent linear equation as

$$\begin{bmatrix}y_1\\y_2\\\vdots\\y_n\end{bmatrix}=\begin{bmatrix}1&x_1\\1&x_2\\\vdots&\vdots\\1&x_n\end{bmatrix}\begin{bmatrix}\beta_0\\\beta_1\end{bmatrix} \tag{1.15}$$

Let

$$Y=\begin{bmatrix}y_1\\y_2\\\vdots\\y_n\end{bmatrix},\quad X=\begin{bmatrix}1&x_1\\1&x_2\\\vdots&\vdots\\1&x_n\end{bmatrix},\quad B=\begin{bmatrix}\beta_0\\\beta_1\end{bmatrix} \tag{1.16}$$

As equation (1.16), we see that relation is Y=XB. In Matlab, you can use the\operator which perform least-square regression as B=X \ Y. The script as follow.

```
load name_of_file
x=hwydata(:,14); %Population of state
y=hwydata(:,4); %Accident of state
format long
b1=x\y %Slope of regression coefficient
yCalc1=b1*x ;
scatter(x,y)
hold on
```

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```
grid on
plot(x,yCalc1))
X = [ones(length(x),1), x] ] %Calculate  by padding x with column of ones
b=X\y
yCalc2=X*b ;
plot(x,yCalc2,'***')
grid on
```

Generally, the workflow can be divided into three phases. We outline them as follows. Phase 1, we do some investigation for predicting facial beauty. It is involving review of the literature, obtaining dataset that can be used to learn the model and trying various approaches to find the most suitable technique for implementation. Phase 2, we are using any dataset and approach from previous phase. We create a learnt model for predicting facial beauty. We also make a representation of this model to be recreated in next step. Phase 3, we implement a mobile application that capable of predicting facial beauty using learnt model from previous phase. Facial beauty assessment is a real deal in real application. We can get higher facial beauty prediction accuracy by using optimized feature set. As we know that computational models were built using machine learning methods such as linear regression, the model were usually evaluated by Pearson correlation between machines predicted attractiveness and human rating score. Facial beauty perception is a function of facial features. Pearson correlation is a statistical measure of the strength of a linear relationship between a paired dataset. It can denote by *r* and have constrained as follows (www.statstutor.ac.uk):

$$-1 \le r \le 1 \qquad (1.17)$$

Positive values denote positive linear correlation when negative values denote negative linear correlation. A value of null indicated that there is no linear correlation. The closer the value to 1 or -1, the stronger linear correlation. When r =1 or r = -1, we say that we have a perfect correlation. It means the point being in a perfect straight line. We also have to remember that the correlation does not relate to the gradient beyond sharing its sign. Pearson correlation is a measure for linear relationship and thus a value of r= 0 does not imply that there is no relationship between variables. We can describe the strength of correlation using guide that Evans (1996) have suggest for absolute value r. For example, correlation value of r =.20 would be weak positive correlation while r=.80 would be a very strong positive correlation. Although individual perception different exist, but may share some identical properties. One application of facial beauty perception is face beautification. Each hypothesis has tendency corresponds to one approach. If one application used averageness method then it evokes a beautification method that warps face to the average face.

The same thing also happens when application used symmetry that makes a face ideally symmetric. All methods cannot guarantee that result will beautiful. Some application prefers used phi mask by golden ratio methods that makes a face satisfy the most possible golden ratios. Instead of exploring what traits make a face attractive, there is some new hypothesis that focuses on discovering general characteristic of the perception functions such as weighted average method. The weighted average hypothesis by examining computational models. When we learn that the model from data received consistently supportive result, then we carried out perceptual experiment to validate the hypothesis. As article on applied perception by Fangmei et al (2014), the corollary of weighted average is that attractive facial geometric features construct a convex set it derives a convex hull based face beautification methods. This method is compatible with mainstream hypotheses such as symmetry and golden ratio methods. Application nFace, Golden Ratio Face Rater, and How Hot are you can decide attractiveness rate from uploaded images. It used golden ratio symmetry and proportional Φ (phi) that about 1.1618.[2] Golden ratio has been defined by result of university study Pamela M. Pallet, Stephen Link, and Kang Lee, but supported by university study in 2009.[3] It has been debated as beauty standard because a paradigm that beauty is subjective and different for every race and region. The paradigm has been defined by Dr. Stephen Marquardt, an oral and maxillofacial surgeon. In his research, Dr. Stephen found that beauty is universal and can decide for both gender used beauty mask based pentagon and hexagon that contain phi in its dimension.[2] The beauty in human can almost fulfill golden ratio whilst smile.[2] Dr. Kendra Schmid, an assistant professor of biostatics, divide attractiveness rate into score 1–10 if: (i) length of face is about 1.5 times its width; (ii) have almost same distance while face divide by three horizontally; and (iii) length of ear and nose is same also width of eyes and distance between eyes is same.[4]

The attractiveness rate from tested applications will be compared by golden ratio scale. Accuracy rate can be get from sum of images which equivalent with golden ratio and divide by sum of samples. The accuracy rate shows how good a results or how accurate a prediction if compared by true value. In mathematical, an attractiveness rate can be written

$$\frac{\sum \bigcap HHAY, Nface, GRFR^{C}}{\sum n} \times 100\% \qquad (1.18)$$

Whereas $\bigcap HHAY, Nface, GRFR^{C}$ intersection from tested application which equivalent with golden ratio and n is sum of images. For accuracy rate of age prediction is ratio of age prediction and true age, or can be written as

$$\frac{\sum \left(\frac{Age\ prediction}{True\ age} \times 100\% \right)}{\sum n} \qquad (1.19)$$

Application Guess my Age and Face Age can predict age of people used artificial intelligence from Microsoft. We want to know how accurate these freeware in predicting age. We also want to know how accurate that nFace, Golden Ratio Face Rater, and How Hot are you in deciding attractiveness rate.

Experiment methods

We have chosen freeware for android based on its rating minimal got three stars and has been downloaded minimal 1,000 times. The freeware which can access in Google play store are Guess my Age by GlintTecApps, Face Age by NeoAndroid in Cos, nFace by Cubadomus, How Hot are You by Dainty Apps, and Golden Ratio Face Rater by Hue Studio. All freeware has been installed in android Smartphone Operating System KITKAT 4.4.4 with CPU Dualcore which its speed 1.2 gigahertz and Random Access Memory 0.5 gigabyte. Images contain people that age ranges between 20 years old to 60 years old. We used 110 piece images for each freeware. It needs internet connection for operating such as Face Age, Golden Ratio Face Rater, and Guess my Age, but the later go offline. All images that we used in this research belong to the author.

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Result and discussions

We test the freeware beforehand with synthetic images which contain different shapes (such as circle, square, triangle, and hexagon) and animal images about three times. This should be done to ensure that application runs well or not. All freeware show result that the application did not detect any faces in the images repeatedly consistent. The freeware used face recognition system, so if any application can detect face in the images (Figure 1) then applications is not running well and did not use for this experiment. After verified that all freeware in good conditions, then we test our images sample for each application. We used original images that captured in almost same resolution, orientation, illumination, and expressions. Those images should have less variability and high quality as database which suggestive for facial beauty analysis.[5] Figure 2 shows age prediction by Face Age. We need theoretic trending for comparison. It figured as linear graphic which means age prediction should be the same with real age of object. We get the highest accuracy rate from Face Age about 98.59% and the lowest about 39.28%. Images with the lowest accuracy are containing two peoples which located behind main face and it tilted that detected. The average accuracy rate of Face Age is satisfactory about 73.98%. This application can detect multiple faces in same image. It also offers gender detection, sunglasses and smile detection. From all sample, it is not found mistake in those three aspects. From all sample, images that have people wear sunglasses will say 'sunglasses' and 'non-sunglasses' for that have not. Face Age shows that smile 0% whilst people do not smile, 100% whilst people have full smile, and percentage between 0%−100% whilst people do not have full smile. Figure 3 shows age prediction result from Guess my Age. The highest accuracy rate is 98.30% and the lowest accuracy rate is 47.36%, while average accuracy rate is 71.05%. Guess my Age only offer age prediction and gender detection with picture icon. Even it cannot detect multiple faces in same images, but give exact gender detection.

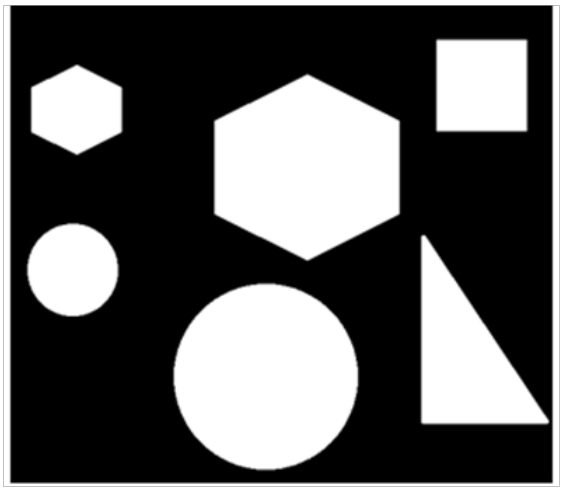

Figure 1 Synthetic images are containing different shapes.

The use of make up in people is effecting the age prediction by Face Age and Guess my Age (Figure 4). The result show that age prediction by Guess my Age with makeup and Face Age without make up almost has same trending. For age prediction by Guess my Age without make up and Face Age with makeup, it has slight different trending. We can say that the effect of makeup is not significant. Table 1 shows comparison of age prediction result by both freeware between people with makeup and without make up. For Face Age, there is a significant different in fourth row and sixth row. The makeup face makes age prediction younger than non-make up face in images with people 56 years old. For Guess my Age, we see a significant different in first row, third row, fourth row, and sixth row. In first row, Guess my Age predicts a makeup face older than non-make up face, but in later rows it predict younger than non-make up face. The accuracy of age prediction both application averages to 66.94% for makeup face and 70.91% for non-make up face.

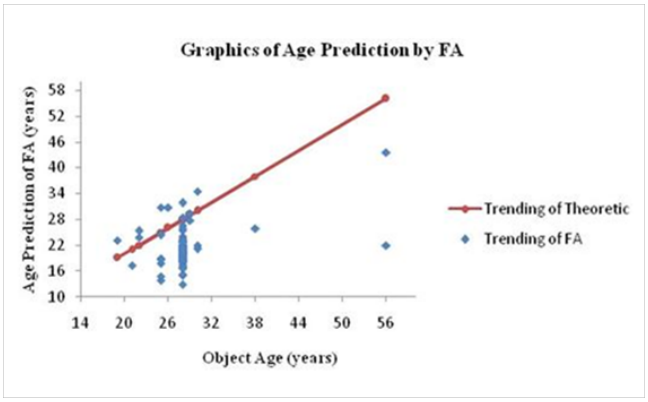

Figure 2 Graphics of face age result.

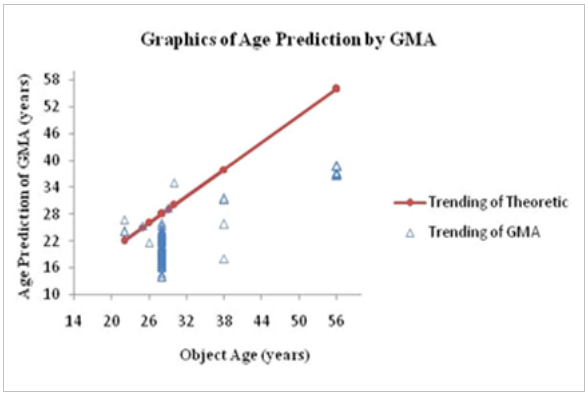

Figure 3 Graphics of guess my age result.

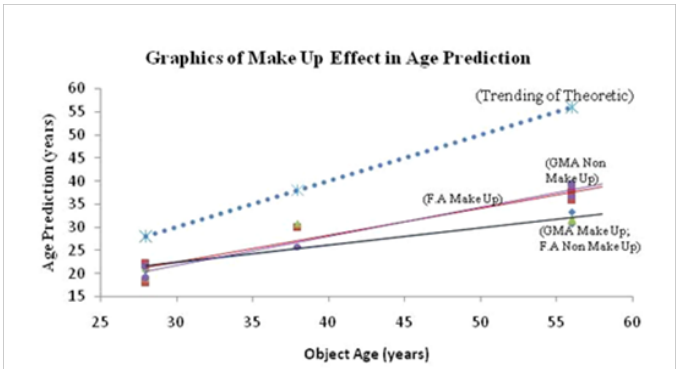

Figure 4 Graphics of comparison result between face age and guess my age.

The position of face should straight to camera. If it tilted can make application may not detect face. Even it detected, age prediction or attractiveness rate can be less accurate. This is because attractiveness rate used golden ratio symmetry and proportional that measure when face forward.[5,6] Application How hot are you have six categories (such as 'hmm', 'ok', 'nice', 'hot', stunning', and 'godlike') more

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many than nFace and Golden Ratio Face Rater that both have four categories (Table 2). It is shows that how hot are you indicate more accurate than later application. Symmetry and proportional of golden ratio give beauty scale standard from 1–10 with ten are the perfect score.[7] Score 9.0–10.0 seems unrealistic or image has been retouched. Score 8.0–8.9 shows very attractive face (labeled by 'cute', 'sexy', 'hot', 'stunning', or 'godlike'), while score 7.0–7.9 shows attractive face (labeled by 'nice' or 'normal'). Average face shows by score 6.0–6.9 (labeled by 'normal' or 'ok') and score ≤5.9 indicate unattractive face (labeled by 'hmm' or 'mmm'). A bit different, Golden Ratio Face Rater have score 7.5–8.9 for attractive face (labeled by 'beautiful'), and score <5.0 indicate unattractive face (labeled by 'ugly'). While compare the application, we get low accuracy rate about 60%. This can happen because nFace and Golden Ratio Face Rater only measure face symmetry whilst How hot are you is not. Face symmetry alone cannot use to decide the attractiveness rate. Mostly, face that considered as beautiful have non-perfect symmetry[8] or average face.[5] How hot are you have[9] about 36% more accurate than nFace and Golden Ratio Face Rater which only 15%.[10,11]

Table 1 Comparison of age prediction between image with makeup and without make up. The units are in years

Object age	Face age		Guess my age	
	Make up	Non-make up	Make up	Non-make up
38	30.2	29.9	30.7	25.8
28	20.7	22.1	21.3	21.5
56	33.3	35.9	31.4	39.4
56	30.8	37.6	31.5	36.7
28	19.3	17.9	21.3	18.9
56	30.7	38	31.8	38.9
28	21.2	21.8	19	21.5

Table 2 Comparison of attractiveness scale based on golden ratio

Symmetry and proportional of golden ratio (Ivonnete, Katie: 2011)	Freeware		
	How hot are you	nFace	Golden ratio face rater
≤ 5.9	Hmm	Mmm	Ugly (<5.0)
6.0–6.9	Ok	Normal	Normal
7.0–7.9	Nice		
8.0–8.9	Hot	Cute	Beautiful (7.5–8.9)
	Stunning	Sexy	
9.0–10.0	Godlike		
	Unrealistic Result		Perfect

Conclusion

Age prediction used artificial intelligence by Microsoft has highest accuracy rate about 98.59% and lowest accuracy rate about 39.28% for Face Age. Face Age have average accuracy rate about 74.98% and it offers multiple faces detection, gender detection, sunglasses, and smile detection. For Guess my Age, highest accuracy rate about 98.30% while lowest accuracy rate about 47.36%. Guess my Age gives average accuracy rate about 71.05%. Guess my Age offers age prediction and gender detection. Attractiveness determination have low accuracy rate about 60%. It can happen because nFace and Golden Ratio Face Rater only measure face symmetry while beauty face is not necessary have perfect face symmetry. Freeware How hot is you have 21% more accurate than nFace and Golden Ratio Face Rater?

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Conflicts of interest

The author declares there is no conflict of interest.

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