1.What is the difference between a biometric system operating in verification and recognition modes?

As for verification, it is just like “Are you who you say you are”.And verification is 1 to 1 match.
In a verification event, there are always four steps:1.An identity is asserted,e.g.“I am a super star”. 2.Enrolled template of claimed identity is retrieved. 3.New template acquired,compared to retrieved one. 4.Claimed identity verified(accepted) or rejected.
Because verification systems only need to compare the presented biometric to biometric reference stored in the system, they can generate results more quickly and are more accurate than recognition systems,even when the size of the database increases.

As for recognition,it is just like “Who is this person”. And recognition is 1 to N match.
In a recognition event, there are three steps:1.No identity is asserted. 2.Template for recognition is acquired. 3. Template for recognition is matched against all enrolled templates to find the best match.

2.What is the difference between open set 1-to-N matching and closed set 1-to-N matching?

First, I will explain what is 1-to-N matching. This is a type of application involves matching against all N enrolled identities to determine which one matches. Recognition involves 1-to-N matching.
If the template to be recognized is assumed to always match some enrolled template, this is called a “closed set” problem.In “closed set”.Such as in a closed-set face 1to N match,the core question is“whose face is this?”
So in closed-set 1-to-N matching,only subjects known to be in the gallery are searched.The system’s ability to identify the subject is evaluated based on the fraction of searches in which the probe images scored at rank k or higher.The relationship between identification rate and rank may be graphed on a Cumulative Match Characteristic(CMC) curve.

If the template to be recognized may not match any enrolled template, this is called a “open set” problem.In open set.Such as in a open-set face 1to N match,the core question is“Do we know this face?”
In open-set 1:N matching, each subject is searched against the gallery,and an alarm is raised if the subject occurs in the gallery. A subject is considered to be “in the gallery” if the probe image scored above the threshold at the rank k or higher.In evaluation,the system’s ability to detect and identify is measured as two rates: the true accept rate and the false accept rate. An open-set 1-to-N matching ROC plots TAR vs. FAR. This may be generalized using rank,where the subject must be detected and identified at rank k or better.

3.In a verification system, when a person makes an identity claim that is true, it ends up as one of what two types of results?

True Accept(True match) or False Reject(False non-match).

4.In a verification system, when a person makes an identity claim that is false, it ends up as one of what two types of results?

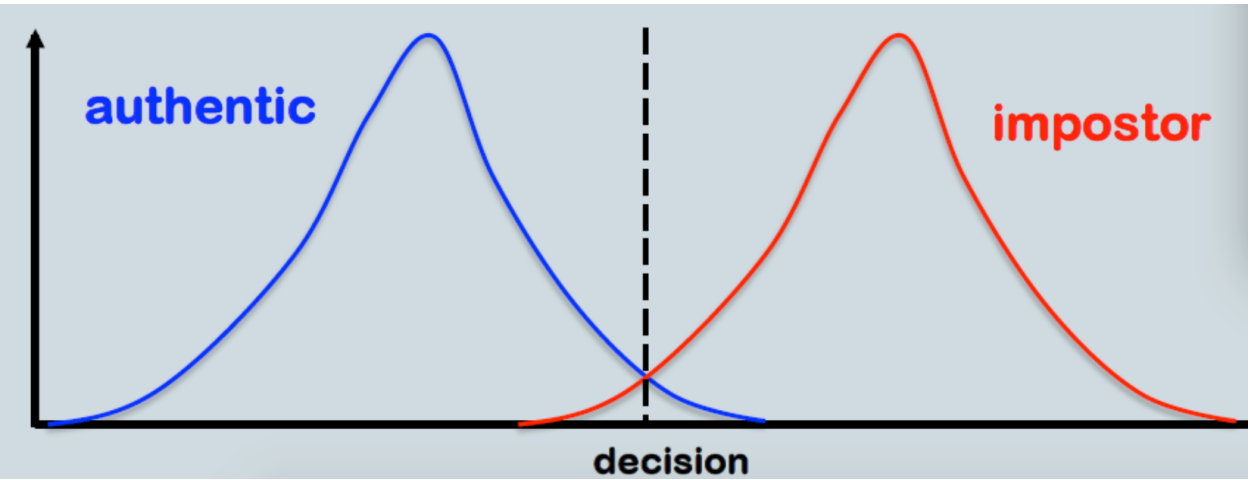
False Accept(False match) or True Reject(True non-match).

5.In a verification system that uses a similarity score (the greater the score is, the more similar the two templates are), as opposed to a difference score, what happens to the False Match Rate and the False Non-Match Rate if the value of the decision threshold is increased?

Increasing the decision threshold means it becomes harder to match with a template,because the score has to be greater than the threshold to claim this is a match.
The False match rate (FMR) will decrease.
The False Non-match Rate(FNMR) will increase.

6.What makes up the authentic distribution and what makes up the imposter distribution?

The family of true claim scores is called the authentic distribution, or sometimes the genuine distribution.Different true identity claims will result in different match scores.
The family of false identity claim scores is called the impostor distribution.

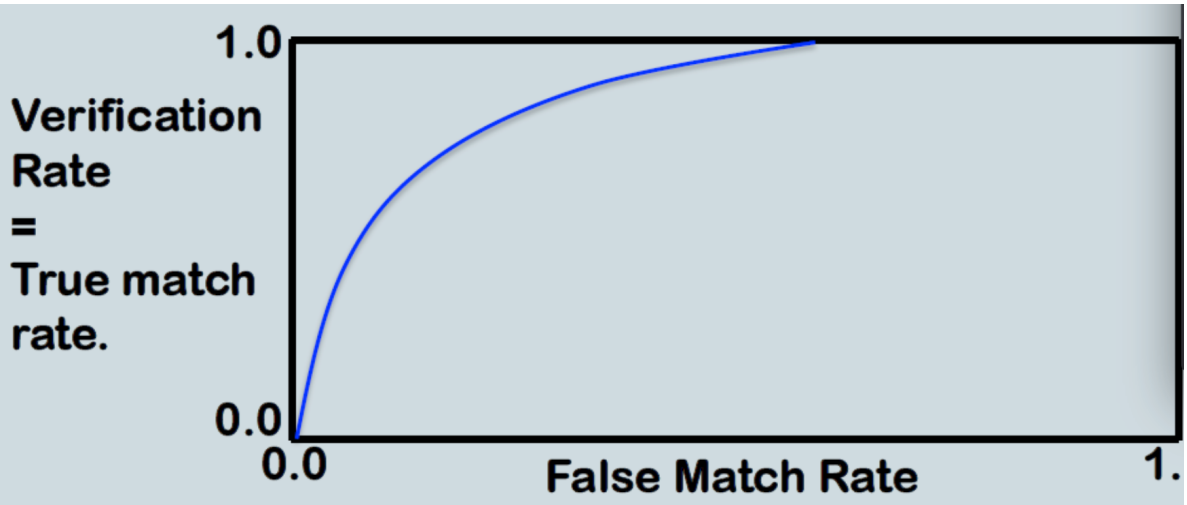


So the authentic distribution consists of two parts:
1.True match:authentic comparison with match score below threshold
2.False non-match:authentic comparison with score above threshold

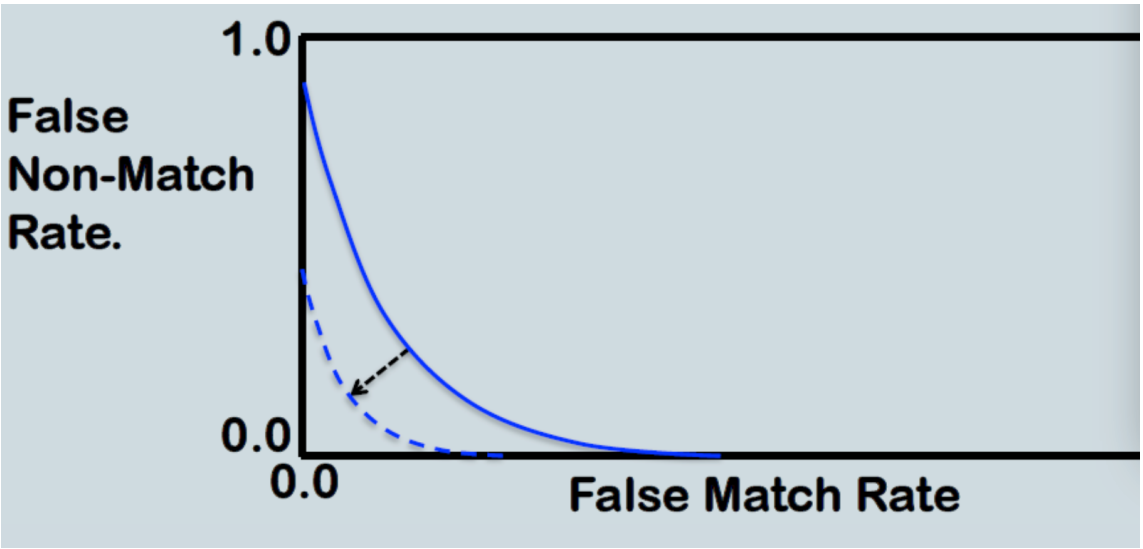
The imposter distribution consists of two parts:
1.True non-match:imposter comparison with score above threshold.
2.False match:impostor comparison with score below threshold.

7.Explain what is ROC (Receiver Operating Characteristic) curve or DET (Detection Error Tradeoff) curve?

This is a sample of ROC curve. ROC curve is used in verification system. The True match rate is the Y axis and the False Match Rate is the x axis at various threshold setting.In this form of ROC curve, a better core is toward the upper left.

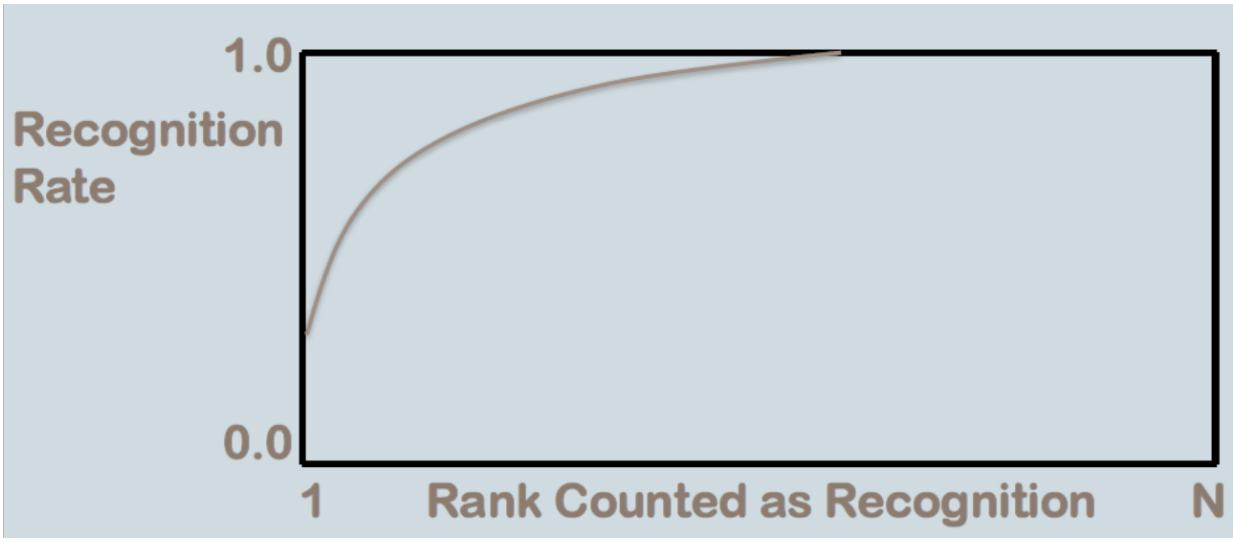


This is another form of ROC curve. FNMR is the Y axis. better is to the lower left. And this is the DET curve.



8.Explain what is CMC (Cumulative Match Characteristic) curve?

In a recognition system, performance is evaluated by how often the closet match is the correct identity,the rank one recognition rate. Below is a sample of CMC curve. CMC curve is used as a measure of 1:n recognition system. It judges the ranking capabilities of an recognition system. It plot the recognition rate at rank-k. A probe is given rank-k when the actual subject is ranked in position k by an recognition system. The recognition rate is an estimate of the probability that a subject is recognized correctly at least at rank-k. Hence, recognition rate is necessarily an increasing function of k.



9.Explain the primary reason that all commercial iris recognition technology uses near-infrared illumination, as opposed to visible light

Light-colored irises may look similar in visible light and near infrared.But using near-IR allows usable texture imaging even for “dark” irises.The spectrum of near-infrared is nearer to the spectrum of actual system than visible light spectrum. Using visible light will have loss for “dark” irises. So they use the near-infrared illumination, instead of the visible light.

10.Explain why it is necessary, in the Daugman-style approach to iris recognition, to have an estimate for the part of the iris-sclera boundary that is occluded.

Because iris image segmentation plays an important role in an Daugman-style approach to iris recognition system since success of the system in upcoming stages is directly dependent on the precision of this stage.The main purpose of segmentation stage is to localize the two iris boundaries namely, inner boundary of iris-pupil and outer one of iris-sclera. And we don’t use the code generated by this iris-sclera part this is occluded.we need to estimate that and drop it to ensure that this part are not to be used.

11.What is done to improve the chances of finding the correct iris-sclera boundary even in the case where it is partially occluded by eyelid

The first way to only localize the left and the right iris-sclera boundaries and not localize the upper and lower boundaries,which can still get the iris-sclera boundary.
The second way is to use a 1D rank filter and histogram filter. A raw eyelid edge map is calculated in this method and the exact shape of the eyelid is obtained by parabolic curve fitting.
The third way is: Canny edge detection is performed on eye image in pre-processing stage. By performing such edge detection, a matrix is obtained with the same dimensions as of the image itself which its elements are high in areas where there is a definite boundary and the elements are low in areas where there is no perfectly definite boundary, such as iris outer boundary. Through multiplying of 2.76 in the matrix of pixel values of iris image and intensifying light in eye

image, the edges are enhanced. Applying Canny edge detection and multiplying that to the constant value of 2.76 result in better revelation of iris outer boundary edge points.

12.What is the size of the data structure that would be used to accumulate intermediate results in Hough transform for circular outlines with a radius of 15 to 30 in a 240 x 480 image?

Because the radius is 15 to 30, so the center of the circular should outlines be in 15 to 225 and 15 to 465. So the size of the area is 210*450*16=94500*16=1512000.

13.The Gabor filter is a combination of what two functions?

A Gaussian kernel function modulated by a sinusoidal plane wave(Gabor filter = Gaussian * sinusoid).

14.Does rotational shifting to align the iris codes changes the imposter distribution, the authentic distribution, or both? How?

Iris codes from different images of the same eye have to be rotationally aligned in order to match. This is done by matching multiple times with rotational shifts of the code.
So both the imposter distribution and authentic distribution will change. For a given threshold, shifting will decrease the FRR and increase the FAR.

15.What is the number of Gabor filter results in the standard Daugman “iris code” format? Given the standard Daugman “iris code” has 2048 bits.

Daugman keeps only the sign of the Re and Im parts of the result; the phase,or the quadrant in the complex plane. Which means one result=2 bits of iris code.

So there will be 1024 results.

16.What is an eigenface?

Eigenface can be thought of as the principal components of initial training set of the face images. Recognition is performed by projecting a new image into the subspace spanned by the eigenfaces and then classifying the face by comparing its position in face space with the positions of known individuals.
Engenface is the name given a set of eigenvectors when they are used in the face recognition.The eigenvectors are derived from the covariance matrix of the probability distribution over the high-dimensional vector space of face images.The eigenfaces form a basis set of all images used to construct the covariance matrix.This produces dimension reduction by allowing the smaller set of basis images to represent the original training images. Classification can be achieved by comparing how faces are represented by the basis set.
The approach to face recognition involves the following steps:
1.Acquire an initial set of face images.(the training set)

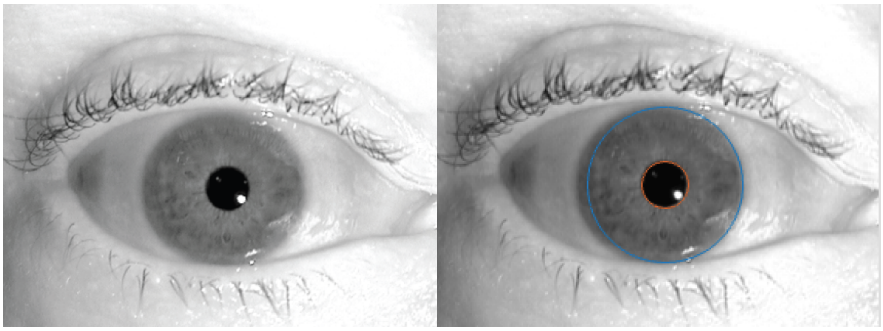
2.Calculate the eigenfaces from the training set,keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced , the eigenfaces can be updated or recalculated.
3. Calculate the corresponding distribution in M-dimensional weight space for each known individual, by projecting their face images onto the “face space”

17.The training phase of the eigenface method results in what items that are used for face recognition?

Mean face, eigenvectors, projected enrolled images.

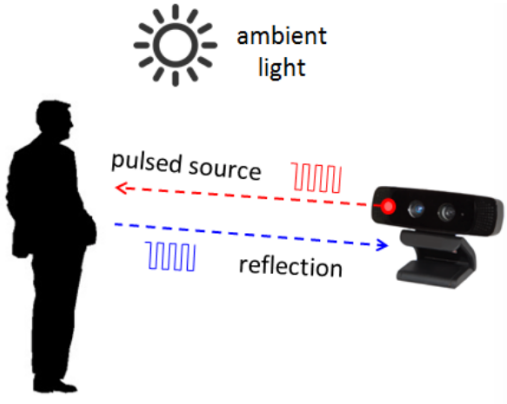
Because the step is:
1.Acquire an initial set of face images.(the training set)
2.Calculate the eigenfaces from the training set,keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced , the eigenfaces can be updated or recalculated.
3. Calculate the corresponding distribution in M-dimensional weight space for each known individual, by projecting their face images onto the “face space”

18.Please segment iris manually (highlight the boundaries of iris) in the picture below.



19.Explain what is the time-of-flight based sensing technology to acquire 3D face?

It can provide 3D imaging using a low-cost CMOS pixel array together with an active modulated light source.And we can use this to acquire 3D face.



It works by illuminating the scene with a modulated light source and observing the reflected light. The phase shift between the illumination and the reflection is measured and translated to distance.Typically, the illumination is from a solid-state laser or a LED operating in the near-infrared range (~850nm) invisible to the human eyes. An imaging sensor designed to respond to the same spectrum receives the light and converts the photonic energy to electrical current. Note that the light entering the sensor has an ambient component and a reflected component. Distance (depth) information is only embedded in the reflected component. Therefore, high ambient component reduces the signal to noise ratio (SNR).To detect phase shifts between the illumination and the reflection, the light source is pulsed or modulated by a continuous-wave (CW), source, typically a sinusoid or square wave. Square wave modulation is more common because it can be easily realized using digital circuits.Pulsed modulation can be achieved by integrating photoelectrons from the reflected light, or by starting a fast counter at the first detection of the reflection. The latter requires a fast photo-detector, usually a single-photon avalanche diode (SPAD). This counting approach necessitates fast electronics, since achieving 1 millimeter accuracy requires timing a pulse of 6.6 picoseconds in duration. This level of accuracy is nearly impossible to achieve in silicon at room temperature.

20. Sketch out how you would use a face recognition system to aid the task of finding out who had created multiple identities with different driver's licenses?

Formal system about driver licenses only compared an applicant's new photo with his old photo in database. This one-to-one match only helps if someone is trying to get his picture on your driver's license. I will use face recognition system to ensure that people don't have licenses under another name. So this will be a one-to many match. And the system will search the similar images in database. And this system must be resistant to changes in lighting, skin tone,hairstyle,eyeglasses and so on.
First we need to use face detection to detect face and extract the face. Then we use face recognition technique, like feature matching to find out multiple same images. Then it will be easy to find most similarity images. The most similarity images will be the results we are looking for.