# Face Recognition EigenFace

## Overview

**PCA**
PCA Algorithm reduces dimensionality of a dataset to low dimension subspace by linear projection such that reconstruction error is minimal.

**Eigen Faces**
Using PCA, we can find the vectors of the covariance matrix of the image that best account for the distribution of the image in the entire space or we can say eigenvectors with highest eigenvalues. So each image can be represented as a linear combination of the eigen faces.

## Algorithm

There are 546 (112 X 92) grayscale face images.
Converting matrix into a column matrix of size (112*92).
We have all 546 images in matrix A of size (112*92 X 546).

1. First the mean of all the images is calculated.
2. A_tilde stores all image vectors A - A mean
3. Covariance matrix of A_tilde is calculated
4. C = 1/m(A_tilde. Tran(A_tilde))
5. L = 1/m(Tran(A_tilde).A_tilde)
6. C & L have the same eigenvalues.
7. We find eigenvectors of C using A_tilde. Vi where Vi is an eigenvector of L.
8. We take the top 350 eigenvectors. Because they are sufficient for identification
9. We normalize these eigenvectors.
10. New image(omega) = mean subtracted image projected on face space spanned by 350 eigenvectors.
11. We compute error by comparing distance between given face image and projected img
12. If error is less than threshold then we say the two images are the same.

# Results

| Image | True Positive | True Negative | Total Image |
|---|---|---|---|
| 1i | 12 | 520 | 19 |
| 1f | 3 | 519 | 22 |
| 1p | 6 | 513 | 25 |
| 1c | 1 | 521 | 25 |
| 1g | 6 | 513 | 18 |
| 1b | 1 | 522 | 24 |
| 1o | 4 | 524 | 18 |
| 1h | 7 | 499 | 21 |
| 1d | 2 | 523 | 23 |
| 1e | 7 | 506 | 25 |
| 1t | 8 | 512 | 34 |
| 1n | 7 | 508 | 29 |
| 1l | 1 | 513 | 33 |
| 1j | 8 | 513 | 31 |
| 1a | 0 | 509 | 37 |
| 1q | 6 | 517 | 25 |
| 1s | 12 | 493 | 47 |
| 1r | 15 | 504 | 32 |
| 1m | 8 | 512 | 25 |
| 1k | 3 | 513 | 33 |
|  | 117 | 10254 | 546 |

# Performance

**Accuracy**
(True Positive+True Negative ) / (True Positive  + False Positive + False Negative + True Negative) *100

Accuracy = ( (117 + 10254) / (546 * 20)) * 100 = **94.973 %**