Eigen Values and Eigen Vectors :
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https://medium.com/fintechexplained/what-are-eigenvalues-and-eigenvectors-a-must-know-concept-for-machine-learning-80d0fd330e47

Eigenvector—Every vector (list of numbers) has a direction when it is plotted on a XY chart. Eigenvectors are those vectors when a linear transformation (such as multiplying it to a scalar) is performed on them then their direction does not change. This attribute of Eigenvectors make them very valuable as I will explain in this article.

Eigenvalue—The scalar that is used to transform (stretch) an Eigenvector. Eigenvectors and eigenvalues are used to reduce noise in data. They can help us improve efficiency in computational intensive tasks. They also eliminate features that have a strong correlation between them and also help in reducing over-fitting.

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Component analysis is one of the key strategies that is utilised to reduce dimension space without losing valuable information. The core of component analysis (PCA) is built on the concept of eigenvalues and eigenvectors.

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Practical usecases of Eigenvectors and Eigenvalues:
They are used to reduce dimension space. If you want to forecast a financial variable e.g.interest rates then you will gather data for variables that interest rate is dependent on. Then you will join the variables to create a matrix. You might also be loading textual information and converting it to vectors.
At times, this can increase your dimension space to 100+ columns.
The technique of Eigenvectors and Eigenvalues are used to compress the data. Many algorithms such as PCA rely on eigen values and eigenvectors to reduce the dimensions.

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What are Eigenvalues and Eigenvectors?
Eigenvectors are used to make linear transformation understandable. Think of eigenvectors as stretching/compressing a X-Y line chart without changing its direction.

Eigenvectors and eigenvalues revolve around the concept of matrices. Matrices are used in machine learning problems to represent a large set of information. Eigenvalues and eigenvectors is about constructing one vector with one value to represent a large matrix

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Key Concepts: Let’s go over the following bullet points before we calculate Eigenvalues and Eigenvectors
Eigenvalues and Eigenvectors have following components:

A matrix has a size of X rows and Y columns.
A square matrix is the one which has a size of n, implying that X and Y are equal.
Square matrix is represented as A. This is an example of a square matrix

Eigenvector is an array with n entries where n is the number of rows (or columns) of a square matrix. Eigenvector is represented as x. Key Note: The direction of an eigenvector does not change when a linear transformation is applied to it.
Therefore, Eigenvector should be a non-null vector
Now Eigenvalues: We are required to find a number of values, known as eigenvalues such that
A * x - Lambda * x = 0
Eigenvalues are represented as lambda.

The above equation states that we need to multiply a scalar lambda (eigenvalue) to the vector x such that it is equal to the linear transformation of matrix A once it is scaled by vector x (eigenvector).

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How do I calculate Eigenvalue?
For a matrix A of size n, find Eigenvalues of size n.
The aim is to find: Eigenvector and Eigenvalues of A such that:
A * Eigenvector — Eigenvalue * EigenVector = 0

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Let’s calculate Eigenvalue and Eigenvector together

If there are any doubts then do inform me.

Let’s find eigenvalue of following matrix:

$$\begin{pmatrix} 2 & -1 \\ 4 & 3 \end{pmatrix}$$

First multiply lambda to an identity matrix and then subtract the two matrices

$$\left(\begin{pmatrix} 2 & -1 \\ 4 & 3 \end{pmatrix} - \lambda \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\right)$$

We will then be left with a matrix which we need to compute a determinant of:

$$\begin{pmatrix} 2-\lambda & -1 \\ 4 & 3-\lambda \end{pmatrix}$$

Find determinant of the following matrix:

$$\det\begin{pmatrix} 2-\lambda & -1 \\ 4 & 3-\lambda \end{pmatrix} = \lambda^2 - 5\lambda + 10$$

Once we solve the quadratic equation above, we will be left with two Eigenvalues:

$$\frac{5}{2} + i\frac{\sqrt{15}}{2}, \frac{5}{2} - i\frac{\sqrt{15}}{2}$$

Now that we have computed Eigenvalues, let’s calculate Eigenvectors together

Take the first Eigenvalue (Lambda) and substitute the eigenvalue into following equation:

***x* * (A - Lambda * I) = 0**

For the first eigenvalue, we will get following Eigenvector:

$$\begin{pmatrix} 2 & -1 \\ 4 & 3 \end{pmatrix} - \left(\frac{5}{2} + i\frac{\sqrt{15}}{2}\right)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} -\frac{1}{2} - i\frac{\sqrt{15}}{2} & -1 \\ 4 & \frac{1}{2} - i\frac{\sqrt{15}}{2} \end{pmatrix}$$

This Eigenvector now represents the key information of matrix A

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Calculating Eigen Values and Eigen Vectors in Python :

```
from numpy import linalg as LA
input = np.array([[2,-1],[4,3]])
eigenvalues, eigenvectors = LA.eig(input)
print(eigenvalues)
print(eigenvectors)
```

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```
#Load Library
import numpy as np

#Create a Matrix
matrix = np.array([[1,2,3],[4,5,6],[7,8,9]])
print(matrix)

# Calculate the Eigenvalues and Eigenvectors of that Matrix
eigenvalues,eigenvectors=np.linalg.eig(matrix)
print(eigenvalues)
print(eigenvectors)
```

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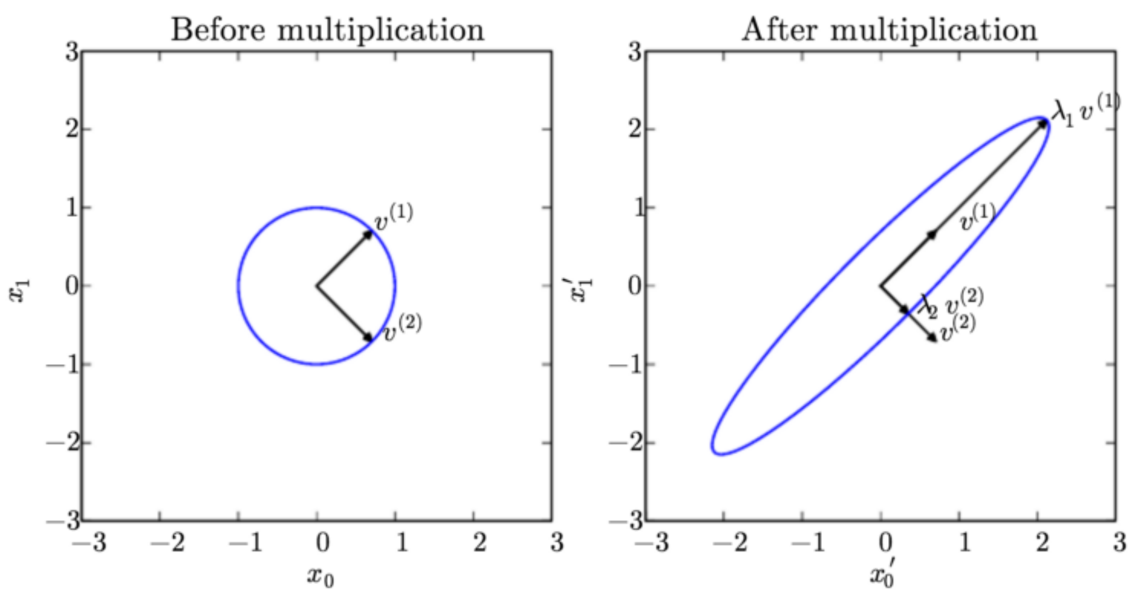
An Eigen vector of a square matrix *A* is a non zero vector *v* such that multiplication by *A* alters only the scale of *v*.
A* . *v* = lambda . *v
here *v* is the eigen vector and lambda is the eigen value.

```
## numpy program to find eigen vectors.

from numpy import array
```

```
from numpy.linalg import eig

# define matrix
A = array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
print(A)
# calculate eigendecomposition
values, vectors = eig(A)
print(values)
print(vectors)
```



Eigen decomposition is very useful in machine learning. It is particularly useful for concepts like dimensionality reduction.

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