FTDS // VECTOR

Hacktiv8 DS Curriculum Team

Phase 0 Learning Materials

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Curriculum
Team

Contents

- Basic understanding of vector
- Able to perform operations of vector
- Able to implement vector concepts in Python

Vector is well-known in Physics and Mathematics. In terms of those, vector is defined by a quantity which has value and direction.

Yet in Computer Science as well as Data Science, Vector is defined by values that represent observations/predictions. Simply, you can say, vector is a list of numbers.

Notation: $\boldsymbol{a}$

With bold letters

Example: $\textbf{video} = \begin{pmatrix} 10.5 \\ 5.2 \\ 3.25 \\ 7.0 \end{pmatrix}$

A video of that lasts 10.5 minutes, but only 5.2% viewers watch for more than a minute. It gets3.25 views per day on average and it was flagged 7 times as spam.

Define a Vector on Code

```
# create a vector
import numpy as np
# define vector
v = np.array([1, 2, 3])
print(v)
```

Output: [1 2 3]

Vector norm can be defined by the .magnitude of the vector

$$\|\boldsymbol{u}\| = \sqrt{\sum_i u_i^2} = \sqrt{u_1^2 + \cdots + u_n^2}$$

Where $\boldsymbol{u} = \begin{pmatrix} u_1 \\ u_2 \\ \vdots \\ u_n \end{pmatrix}$

Vector Norm on Code

```
# Computational Thinking:
norm = 0
for i in range( len( vector ) ):
    norm=0
    norm+=vector[ I ]**2
norm=sqrt( norm )
```

```
# Using Numpy
import numpy as np
# define vector
a = array([1, 2, 3])
# calculate norm
v_norm= np.linalg.norm(a)
print(v_norm)
```

Output: 3.74165738677

Vector can be added or substracted with other vectors. The count of elements shoud be the same

$$c = a \pm b$$

$$c = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} \pm \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = \begin{pmatrix} a_1 \pm b_1 \\ a_2 \pm b_2 \\ \vdots \\ a_n \pm b_n \end{pmatrix}$$

Addition/Substraction on Code

```
# Addition
import numpy as np
# define vector
a = array([1, 2, 3])
b = array([1, 0, 1])
# adding vectors
c = a + b
print(c)
```

Output: [2, 2, 4]

```
# Substraction
import numpy as np
# define vector
a = array([1, 2, 3])
b = array([1, 0, 1])
# substracting vectors
c = a - b
print(c)
```

Output: [0, 2, 2]

There are three ways to do multiplication with vectors, which are multiply by scalar, by vector, and dot product.

$$\boldsymbol{b} = k\boldsymbol{a}$$

To perform vector multiplication by a scalar, just multiply each element with the scalar.

$$\boldsymbol{b} = k\begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} = \begin{pmatrix} k \cdot a_1 \\ k \cdot a_2 \\ \vdots \\ k \cdot a_n \end{pmatrix}$$

To perform vector multiplication by vector, the steps resemble the addition/substraction. The operation is performed element-wise.

$$c = a \times b$$

$$c = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} \times \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = \begin{pmatrix} a_1 \times b_1 \\ a_2 \times b_2 \\ \vdots \\ a_n \times b_n \end{pmatrix}$$

Dot product is quite different to the other multiplications. The result of dot product is scalar. Furthermore, using dot product, we can get an angle between two vectors. It represents how far/close each vector to another.

$$c = \boldsymbol{a} \cdot \boldsymbol{b}$$

$$c = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} \cdot \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = a_1 \times b_1 + a_2 \times b_2 + \cdots + a_n \times b_n$$

The dot product formula can also be writteb by: $\boldsymbol{a} \cdot \boldsymbol{b} = \|\boldsymbol{a}\| \|\boldsymbol{b}\| \cos \boldsymbol{\theta}$

Multiplication on Code

```
# Vector-Vector
import numpy as np
# define vector
a = array([1, 2, 3])
b = array([2, 0, 1])
# multiplying vectors
c = a * b
print(c)
```

Output: [2, 0, 3]

```
# Vector-Scalar
import numpy as np
# define vector
a = array([1, 2, 3])
# multiplying vector
c = a * 3
print(c)
```

Output: [3, 6, 9]

```
# Dot Product
import numpy as np
# define vector
a = array([1, 2, 3])
b = array([2, 0, 1])
# multiplying vector
c = a.dot(b)
print(c)
```

Output: 5

A vector can be divided by a vector. Division is performed the same as vector-vector multiplication.

$$\boldsymbol{c = \frac{a}{b}}$$

$$\boldsymbol{c} = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} / \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = \begin{pmatrix} a_1/b_1 \\ a_2/b_2 \\ \vdots \\ a_n/b_n \end{pmatrix}$$

Division on Code

```
# Vector-Vector Division
import numpy as np
# define vector
a = array([1, 2, 3])
b = array([2, 2, 1])
# Dividing vectors
c = a / b
print(c)
```

Output: [0.5, 1., 3.]