NMK40403

Artificial Intelligence

Lab 1: Vectors.

Mohamed Elshaikh
UNIMAP - FKTEN

1 Objectives

- Vector in Python
- Plot vectors
- Linear operation in vectors
- Dot product in vectors

2 Vector in Python

A vector is known as a single dimension-array. In Python, vector is a single one-dimension array of lists and behaves same as a Python list. According to a Google, vector represents direction as well as magnitude; especially it determines the position one point in a space relative to another.

3 Creating Vector in Python

Python Numpy module provides the **numpy.array()** method which creates a one dimensional array i.e. a vector. A vector can be horizontal or vertical.

3.1 Syntax:

```
np.array(list)
```

The above method accepts a list as an argument and returns numpy.ndarray.

Let's understand the following example -

3.2 Example - 1: Horizontal Vector

```
# Importing numpy
import numpy as np
# creating list
list1 = [10, 20, 30, 40, 50]
# Creating 1-D Horizontal Array
vtr = np.array(list1)

vtr = np.array(list1)

print("We create a vector from a list:")
print(vtr)
```

3.3 Output:

```
We create a vector from a list:
[10 20 30 40 50]
```

3.4 Example - 2: Vertical Vector

```
# Importing numpy
import numpy as np
# defining list
list1 = [[12],
      [40],
      [6],
      [10]]

# Creating 1-D Vertical Array
vtr = np.array(list1)

vtr = np.array(list1)

print("We create a vector from a list:")
print(vtr)
```

3.5 Output:

```
We create a vector from a list:
[[12]
 [40]
 [ 6]
 [10]]
```

4 Basic Operation of Python vector

After creating a vector, now we will perform the arithmetic operations on vectors.

Below is the list of basic operations that we can perform in vector.

- Arithmetic
- Subtraction
- Multiplication
- Division
- Dot Product
- Scalar Multiplications

4.1 Addition of Two Vectors

In the vector addition, it takes place element-wise manner which means addition will happen element by element and the length would same as of the two additive vectors.

4.2 Syntax:

```
vector + vector
```

Let's understand the following example.

4.3 Example -

```
import numpy as np

list1 = [10,20,30,40,50]
list2 = [11,12,13,14,15]



vtr1 = np.array(list1)

vtr2= np.array(list2)

print("We create vector from a list 1:")
print(vtr1)
print("We create vector from a list 2:")
print(vtr2)

vctr_add = vctr1+vctr2
print("Addition of two vectors: ",vtr_add)
```

4.4 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
We create vector from a list 2:
[11 12 13 14 15]
Addition of two vectors:  [21 32 43 54 65]
```

5 Subtraction of Two Vectors

The subtraction performs same as the addition, it follows the element-wise approach and vector 2 elements will get subtracted from the vector 1. Let's understand the following example.

5.1 Example -

```
import numpy as np

list1 = [10,20,30,40,50]
list2 = [5,2,4,3,1]

vtr1 = np.array(list1)

vtr2= np.array(list2)

print("We create vector from a list 1:")
print(vtr1)
print("We create a vector from a list 2:")
print(vtr2)

vtr_sub = vtr1-vtr2
print("Subtraction of two vectors: ",vtr_sub)
```

5.2 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
We create vector from a list 2:
[5 2 4 3 1]
Subtraction of two vectors:  [5 18 26 37 49]
```

6 Multiplication of Two Vectors

The vector 1 elements are multiplied by the vector 2 and return the same length vectors as the multiplying vectors. Let's understand the following example.

6.1 Example -

```
import numpy as np

list1 = [10,20,30,40,50]
list2 = [5,2,4,3,1]

vtr1 = np.array(list1)

vtr2= np.array(list2)

print("We create vector from a list 1:")
print(vtr1)
print("We create a vector from a list 2:")
print(vtr2)

vtr_mul = vtr1*vtr2
print("Multiplication of two vectors: ",vtr_mul)
```

6.2 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
We create vector from a list 2:
[5 2 4 3 1]
Multiplication of two vectors:  [ 50  40 120 120  50]
```

The multiplication is performed as follows.

```
vct[0] = x[0] * y[0]
vct[1] = x[1] * y[1]
```

The first element of the vector 1 is multiplied by corresponding vector's 2 first element and so on.

7 Division Operation of Two vectors

In the division operation, the resultant vector contains the quotient value that is get from the division of two vector's elements.

Let's understand the following example.

7.1 Example –

```
import numpy as np

list1 = [10,20,30,40,50]
list2 = [5,2,4,3,1]

vtr1 = np.array(list1)

vtr2= np.array(list2)

print("We create vector from a list 1:")
print(vtr1)
print("We create a vector from a list 2:")
print(vtr2)

vtr_div = vtr1/vtr2
print("Division of two vectors: ",vtr_div)
```

7.2 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
We create vector from a list 2:
[5 2 4 3 1]
Division of two vectors:  [ 2.   10.          7.5        13.33333333        50.
```

As we can see in the above output, the division operation returned the quotient value of elements.

8 Vector Dot Product

The vector dot product performs between the two same-length sequential vectors and returns the single dot product. We will use the **.dot()** method to perform the dot product. It will happen as below.

```
vector c = x . y = (x1 * y1 + x2 * y2)
```

Let's understand the following example.

8.1 Example -

```
import numpy as np

list1 = [10,20,30,40,50]
list2 = [5,2,4,3,1]

vtr1 = np.array(list1)

vtr2= np.array(list2)

print("We create vector from a list 1:")
print(vtr1)
print("We create a vector from a list 2:")
print(vtr2)

vtr_product = vtr1.dot(vtr2)
print("Dot product of two vectors: ",vtr_product)
```

8.2 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
We create vector from a list 2:
[5 2 4 3 1]
Dot product of two vectors:  380
```

9 Vector-Scalar Multiplication

In the scalar multiply operation; we multiply the scalar with the each component of the vector. Let's understand the following example.

9.1 Example -

```
import numpy as np
list1 = [10,20,30,40,50]
vtr1 = np.array(list1)

scalar_value = 5

print("We create vector from a list 1:")
print(vtr1)

# printing scalar value
print("Scalar Value  : " + str(scalar_value))

vtr_scalar = vtr1 * scalar_value
print("Multiplication of two vectors: ",vtr_scalar)
```

9.2 Output:

```
We create vector from a list 1:
[10 20 30 40 50]
Scalar Value  : 5
Multiplication of two vectors:  [ 50 100 150 200 250]
```

In the above code, the scalar value multiplied by the each element of the vector in s * v = (s * v1, s * v2, s * v3) manner.

10 Plot vectors in Python using Matplotlib

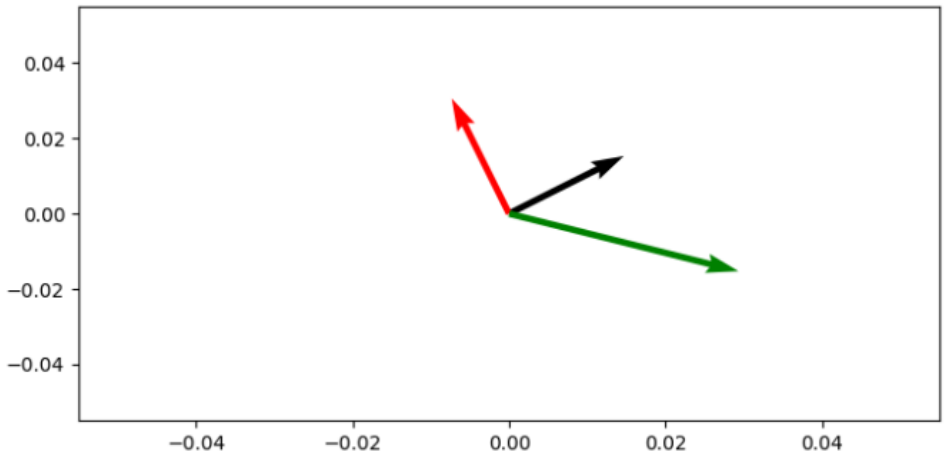
plot vectors in Python using matplotlib, we can take the following steps −

- Create a matrix of 2×3 dimension.
- Create an origin point, from where vecors could be originated.
- Plot a 3D fields of arrows using **quiver()** method with **origin, data, colors** and **scale=15**.

10.1 Example

```
import numpy as np
from matplotlib import pyplot as plt
plt.rcParams["figure.figsize"] = [7.00, 3.50]
plt.rcParams["figure.autolayout"] = True
data = np.array([[2, 1], [-1, 2], [4, -1]])
origin = np.array([[0, 0, 0], [0, 0, 0]])
plt.quiver(*origin, data[:, 0], data[:, 1],
color=['black', 'red', 'green'], scale=15)
plt.show()
```

10.2 Output



Ex.

1- Given a =(2, -5) b=(2,3) find a+b and a-b, and plot your result with python.

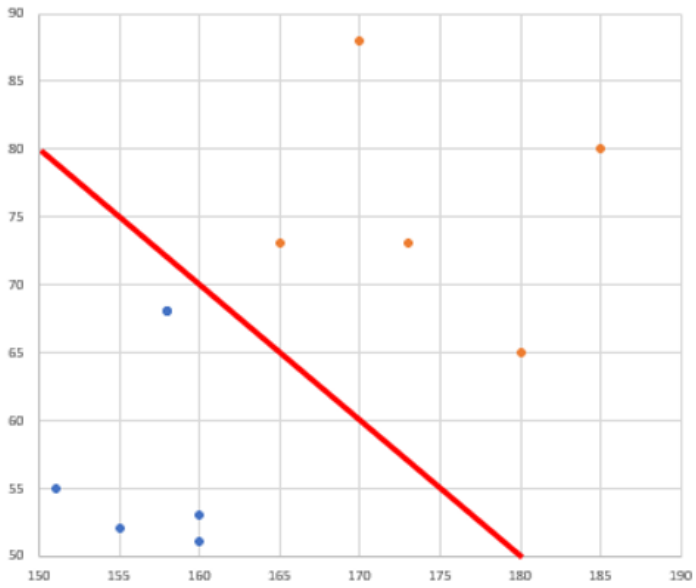


Figure (Ex.2-2)

Gender	Length	Weight
F	151	55
F	155	52
F	158	68
F	160	51
F	158	68
F	160	53
M	165	73
F	168	60
M	170	88
M	173	73
M	180	65
M	185	80

Table (Ex.2-1)

2- Table (Ex.2-1) shows the data for group of human and their gender classification in respect to weight and length, use this table to find the length between each human coordinates and the red line in figure (Ex.2-2).