1 Array maths in NumPy

NumPy allows easy standard mathematics to be performed on arrays, a well as moire complex linear algebra such as array multiplication.

Lets begin by building a couple of arrays. We'll use the np.arange method to create an array of numbers in range 1 to 12, and then reshape the array into a 3 x 4 array.

```
import numpy as np

# note that the arange method is 'half open'
# that is is includes the lower number, and goes up yo, but not including,
# the higher number

array_1 = np.arange(1,13)
array_1 = array_1.reshape (3,4)

print (array_1)

OUT:

[[ 1  2  3  4]
 [ 5  6  7  8]
 [ 9 10 11 12]]
```

1.1 Maths on a single array

We can multiple an array by a fixed number (or we can add, subtract, divide, raise to power, etc):

```
print (array_1 *4)

OUT:

[[ 4  8 12 16]
 [20 24 28 32]
 [36 40 44 48]]


print (array_1 ** 0.5) # square root of array

OUT:

[[1.         1.41421356 1.73205081 2.        ]
 [2.23606798 2.44948974 2.64575131 2.82842712]
 [3.         3.16227766 3.31662479 3.46410162]]
```

We can define a vector and multiple all rows by that vector:

```
vector_1 = [1, 10, 100, 1000]

print (array_1 * vector_1)

OUT:

[[    1    20   300  4000]
 [    5    60   700  8000]
 [    9   100  1100 12000]]
```

To multiply by a column vector we will transpose the original array, multiply by our column vector, and transpose back:

```
vector_2 = [1, 10, 100]

result = (array_1.T * vector_2).T

print (result)

OUT:

[[   1    2    3    4]
 [  50   60   70   80]
 [ 900 1000 1100 1200]]
```

1.2 Maths on two (or more) arrays

Arrays of the same shape may be multiplied, divided, added, or subtracted.

Let's create a copy of the first array:

```
array_2 = array_1.copy()

# If we said array_2 = array_1 then array_2 would refer to array_1.
# Any changes to array_1 would also apply to array_2
```

Multiplying two arrays:

```
print (array_1 * array_2)

OUT:

[[  1   4   9  16]
 [ 25  36  49  64]
 [ 81 100 121 144]]
```

1.3 Matrix multiplication ('dot product')

See `https://www.mathsisfun.com/algebra/matrix-multiplying.html` for an explanation of matrix multiplication, if you are not familiar with it.

We can perform matrix multiplication in numpy with the np.dot method.

```
array_2 = np.arange(1,13)
array_2 = array_1.reshape (4,3)

print ('Array 1:')
print (array_1)
print ('\nArray 2:')
print (array_2)
print ('\nDot product of two arrays:')
print (np.dot(array_1, array_2))

OUT:

Array 1:
[[ 1  2  3  4]
 [ 5  6  7  8]
 [ 9 10 11 12]]

Array 2:
[[ 1  2  3]
 [ 4  5  6]
```

```
 [ 7  8  9]
 [10 11 12]]

Dot product of two arrays:
[[ 70  80  90]
 [158 184 210]
 [246 288 330]]
```