**Deep Learning with Python, Francois Chollet book notes**

Chapter 2: Before we begin, mathematical building blocks of neural networks Page 25

2.2 Tensors

**Scalar 0D tensor**

* A scalar is a 0 dimensional tensor.
* A float32 or float64 number in numpy is a scalar tensor.
* *Ndim* gives us the number of axes or rank (its also called dimension sometimes but next we will see why dimension can be confusing)
* >> a = np.array(12)

>> a.ndim returns 0

**Vector 1D tensor**

* An array of number is called as a vector or 1D tensor.
* Ex: b = np.array([1,2,3,4]

>> b.ndim will return 1

* Note that *ndim* will always return the RANK of a tensor even if the function name includes *dim*.
* Think of rank as axes x, y, z. Question how many axes will you require to draw the data in a tensor? The answer gives u a rank. Lets say rank is 5 then we call that tensor 5D tensor.
* A dimension can also be referred to as no. of dimensions in an array. So above array has 4 dimensions as it has 4 elements. But it is also called 1D tensor. So the dimension in 1D is actually rank.

**Matrices 2D tensors**

* An array of vector is a matrix or 2D tensor.
* How many axes can you draw a matrix on? 2 hence the rank = 2 and hence 2D tensor.
* >> x = [[1,2,3],[4,5,6],[7,8,9]]

**3D tensor**

* By packing the 2 xs into an array you get a 3D tensor. By packing two or more 3D tensors you get a 4D tensor and so on..
* >> y = [x, x]

>> y.ndim will return 3

* Here two axes are for the rows and columns of the matrix and 3rd axis for the elements (matrices) in the outer most array [].
* Shape of y is (2, 3, 3). This 2, 3 and 3 are the number of dimensions (different than rank) along each axis. Rank can be calculated based on shape as well. We have 2 elements of 3 x 3 matrices.

**Key attributes**

* *Number of axes (rank) –* Returned using ndim. We have seen plenty of examples above.
* *Shape –* Tuple describes the number of dimensions along each axis. Total elements in shape tuple equal rank. A scalar has empty shape (), a vector has shape like (5,) etc...
* Dtype – Returns the data type of number in a tensor. Various dtypes are float32, uint8, float 64 and so on. Rarely will you see a ‘char’ tensor. **Char tensors are not implemented in numpy for technical reasons.**

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