

What are Tensors?

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Wikipedia:

A **tensor** is an algebraic object that describes a multilinear relationship between sets of algebraic objects related to a vector space.

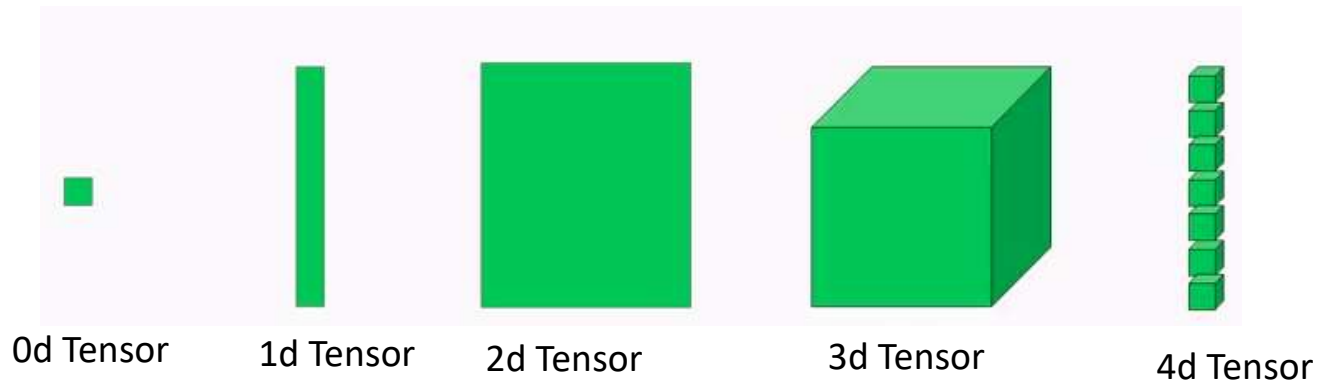
In short, tensors are generalization of scalars and vectors

# What are Tensors?

Wikipedia:

A **tensor** is an algebraic object that describes a multilinear relationship between sets of algebraic objects related to a vector space.

In short, tensors are generalization of scalars data and vectors.



# Types of Tensors?

(10)

Scalar

Rank = 0

Shape = (0)

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(10)

Scalar

Rank = 0

Shape = (0)

1  
2  
3

Vector

Rank = 1

Shape = (3)

# Types of Tensors?

(10)

Scalar

Rank = 0

Shape = (0)

1  
2  
3

Vector

Rank = 1

Shape = (3)

3 number of Rank 0 tensors

## Types of Tensors?

$$\begin{bmatrix} 1 & 2 \\ 4 & 5 \\ 7 & 8 \end{bmatrix}$$

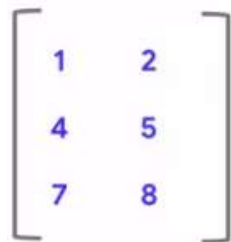
Matrix

Rank = 2

Shape = (3x2)

3 number of Rank 1 tensors of shape 2

# Types of Tensors?

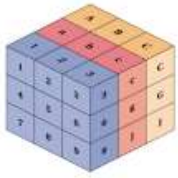


Matrix

Rank = 2

Shape = (3x2)

3 number of Rank 1 tensors of shape 2



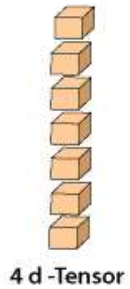
Rank = 3

Shape = (3x3x3)

3 number of Rank 2 tensors of shape 3x3



# Types of Tensors?

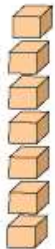


Rank = 4

Shape = (7x3x3x3)

7 number of Rank 3 tensors of shape 3x3x3

# Types of Tensors?

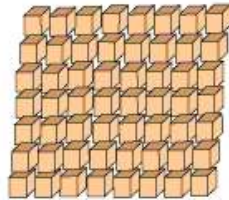


4 d -Tensor

Rank = 4

Shape = (7x3x3x3)

7 number of Rank 3 tensors of shape 3x3x3



5 d -Tensor

Rank = 5

Shape = (7x8x3x3x3)

7 number of Rank 4 tensors of shape 8x3x3x3

# Tensors in TensorFlow

```
import tensorflow as tf
```

```
t = tf.constant( 4 )
```

```
print( t )
```



```
tf.Tensor( 4,      shape=(),      dtype=int32  )
```

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t = tf.constant( 4 )  
print( t )
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```
tf.Tensor( 4,      shape=(),      dtype=int32  )
```

```
import tensorflow as tf
```

```
t = tf.constant( [2.0, 3.0, 4.0] )  
print(t)
```



```
tf.Tensor([2. 3. 4.], shape=(3,), dtype=float32)
```

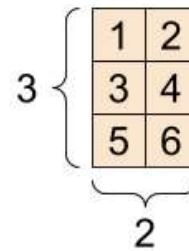
# Tensors in TensorFlow

```
import tensorflow as tf

t = tf.constant( [ [1, 2],
                  [3, 4],
                  [5, 6]
                ])

print(t)
```

```
tf.Tensor( [[1 2] [3 4] [5 6]], shape=(3, 2),
dtype=float16)
```



No. of rows = 3

No. of Columns = 2

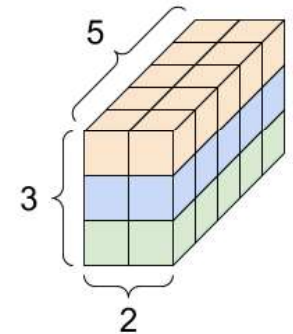
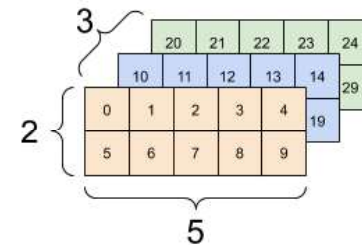
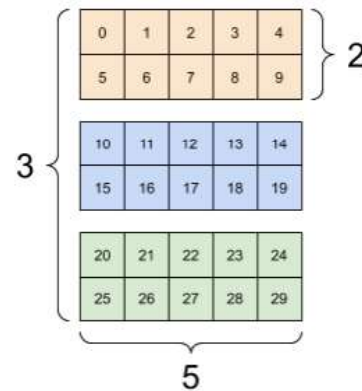
# Tensors in TensorFlow

```
import tensorflow as tf
```

```
t = tf.constant([  
    [0, 1, 2, 3, 4],  
    [5, 6, 7, 8, 9] ],  
    [ [10, 11, 12, 13, 14],  
      [15, 16, 17, 18, 19] ],  
    [ [20, 21, 22, 23, 24],  
      [25, 26, 27, 28, 29] ]  
    ])
```

```
print(t)
```

```
tf.Tensor( [[[ 0  1  2  3  4] [ 5  6  7  8  9]] [[10 11 12 13  
14] [15 16 17 18 19]] [[20 21 22 23 24] [25 26 27  
28 29]]], shape=(3, 2, 5), dtype=int32)
```



# Components of a Tensor?

```
import tensorflow as tf  
  
t = tf.constant( [2.0, 3.0, 4.0] )  
print(t)
```



tf.Tensor([2. 3. 4.], shape=(3,), dtype=float32)

Values

Shape (Rank)

Data type

# Summary

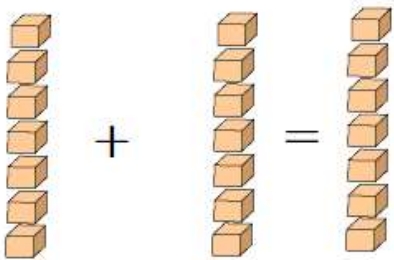
- What are Tensors?
- Different types of Tensors
- Rank of a Tensor
- Shape of a Tensor
- Components of a Tensor



# Operations between two Tensors

**Given two tensors x and y,**

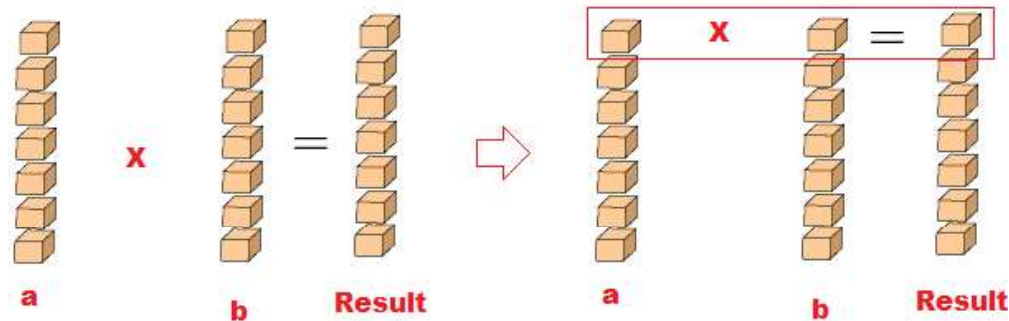
- Arithmetic operations such as **plus, minus, multiplication, division** can be performed between x and y, and produce another tensor.
  - $x + y$ ,  $x - y$ ,  $x * y$ ,  $x / y$
- To perform a binary operation between two tensors, the shape of the two should be compatible.
- Element wise operations between the two tensors are performed.



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## Broadcast (Stretch)

**X (1d array): 3**

**Y (1d array) 1**

**Result (1d array) : 3**

## Broadcast (Stretch)

X (1d array):    3                    [ 1, 2, 3]

Y (1d array    1                    2

Result (1d array) :    3

## Broadcast (Stretch)

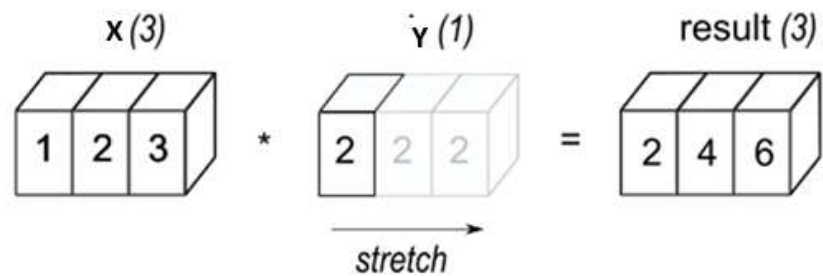
X (1d array): 3 [ 1, 2, 3]

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TensorFlow performs broadcast of the lower shape tensor.

It means, the low dimensional tensor is replicated till we find the matching shape



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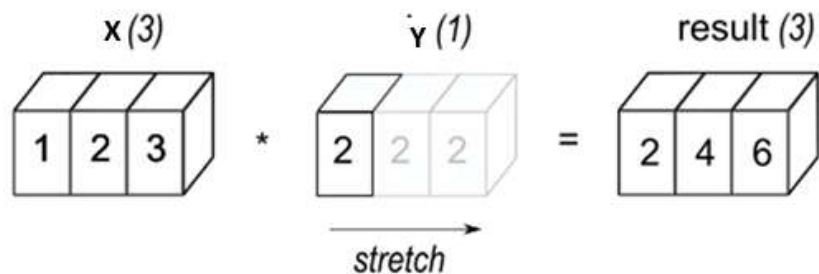
X (1d array): 3                    [ 1, 2, 3]

Y (1d array) 1                    2

Result (1d array) : 3

TensorFlow performs broadcast of the lower shape tensor.

It means, the low dimensional tensor is replicated till we find the matching shape



## Two Sides Broadcast (Stretch)

X (1d array): 3

Y (2d array): 3 x 1

Result (2d array): 3 x 3

1	2	3		4	4	4		5	6	7
1	2	3		5	5	5		6	7	8
1	2	3		6	6	6		7	8	9