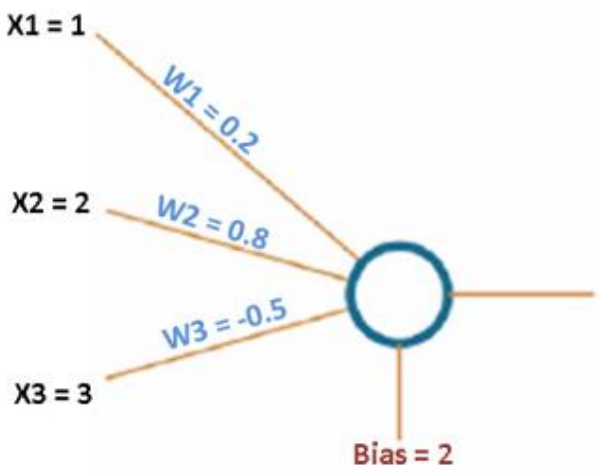
الغاية من الجلسة :

برمجة عصبون أولي ومن ثم طبقة في شبكة عصبونية باستخدام لغة البرمجة بايثون.

A Single Neuron:

Example #1:

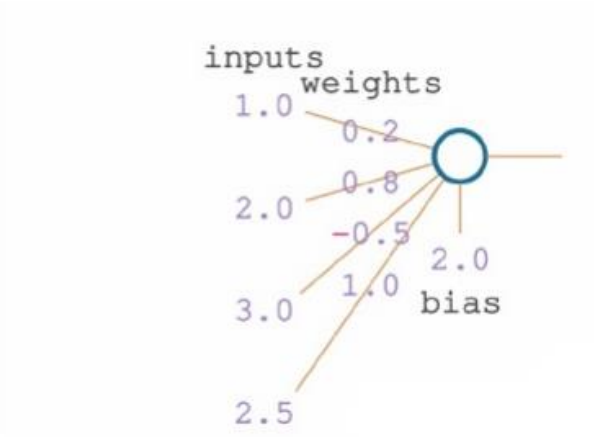


In [6]:
```
# the input here is a list of 3 features (1 sample).
inputs = [1, 2, 3]

# Each connection between neurons has a weight associated with it, which is a tra
weights = [0.2, 0.8, -0.5]

#he purpose of the bias is to offset the output positively or negatively
bias = 2

# the hypotheses H(x) = W*X + bias
outputs = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[2]*weights[2] + bi

print(outputs)
```

```
2.3
```

A Single Neuron (4 inputs):

Example #2:



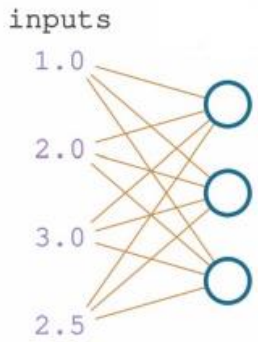
In [2]:
```
inputs = [ 1.0 , 2.0 , 3.0 , 2.5 ]
weights = [ 0.2 , 0.8 , - 0.5 , 1.0 ]

bias = 2.0

output = (inputs[0]*weights[0] +
          inputs[1]*weights[1] +
          inputs[2]*weights[2] +
          inputs[3]*weights[3] + bias)

print (output)
```

```
4.8
```

A Layer of Neurons

Example #3:

here there are 4 inputs in the input layer. and 3 neurons in the output layer.

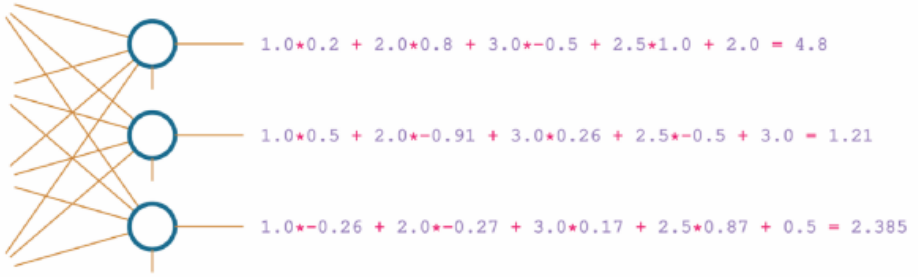


In [8]:
```
inputs = [ 1, 2, 3, 2.5 ]

# each neuron has a list of weights:
weights1 = [ 0.2, 0.8, - 0.5, 1 ]
weights2 = [ 0.5, - 0.91, 0.26, - 0.5 ]
weights3 = [ - 0.26, - 0.27, 0.17, 0.87 ]

# each neuron has a bias:
bias1 = 2
bias2 = 3
bias3 = 0.5
```

In [9]:
```
# here the output are 3 neurons, so it will be a list of three values.
outputs = [
                # Neuron 1:
                inputs[0] * weights1[0] + inputs[1] * weights1[1] + inputs[2] * w

                # Neuron 2:
                inputs[0] * weights2[0] + inputs[1] * weights2[1] + inputs[2] * w

                # Neuron 3:
                inputs[0] * weights3[0] + inputs[1] * weights3[1] + inputs[2] * w
          ]
```

In [10]:
```
outputs
```

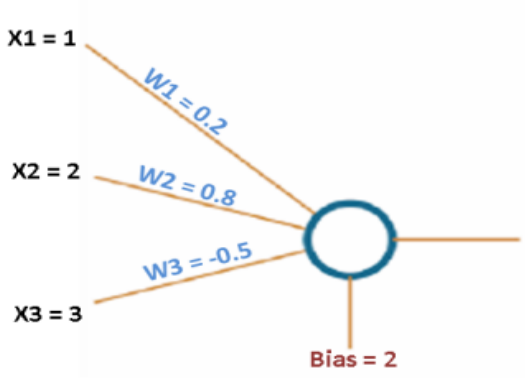
Out[10]:
```
[4.8, 1.21, 2.385]
```



What is NumPy?

It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.

A Single Neuron with NumPy:

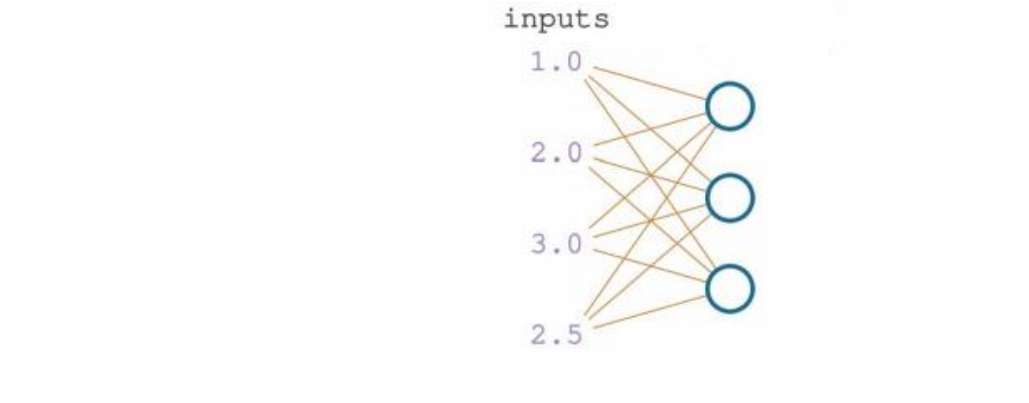


In [2]:
```
# firstly we will import the needed library.
import numpy as np

inputs = [1, 2, 3]

weights = [0.2, 0.8, -0.5]

bias = 2

# insted of this: outputs = inputs[0]*weights[0] + inputs[1]*weights[1] + inputs[
# to multiply the vectors:
outputs = np.dot(weights, inputs) + bias

print(outputs)
```

```
2.3
```

This makes the code much simpler to read and write (and faster to run)

A Layer of Neurons with NumPy



In [4]:
```
inputs = [ 1, 2, 3, 2.5 ]

''' insted of these three lists:
weights1 = [ 0.2, 0.8, - 0.5, 1 ]
weights2 = [ 0.5, - 0.91, 0.26, - 0.5 ]
weights3 = [ - 0.26, - 0.27, 0.17, 0.87 ]

we will put them together in one array:
'''
weights = [
    [ 0.2 , 0.8 , - 0.5 , 1 ],
    [ 0.5 , - 0.91 , 0.26 , - 0.5 ],
    [ - 0.26 , - 0.27 , 0.17 , 0.87 ]
          ]

# and list for the biases values:
biases = [ 2.0 , 3.0 , 0.5 ]
```

In [6]:
```
# here the output are 3 neurons, so it will be a list of three values.
layer_outputs = np.dot(weights, inputs) + biases

print(layer_outputs)
```

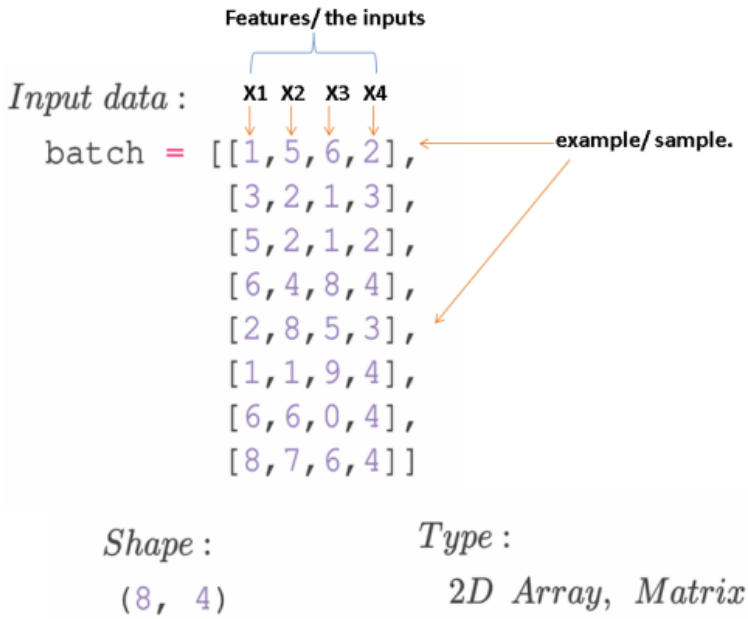
```
[4.8   1.21  2.385]
```

A Batch of Data

Often, neural networks expect to take in many samples at a time for two reasons. One reason is that it's faster to train in batches in parallel processing, and the other reason is that batches help with generalization during training.

If you fit (perform a step of a training process) on one sample at a time, you're highly likely to keep fitting to that individual sample, rather than slowly producing general tweaks to weights and biases that fit the entire dataset. Fitting or training in batches gives you a higher chance of making more meaningful changes to weights and biases.

An example of a batch of data could look like:



For example, every sample is a describing for a house.

So: X1: the area of this house. X2: number of rooms. .. .. And so on.

In [7]:
```
import numpy as np

# Batch of 3 examples:
inputs = [
    [ 1.0 , 2.0 , 3.0 , 2.5 ],
    [ 2.0 , 5.0 , - 1.0 , 2.0 ],
    [ - 1.5 , 2.7 , 3.3 , - 0.8 ]
         ]


weights = [
    [ 0.2 , 0.8 , - 0.5 , 1.0 ],
    [ 0.5 , - 0.91 , 0.26 , - 0.5 ],
    [ - 0.26 , - 0.27 , 0.17 , 0.87 ]
          ]

biases = [ 2.0 , 3.0 , 0.5 ]
```

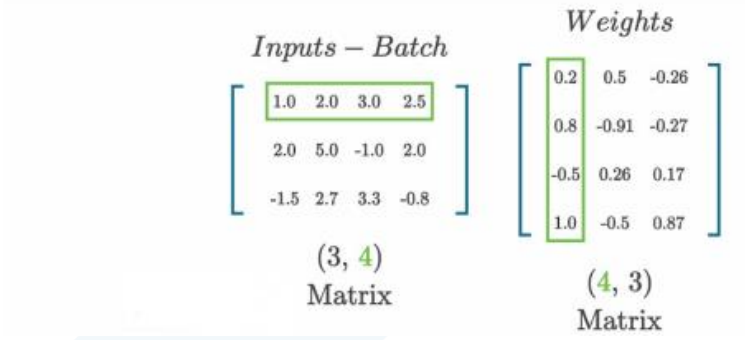
In [8]:
```
layer_outputs = np.dot(inputs, np.array(weights).T) + biases

print (layer_outputs)
```

```
[[ 4.8    1.21   2.385]
 [ 8.9   -1.81   0.2  ]
 [ 1.41   1.051  0.026]]
```

As you can see, our neural network takes in a group of samples (inputs) and outputs a group of predictions.

Why we use W.T (Transported of weights array)?

```
inputs = [[1.0, 2.0, 3.0, 2.5],
          [2.0, 5.0, -1.0, 2.0],
          [-1.5, 2.7, 3.3, -0.8]]
weights = [[0.2, 0.8, -0.5, 1.0],
           [0.5, -0.91, 0.26, -0.5],
           [-0.26, -0.27, 0.17, 0.87]]
```



we need to perform the dot product of each input and each weight set in all of their combinations. The dot product takes the row from the first array and the column from the second one, but

currently the data in both arrays are row-aligned. Transposing the second array shapes the data to be column-aligned. The matrix product of inputs and transposed weights will result in a matrix containing all atomic dot products that we need to calculate. The resulting matrix consists of outputs of all neurons after operations performed on each input sample:

$$\begin{bmatrix} 1.0 & 2.0 & 3.0 & 2.5 \\ 2.0 & 5.0 & -1.0 & 2.0 \\ -1.5 & 2.7 & 3.3 & -0.8 \end{bmatrix} \begin{bmatrix} 0.2 & 0.5 & -0.26 \\ 0.8 & -0.91 & -0.27 \\ -0.5 & 0.26 & 0.17 \\ 1.0 & -0.5 & 0.87 \end{bmatrix} = \begin{bmatrix} 2.8 & -1.79 & 1.885 \\ 6.9 & -4.81 & -0.3 \\ -0.59 & -1.949 & -0.474 \end{bmatrix}$$

$$\begin{bmatrix} 2.8 & -1.79 & 1.885 \\ 6.9 & -4.81 & -0.3 \\ -0.59 & -1.949 & -0.474 \end{bmatrix} + \begin{bmatrix} 2.0 & 3.0 & 0.5 \end{bmatrix} = \begin{bmatrix} 4.8 & 1.21 & 2.385 \\ 8.9 & -1.81 & 0.2 \\ 1.41 & 1.051 & 0.026 \end{bmatrix}$$