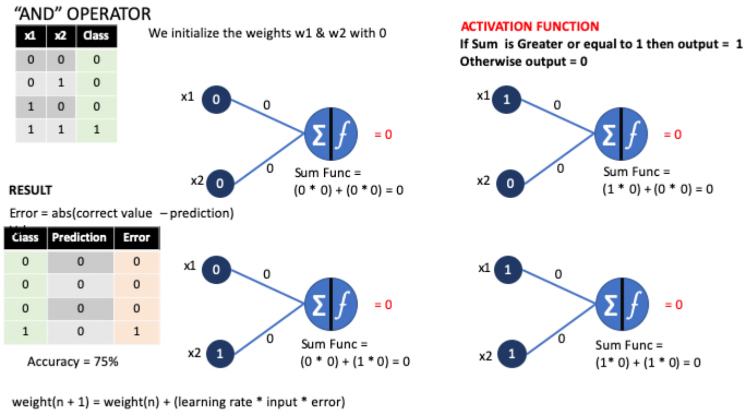
Author: Dr Mike Lakoju, CardiffMet



"AND" OPERATOR

x1	x2	Class
0	0	0
0	1	0
1	0	0
1	1	1

We initialize the weights w1 & w2 with 0

ACTIVATION FUNCTION

If Sum is Greater or equal to 1 then output = 1
Otherwise output = 0

RESULT

Error = abs(correct value – prediction)

Class	Prediction	Error
0	0	0
0	0	0
0	0	0
1	0	1

Accuracy = 75%

weight(n + 1) = weight(n) + (learning rate * input * error)

Import Library

In [1]:
```
import numpy as np
```

Define "Inputs, outputs and weights" as Numpy arrays

Inputs

In [2]:
```
# Creating input values as a matrix not as a vector
inputs = np.array([[0,0], [0,1], [1,0], [1,1]])
```

In [3]:
```
# Chcking the shape of the inputs

inputs.shape
```

Out[3]:
```
(4, 2)
```

Outputs

In [4]:
```
outputs = np.array([0, 0, 0, 1])
```

In [5]:
```
#Checking the shape of the outputs

outputs.shape
```

Out[5]:
```
(4,)
```

Weights

In [6]:
```
# one weight for x1 and one for x2
weights = np.array([0.0, 0.0])
```

Learning Rate

In [7]:
```
learning_rate = 0.1
```

Step function

In [8]:
```
# This is our Activation function

def step_function(sum):
  if (sum >= 1):
    #print(f'The Sum of Weights is Greater or equal to 1')
    return 1
  else:
        #print(f'The Sum of Weights is NOT > or = to 1')
        return 0
```

Process Output

We define a function that allows us to calculate/ process the output. The function accepts an instance of our data, then calculate the sum function using Numpy. Finally, we check the output by passing it through the "Step Function."

In [9]:
```
def cal_output(instance):
  sum_func = instance.dot(weights)
  return step_function(sum_func)
```

We pass it as alist in a numpy array ...

In [10]:
```
cal_output(np.array([[1,1]]))
```

Out[10]:
```
0
```

Train

In [11]:
```
# Check the number of outputs
```

```
len(outputs)
```

Out[11]: 4

In [12]:
```
# Checking the index of the input at postion 3 ..
# this is the last inpute value
inputs[3]
```

Out[12]:
```
array([1, 1])
```

In [13]:
```
inputs
```

Out[13]:
```
array([[0, 0],
       [0, 1],
       [1, 0],
       [1, 1]])
```

Note that: usually, we will need to define the number of epochs, because we will never really get a value of zero when dealing with real-world data. However, for this small data, we will run the loop till we obtain zero error

In [14]:
```
def train():
    #
    total_error_value = 1
    # While the total_error_value is not equal to zero. we are asumming that at the start of running our network there will be no zero
    while (total_error_value != 0):
        #making the total_error 0 so we can do other calculations
        total_error_value = 0
        #Looping into each row of the dataset (remember indexing in python starts at zero hence 0-3 which are 4 values)
        for i in range(len(outputs)):
            #Calculating predictions
            prediction = cal_output(inputs[i])
            # Calculating the absolute value of the error
            error = abs(outputs[i] - prediction)
            #Updating the error
            total_error_value  += error

            if error > 0:
                for j in range(len(weights)):
                    #updating the weights for x1 and x2
                    weights[j] = weights[j] + (learning_rate * inputs[i][j] * error)
                    print('Weight updated to: ' + str(weights[j]))
        print('Total error Value: ' + str(total_error_value))
```

In [15]:
```
train()
```

```
Weight updated to: 0.1
Weight updated to: 0.1
Total error Value: 1
Weight updated to: 0.2
Weight updated to: 0.2
Total error Value: 1
Weight updated to: 0.30000000000000004
Weight updated to: 0.30000000000000004
Total error Value: 1
Weight updated to: 0.4
Weight updated to: 0.4
Total error Value: 1
Weight updated to: 0.5
Weight updated to: 0.5
Total error Value: 1
Total error Value: 0
```

Classification

In [16]:
```
# Now we have the final weights that will be used to classify new instances of the data after training.

weights
```

Out[16]:
```
array([0.5, 0.5])
```

In [17]:
```
cal_output(np.array([0,0]))
```

Out[17]: 0

In [18]:
```
cal_output(np.array([0,1]))
```

Out[18]: 0

In [19]:
```
cal_output(np.array([1,0]))
```

Out[19]: 0

In [20]:
```
cal_output(np.array([1,1]))
```

Out[20]: 1

In [ ]:

In [ ]: