

## > Lab - 1 | 22 January 2026

↳ 6 cells hidden

## > Lab - 2 | 29 January 2026

### Perceptron learning Algorithm for Implementing AND Logic Gate

```
import numpy as np
# for AND gate (Input/Output)
x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,0,0,1])
epochs = 4
w,b = np.zeros(2),0

for _ in range(epochs):
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        ### condition area for y_pred
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print("error : ",E,"- at epoch",_)
        w += E*x
        b += E
        print(w,b)
print("-----")
print("Chirag Miglani, 1/23/SET/BCS/414")
print("22 January 2026")
```

```
error : -1 <- at epoch 0
[0. 0.] -1
error : 0 <- at epoch 0
[0. 0.] -1
error : 0 <- at epoch 0
[0. 0.] -1
error : 1 <- at epoch 0
[1. 1.] 0
error : -1 <- at epoch 1
[1. 1.] -1
error : -1 <- at epoch 1
[1. 0.] -2
error : 0 <- at epoch 1
[1. 0.] -2
error : 1 <- at epoch 1
[2. 1.] -1
error : 0 <- at epoch 2
[2. 1.] -1
error : -1 <- at epoch 2
[2. 0.] -2
error : -1 <- at epoch 2
[1. 0.] -3
error : 1 <- at epoch 2
[2. 1.] -2
error : 0 <- at epoch 3
[2. 1.] -2
error : 0 <- at epoch 3
[2. 1.] -2
error : -1 <- at epoch 3
[1. 1.] -3
error : 1 <- at epoch 3
[2. 2.] -2
-----
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22 January 2026
```

### Tasks to be performed

1. Change the epochs and observe the output
2. Change the random weights and bias and observe the convergence of the network.
3. Add logic to stop the training when the error is 'zero' for all the inputs.
4. Repeat the same process for OR gate

5. Try the process for XOR gate and show that the network will not stabilize (Converge).

#### Tasks in Order :

##### *1) Change the epochs and observe the output*

```
import numpy as np
# for AND gate (Input/Output)
x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,0,0,1])
epochs = 10
w,b = np.zeros(2),0

for _ in range(epochs):
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        ### condition area for y_pred
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print("error : ",E,"-> at epoch",_)
        w += E*x
        b += E
        print(w,b)
print("-----")
print("Chirag Miglani, 1/23/SET/BCS/414")
print("22 January 2026")
```

```
error : -1 <- at epoch 0
[0. 0.] -1
error : 0 <- at epoch 0
[0. 0.] -1
error : 0 <- at epoch 0
[0. 0.] -1
error : 1 <- at epoch 0
[1. 1.] 0
error : -1 <- at epoch 1
[1. 1.] -1
error : -1 <- at epoch 1
[1. 0.] -2
error : 0 <- at epoch 1
[1. 0.] -2
error : 1 <- at epoch 1
[2. 1.] -1
error : 0 <- at epoch 2
[2. 1.] -1
error : -1 <- at epoch 2
[2. 0.] -2
error : -1 <- at epoch 2
[1. 0.] -3
error : 1 <- at epoch 2
[2. 1.] -2
error : 0 <- at epoch 3
[2. 1.] -2
error : 0 <- at epoch 3
[2. 1.] -2
error : -1 <- at epoch 3
[1. 1.] -3
error : 1 <- at epoch 3
[2. 2.] -2
error : 0 <- at epoch 4
[2. 2.] -2
error : -1 <- at epoch 4
[2. 1.] -3
error : 0 <- at epoch 4
[2. 1.] -3
error : 0 <- at epoch 4
[2. 1.] -3
error : 0 <- at epoch 5
[2. 1.] -3
error : 0 <- at epoch 5
[2. 1.] -3
error : 0 <- at epoch 5
[2. 1.] -3
error : 0 <- at epoch 6
[2. 1.] -3
error : 0 <- at epoch 6
[2. 1.] -3
```

```

error : 0 <- at epoch 6
[2. 1.] -3
error : 0 <- at epoch 6
[2. 1.] -3
error : 0 <- at epoch 7

```

**2) Change the random weights and bias and observe the convergence of the network.**

```

import numpy as np
# for AND gate (Input/Output)
x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,0,0,1])
epochs = 10
w,b = np.array([2,5]),0

for _ in range(epochs):
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        ### condition area for y_pred
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print("error : ",E,"<- at epoch",_)
        w += E*x
        b += E
        print(w,b)
print("-----")
print("Chirag Miglani, 1/23/SET/BCS/414")
print("22 January 2026")

```

```

[1 3] -4
error : 0 <- at epoch 3
[1 3] -4
error : 0 <- at epoch 3
[1 3] -4
error : 0 <- at epoch 3
[1 3] -4
error : 0 <- at epoch 4
[1 3] -4
error : 0 <- at epoch 4
[1 3] -4
error : 0 <- at epoch 4
[1 3] -4
error : 0 <- at epoch 4
[1 3] -4
error : 0 <- at epoch 5
[1 3] -4
error : 0 <- at epoch 5
[1 3] -4
error : 0 <- at epoch 5
[1 3] -4
error : 0 <- at epoch 6
[1 3] -4
error : 0 <- at epoch 6
[1 3] -4

```

```
[1 3] -4
error : 0 <- at epoch 9
[1 3] -4
+-----+
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```

**3) Add logic to stop the training when the error is 'zero' for all the inputs.**

```
import numpy as np
# for AND gate (Input/Output)
x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,0,0,1])
epochs = 10 # Increased epochs to ensure convergence without fixed iterations
w,b = np.zeros(2),0

for _ in range(epochs):
    errors_in_epoch = False # Flag to track errors in the current epoch
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print("error : ",E,"is at epoch",_)
        if E != 0:
            w += E*x
            b += E
            errors_in_epoch = True
        print(w,b)
    if not errors_in_epoch:
        print(f"Training stopped at epoch {_} as error has become zero for all the following inputs.")
        print("-----")
        print("Chirag Miglani, 1/23/SET/BCS/414")
        print("22 January 2026")
        break

error : -1 is at epoch 0
[0. 0.] -1
error : 0 is at epoch 0
[0. 0.] -1
error : 0 is at epoch 0
[0. 0.] -1
error : 1 is at epoch 0
[1. 1.] 0
error : -1 is at epoch 1
[1. 1.] -1
error : -1 is at epoch 1
[1. 0.] -2
error : 0 is at epoch 1
[1. 0.] -2
error : 1 is at epoch 1
[2. 1.] -1
error : 0 is at epoch 2
[2. 1.] -1
error : -1 is at epoch 2
[2. 0.] -2
error : -1 is at epoch 2
[1. 0.] -3
error : 1 is at epoch 2
[2. 1.] -2
error : 0 is at epoch 3
[2. 1.] -2
error : 0 is at epoch 3
[2. 1.] -2
error : -1 is at epoch 3
[1. 1.] -3
error : 1 is at epoch 3
[2. 2.] -2
error : 0 is at epoch 4
[2. 2.] -2
error : -1 is at epoch 4
[2. 1.] -3
error : 0 is at epoch 4
[2. 1.] -3
error : 0 is at epoch 4
[2. 1.] -3
error : 0 is at epoch 5
[2. 1.] -3
error : 0 is at epoch 5
[2. 1.] -3
error : 0 is at epoch 5
[2. 1.] -3
```

```

error : 0 is at epoch 5
[2. 1.] -3
Training stopped at epoch 5 as error has become zero for all the following inputs.
+-----+
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22 January 2026

```

**4) Repeat the same process for OR gate**

```

import numpy as np

x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,1,1,1])
epochs = 10
w,b = np.zeros(2),0

print("-----OR GATE Perceptron Learning-----")
for _ in range(epochs):
    errors_in_epoch = False
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print(f"Error: {E}, Epoch: {_}")
        if E != 0:
            w += E*x
            b += E
            errors_in_epoch = True
        print(f"Updated weights: {w}, Updated bias: {b}")
    if not errors_in_epoch:
        print(f"Training stopped at epoch {_} as error has become zero for all inputs.")
        break

print("-----+-----")
print("Chirag Miglani, 1/23/SET/BCS/414")
print("22 January 2026")

```

```

-----OR GATE Perceptron Learning-----
Error: -1, Epoch: 0
Updated weights: [0. 0.], Updated bias: -1
Error: 1, Epoch: 0
Updated weights: [0. 1.], Updated bias: 0
Error: 0, Epoch: 0
Updated weights: [0. 1.], Updated bias: 0
Error: 0, Epoch: 0
Updated weights: [0. 1.], Updated bias: 0
Error: -1, Epoch: 1
Updated weights: [0. 1.], Updated bias: -1
Error: 0, Epoch: 1
Updated weights: [0. 1.], Updated bias: -1
Error: 1, Epoch: 1
Updated weights: [1. 1.], Updated bias: 0
Error: 0, Epoch: 1
Updated weights: [1. 1.], Updated bias: 0
Error: -1, Epoch: 2
Updated weights: [1. 1.], Updated bias: -1
Error: 0, Epoch: 2
Updated weights: [1. 1.], Updated bias: -1
Error: 0, Epoch: 2
Updated weights: [1. 1.], Updated bias: -1
Error: 0, Epoch: 3
Updated weights: [1. 1.], Updated bias: -1
Error: 0, Epoch: 3
Updated weights: [1. 1.], Updated bias: -1
Error: 0, Epoch: 3
Updated weights: [1. 1.], Updated bias: -1
Training stopped at epoch 3 as error has become zero for all inputs.
+-----+
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22 January 2026

```

**5) Try the process for XOR gate and show that the network will not stabilize (Converge).**

```

import numpy as np

x_list = np.array([[0,0],[0,1],[1,0],[1,1]])
y_list = np.array([0,1,1,0])
epochs = 10
w,b = np.zeros(2),0

print("-----OR GATE Perceptron Learning-----")
for _ in range(epochs):
    errors_in_epoch = False
    for x,y in zip(x_list,y_list):
        z = np.dot(x,w) + b
        y_pred = 1 if z >= 0 else 0
        E = y - y_pred
        print(f"Error: {E}, Epoch: {_}")
        if E != 0:
            w += E*x
            b += E
            errors_in_epoch = True
        print(f"Updated weights: {w}, Updated bias: {b}")
    if not errors_in_epoch:
        print(f"Training stopped at epoch {_} as error has become zero for all inputs.")
        break

print("-----")
print("Chirag Miglani, 1/23/SET/BCS/414")
print("22 January 2026")

```

```

-----OR GATE Perceptron Learning-----
Error: -1, Epoch: 0
Updated weights: [0. 0.], Updated bias: -1
Error: 1, Epoch: 0
Updated weights: [0. 1.], Updated bias: 0
Error: 0, Epoch: 0
Updated weights: [0. 1.], Updated bias: 0
Error: -1, Epoch: 0
Updated weights: [-1. 0.], Updated bias: -1
Error: 0, Epoch: 1
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 1
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 1
Updated weights: [0. 1.], Updated bias: 1
Error: -1, Epoch: 1
Updated weights: [-1. 0.], Updated bias: 0
Error: -1, Epoch: 2
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 2
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 2
Updated weights: [0. 1.], Updated bias: 1
Error: -1, Epoch: 2
Updated weights: [-1. 0.], Updated bias: 0
Error: -1, Epoch: 3
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 3
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 3
Updated weights: [0. 1.], Updated bias: 1
Error: -1, Epoch: 3
Updated weights: [-1. 0.], Updated bias: 0
Error: -1, Epoch: 4
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 4
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 4
Updated weights: [0. 1.], Updated bias: 1
Error: -1, Epoch: 4
Updated weights: [-1. 0.], Updated bias: 0
Error: -1, Epoch: 5
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 5
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 5
Updated weights: [0. 1.], Updated bias: 1
Error: -1, Epoch: 5
Updated weights: [-1. 0.], Updated bias: 0
Error: -1, Epoch: 6
Updated weights: [-1. 0.], Updated bias: -1
Error: 1, Epoch: 6
Updated weights: [-1. 1.], Updated bias: 0
Error: 1, Epoch: 6

```

```
Updated weights: [0. 1.], Updated bias: 1  
Error: -1, Epoch: 6  
Updated weights: [-1. 0.], Updated bias: 0  
Error: -1, Epoch: 7
```

## › Lab - 3 | 05 February 2026

↳ 8 cells hidden