DL Lab 1

Name: Soumyadeep Ganguly

Reg No: 24MDT0082

In [50]:
```
import numpy as np
import matplotlib.pyplot as plt
```

Q1

McCulloch Pitts: OR Gate

In [51]:
```
def mcp_or_gate(x1, x2):
    theta = 1
    result = 1 if x1 + x2 >= theta else 0
    return result
```

In [52]:
```
print(mcp_or_gate(0, 0))
```

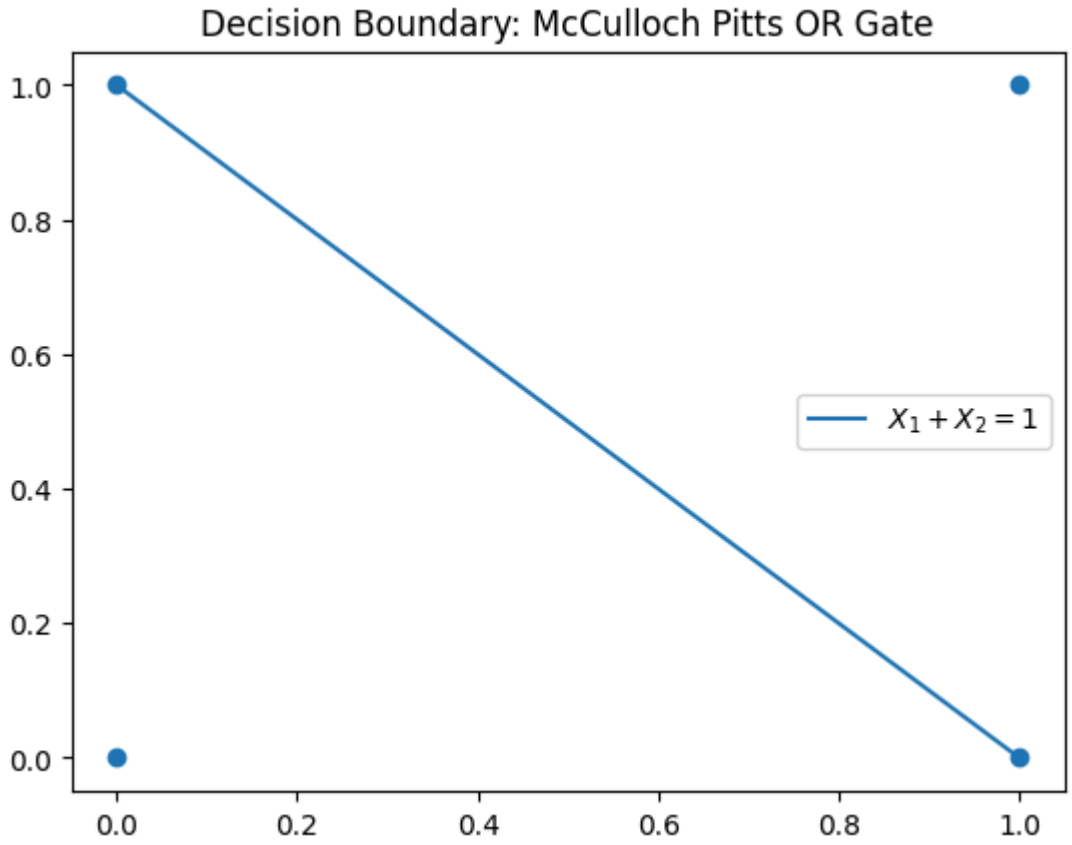
```
0
```

In [53]:
```
input_x1 = [0, 0, 1, 1]
input_x2 = [0, 1, 0, 1]

for i in range(len(input_x1)):
    res = mcp_or_gate(input_x1[i], input_x2[i])
    print(res)
```

```
0
1
1
1
```

In [54]:
```
l1 = np.linspace(0, 1, 100)
l2 = 1 - l1
plt.scatter(input_x1, input_x2)
plt.title("Decision Boundary: McCulloch Pitts OR Gate")
plt.plot(l1, l2, label = '${X_1} + {X_2} = {1}$')
plt.legend()
plt.show()
```



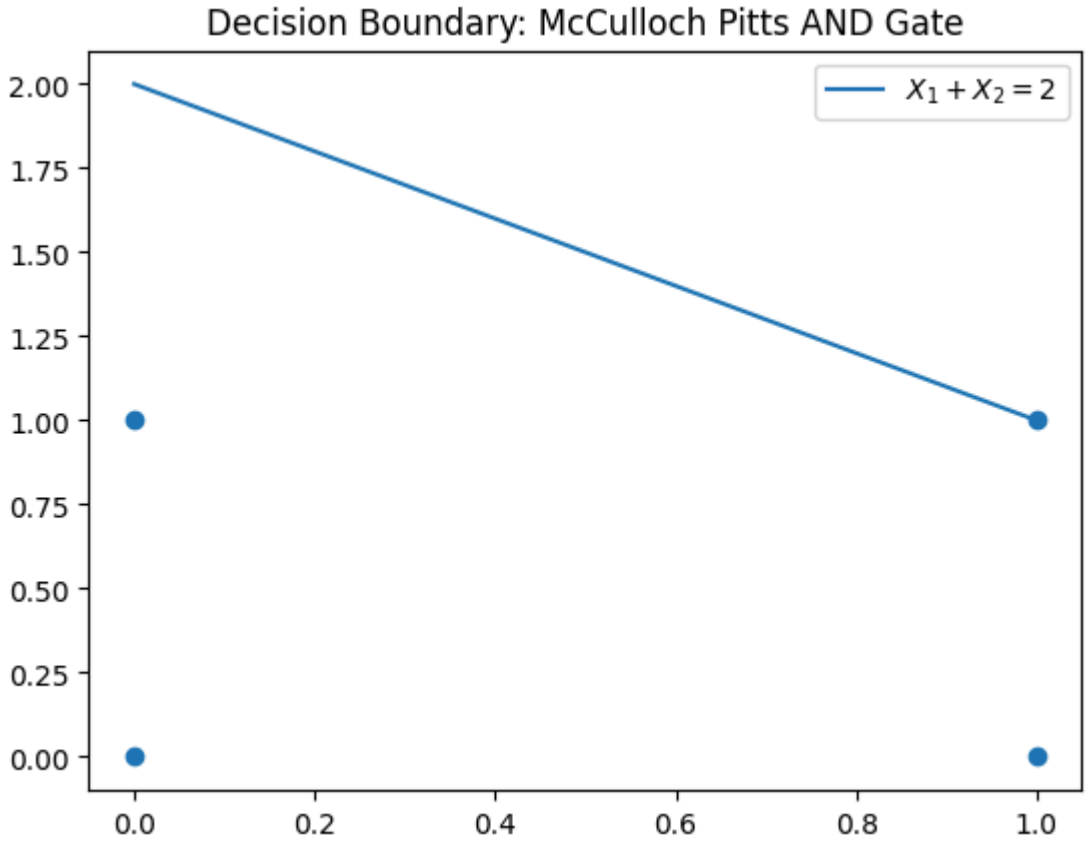
McCulloch Pitts: AND Gate

In [55]:
```
def mcp_and_gate(x1, x2):
    theta = 2
    result = 1 if x1 + x2 >= theta else 0
    return result
```

In [56]:
```
for i in range(len(input_x1)):
    print(mcp_and_gate(input_x1[i], input_x2[i]))
```

```
0
0
0
1
```

In [57]:
```
l1 = np.linspace(0, 1, 100)
l2 = 2 - l1
plt.scatter(input_x1, input_x2)
plt.title("Decision Boundary: McCulloch Pitts AND Gate")
plt.plot(l1, l2, label = '${X_1} + {X_2} = {2}$')
plt.legend()
plt.show()
```



Q2: Perceptron Learning Algorithm

In [58]:
```
X = np.array([
    [1, 0, 0],
    [1, 0, 1],
    [1, 1, 0],
    [1, 1, 1]
])


OR   = np.array([0, 1, 1, 1])
AND  = np.array([0, 0, 0, 1])
```

```
NAND = np.array([1, 1, 1, 0])
NOR  = np.array([1, 0, 0, 0])


def train(X, y, epochs=10):
    w = np.zeros(X.shape[1])

    for i in range(epochs):
        err = 0
        for xi, target in zip(X, y):
            res = np.dot(w, xi)
            if target == 1 and res < 0:
                w = w + xi
                err += 1
            elif target == 0 and res >= 0:
                w = w - xi
                err += 1
        if err == 0:
            print(f"Converged after {i+1} epochs")
            break
    return w
```

In [59]:

```
print("Training OR gate:")
w_or = train(X, OR, epochs=10)
print("Final Weights (OR):", w_or)

print("\nTraining AND gate:")
w_and = train(X, AND, epochs=10)
print("Final Weights (AND):", w_and)

print("\nTraining NAND gate:")
w_nand = train(X, NAND, epochs=10)
print("Final Weights (NAND):", w_nand)

print("\nTraining NOR gate:")
w_nor = train(X, NOR, epochs=10)
print("Final Weights (NOR):", w_nor)
```

```
Training OR gate:
Converged after 4 epochs
Final Weights (OR): [-1.  1.  1.]

Training AND gate:
Converged after 6 epochs
Final Weights (AND): [-3.  2.  1.]

Training NAND gate:
Converged after 6 epochs
Final Weights (NAND): [ 2. -2. -1.]

Training NOR gate:
Converged after 4 epochs
Final Weights (NOR): [ 0. -1. -1.]
```

Q3: XOR function

In [60]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
```

In [61]:
```
X = np.array([[0,0], [0,1], [1,0], [1,1]])
y = np.array([[0], [1], [1], [0]])
```

In [62]:
```
model = Sequential()
model.add(Dense(4, input_dim=2, activation='sigmoid'))
model.add(Dense(1, activation='sigmoid'))
```

```
e:\VIT Study Materials\SEM 3\Deep Learning\LAB\.venv\Lib\site-packages\keras\src\layers\core\dense.py:93: UserWarning: Do not p
ass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as th
e first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [63]:
```
model.compile(loss="binary_crossentropy", optimizer='adam', metrics=['accuracy'])
```

In [64]:
```
model.fit(X, y, epochs=100, verbose=1)
```

```
Epoch 1/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 559ms/step - accuracy: 0.5000 - loss: 0.8586
Epoch 2/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8575
Epoch 3/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 34ms/step - accuracy: 0.5000 - loss: 0.8564
Epoch 4/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 30ms/step - accuracy: 0.5000 - loss: 0.8554
Epoch 5/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 36ms/step - accuracy: 0.5000 - loss: 0.8543
Epoch 6/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 46ms/step - accuracy: 0.5000 - loss: 0.8533
Epoch 7/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 38ms/step - accuracy: 0.5000 - loss: 0.8522
Epoch 8/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 46ms/step - accuracy: 0.5000 - loss: 0.8512
Epoch 9/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 48ms/step - accuracy: 0.5000 - loss: 0.8501
Epoch 10/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 50ms/step - accuracy: 0.5000 - loss: 0.8491
Epoch 11/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - accuracy: 0.5000 - loss: 0.8480
Epoch 12/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - accuracy: 0.5000 - loss: 0.8470
Epoch 13/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8460
Epoch 14/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 56ms/step - accuracy: 0.5000 - loss: 0.8450
Epoch 15/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 36ms/step - accuracy: 0.5000 - loss: 0.8440
Epoch 16/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 38ms/step - accuracy: 0.5000 - loss: 0.8430
Epoch 17/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.8420
Epoch 18/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 38ms/step - accuracy: 0.5000 - loss: 0.8410
Epoch 19/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.8400
Epoch 20/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8390
Epoch 21/100
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8380
Epoch 22/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8370
Epoch 23/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 49ms/step - accuracy: 0.5000 - loss: 0.8360
Epoch 24/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8351
Epoch 25/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8341
Epoch 26/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 44ms/step - accuracy: 0.5000 - loss: 0.8331
Epoch 27/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8322
Epoch 28/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8312
Epoch 29/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8303
Epoch 30/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8294
Epoch 31/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 48ms/step - accuracy: 0.5000 - loss: 0.8284
Epoch 32/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8275
Epoch 33/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 47ms/step - accuracy: 0.5000 - loss: 0.8266
Epoch 34/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8257
Epoch 35/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 48ms/step - accuracy: 0.5000 - loss: 0.8248
Epoch 36/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8239
Epoch 37/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8230
Epoch 38/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8221
Epoch 39/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8212
Epoch 40/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 34ms/step - accuracy: 0.5000 - loss: 0.8203
Epoch 41/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8194
```

```
Epoch 42/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - accuracy: 0.5000 - loss: 0.8185
Epoch 43/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 39ms/step - accuracy: 0.5000 - loss: 0.8177
Epoch 44/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8168
Epoch 45/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8159
Epoch 46/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.8151
Epoch 47/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 44ms/step - accuracy: 0.5000 - loss: 0.8142
Epoch 48/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8134
Epoch 49/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8126
Epoch 50/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 33ms/step - accuracy: 0.5000 - loss: 0.8117
Epoch 51/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 39ms/step - accuracy: 0.5000 - loss: 0.8109
Epoch 52/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 48ms/step - accuracy: 0.5000 - loss: 0.8101
Epoch 53/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 44ms/step - accuracy: 0.5000 - loss: 0.8093
Epoch 54/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.8084
Epoch 55/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.8076
Epoch 56/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.8068
Epoch 57/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 56ms/step - accuracy: 0.5000 - loss: 0.8060
Epoch 58/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 44ms/step - accuracy: 0.5000 - loss: 0.8052
Epoch 59/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.8045
Epoch 60/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 39ms/step - accuracy: 0.5000 - loss: 0.8037
Epoch 61/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 31ms/step - accuracy: 0.5000 - loss: 0.8029
Epoch 62/100
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8021
Epoch 63/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - accuracy: 0.5000 - loss: 0.8014
Epoch 64/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.8006
Epoch 65/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7998
Epoch 66/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.7991
Epoch 67/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.7983
Epoch 68/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7976
Epoch 69/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7968
Epoch 70/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7961
Epoch 71/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7954
Epoch 72/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 38ms/step - accuracy: 0.5000 - loss: 0.7947
Epoch 73/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.7939
Epoch 74/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.7932
Epoch 75/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7925
Epoch 76/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 40ms/step - accuracy: 0.5000 - loss: 0.7918
Epoch 77/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7911
Epoch 78/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7904
Epoch 79/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7897
Epoch 80/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 35ms/step - accuracy: 0.5000 - loss: 0.7890
Epoch 81/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 36ms/step - accuracy: 0.5000 - loss: 0.7883
Epoch 82/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 55ms/step - accuracy: 0.5000 - loss: 0.7876
```

```
Epoch 83/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7870
Epoch 84/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 43ms/step - accuracy: 0.5000 - loss: 0.7863
Epoch 85/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7856
Epoch 86/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7850
Epoch 87/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7843
Epoch 88/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 45ms/step - accuracy: 0.5000 - loss: 0.7836
Epoch 89/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 32ms/step - accuracy: 0.5000 - loss: 0.7830
Epoch 90/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 39ms/step - accuracy: 0.5000 - loss: 0.7823
Epoch 91/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7817
Epoch 92/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7811
Epoch 93/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7804
Epoch 94/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7798
Epoch 95/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 31ms/step - accuracy: 0.5000 - loss: 0.7792
Epoch 96/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 41ms/step - accuracy: 0.5000 - loss: 0.7786
Epoch 97/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step - accuracy: 0.5000 - loss: 0.7779
Epoch 98/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 53ms/step - accuracy: 0.5000 - loss: 0.7773
Epoch 99/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 31ms/step - accuracy: 0.5000 - loss: 0.7767
Epoch 100/100
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 37ms/step - accuracy: 0.5000 - loss: 0.7761
```

Out[64]: <keras.src.callbacks.history.History at 0x229250600e0>

In [65]:
```
pred = model.predict(X)
print(pred)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 51ms/step
[[0.27791783]
 [0.2683039 ]
 [0.35182717]
 [0.34041095]]
```

In [ ]: