Assignment 4
Roman Bamrah 0705310
Dikshith Reddy Macheria 0789055

Q-1 Bias = 1
Learning rate - 0.3
θ = 0.5

X	Y	Output
0	0	0
0	1	0
1	0	0
1	1	1

Epoch 1:

X	Y	Target	Sum	Output
0	0	0	0	0
0	1	0	0	0
1	0	0	0	0
1	1	1	0	0

w1 = 0 + (0.3 x 1) = 0.3
w2 = 0 + (0.3 x 1) = 0.3
b = 0 + (0.3 x 1) = 0.3

Epoch 2: w1 = 0.3 w2 = 0.3 b = 0.3

X	Y	Target	Sum	Output
0	0	0	0.3	0
0	1	0	0.6	1
1	0	0	0.6	1
1	1	1	0.9	1

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Update weights:
w1 = 0.3 - 0.3 = 0
w2 = 0.3 - 0.3 = 0
b = 0.3 - 0.3 = 0

Epoch 3: w1 = 0 w2 = 0 b = -0.3

X	Y	Target	Sum	Output
0	0	0	-0.3	0
0	1	0	-0.3	0
1	0	0	-0.3	0
1	1	1	-0.3	0

Update weights:
w1 = 0 + 0.3 = 0.3
w2 = 0 + 0.3 = 0.3
b = - 0.3 + 0.3 = 0

Epoch 4: w1 = 0.3 w2 = 0.3 b = 0

X	Y	Target	Sum	Output
0	0	0	0	0
0	1	0	0.3	0
1	0	0	0.3	0
1	1	1	0.6	1

No more updates/final weights:
w1 = 0.3
w2 = 0.3
b = 0

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Q-2

Bias = 1
Learning rate = 0.1
θ = 0.5

X	Y	Output
0	0	0
0	1	0
1	0	0
1	1	1

Epoch 1:
Initial weights: w1 = 0, w2 = 0, b = 0

X	Y	Target	Sum	Output
0	0	0	0	0
0	1	0	0	0
1	0	0	0	0
1	1	1	0	0

Update weights:
w1 = 0 + 0.1 = 0.1
w2 = 0 + 0.1 = 0.1
b = 0 + 0.1 = 0.1

Epoch 2: w1 = 0.1, w2 = 0.1, b = 0.1

X	Y	Target	Sum	Output
0	0	0	0.1	0
0	1	0	0.2	0
1	0	0	0.2	0
1	1	1	0.3	0

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Update weights:
w1 = 0.1 + 0.1 = 0.2
w2 = 0.1 + 0.1 = 0.2
b = 0.1 + 0.1 = 0.2

Epoch 3: w1 = 0.2, w2 = 0.2, b = 0.2

X	Y	Target	Sum	Output
0	0	0	0.2	0
0	1	0	0.4	0
1	0	0	0.4	0
1	1	1	0.6	1

No more updates / Final weights:
w1 = 0.2
w2 = 0.2
b = 0.2

Q-3

Bias = 1
Learning rate = 0.3
θ = 0
Bipolar Output: (-1, 1)

X	Y	Output
-1	-1	-1
-1	1	-1
1	-1	-1
1	1	1

Epoch 1:
Initial weights: w1 = 0, w2 = 0, b = 0

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X	Y	Target	Sum	Output
-1	-1	-1	0	1
-1	1	-1	0	1
1	-1	-1	0	1
1	1	1	0	1

For (-1,-1,-1):
w1 = 0 + 0.3 (-1) = -0.3
w2 = 0 + 0.3 (-1) = -0.3
b = 0 + 0.3 (-1) = -0.3

For (-1,1,-1):
w1 = -0.3 + 0.3 (-1) = -0.6
w2 = -0.3 + 0.3 (1) = 0.0
b = -0.3 + 0.3 (-1) = -0.6

For (1,-1,-1):
w1 = -0.6 + 0.3 (1) = -0.3
w2 = -0.3 + 0.3 (-1) = -0.3
b = -0.6 + 0.3 (-1) = -0.9

Epoch 2:
Updated Weights: w1 = -0.3, w2 = -0.3, b = -0.9
w1 = -0.3 - 0.3 = -0.6, w2 = -0.3 - 0.3 = -0.6, b = -0.9 - 0.3 = -1.2
w1 = -0.6 + 0.3 = -0.3, w2 = -0.6 + 0.3 = -0.3, b = -1.2 + 0.3 = -0.9

Epoch 3:
Updated Weights: w1 = -0.3, w2 = -0.3, b = -0.9
w1 = -0.3 + 0.3 = 0.0, w2 = -0.3 + 0.3 = 0.0, b = -0.9 + 0.3 = -0.6

Epoch 4:
Updated Weights: w1 = 0.0, w2 = 0.0, b = -0.6
w1 = 0.0 + 0.3 = 0.3, w2 = 0.0 + 0.3 = 0.3, b = -0.6 + 0.3 = -0.3

Epoch 5:
Final Weights: w1 = 0.3, w2 = 0.3, b = -0.3

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Q-4

Bias = 1
Learning rate = 0.1
θ = 0
Bipolar Output: (-1, 1)

X	Y	Output
-1	-1	-1
-1	1	-1
1	-1	-1
1	1	1

Epoch 1
Initial Weights: w1 = 0, w2 = 0, b = 0
Updated Weights:
w1 = 0 + (0.1 × -2 × -1) = 0.2
w2 = 0 + (0.1 × -2 × -1) = 0.2
b = 0 + (0.1 × -2) = -0.2

Epoch 2: Updated Weights: w1 = 0.2, w2 = 0.2, b = -0.2
w1 = 0.2 - 0.1 = 0.1, w2 = 0.2 - 0.1 = 0.1, b = -0.2 - 0.1 = -0.3
w1 = 0.1 - 0.1 = 0.0, w2 = 0.1 - 0.1 = 0.0, b = -0.3 - 0.1 = -0.4
w1 = 0.0 + 0.1 = 0.1, w2 = 0.0 + 0.1 = 0.1, b = -0.4 + 0.1 = -0.3

Epoch 3: Updated Weights: w1 = 0.1, w2 = 0.1, b = -0.3
w1 = 0.1 + 0.1 = 0.2, w2 = 0.1 + 0.1 = 0.2, b = -0.3 + 0.1 = -0.2

Epoch 4: Updated Weights: w1 = 0.2, w2 = 0.2, b = -0.2
w1 = 0.2 + 0.1 = 0.3, w2 = 0.2 + 0.1 = 0.3, b = -0.2 + 0.1 = -0.1

Epoch 5: Final Weights:
w1 = 0.3, w2 = 0.3, b = -0.1

Question 5:
Is bipolar better?: In contrast to binary activation (0,1), bipolar activation (-1,1) frequently aids in faster convergence. This is because bipolar values minimize stagnation during weight adjustments and offer superior gradient updates.

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Is a larger learning rate better?: Not all the time. Although a higher learning rate can hasten convergence, it may also lead to instability or exceed the ideal weights. A more consistent and accurate learning process is guaranteed with a lower learning rate.

Why do we need a large number of epochs?: By fine-tuning its weights over several iterations, a large number of epochs enables the perceptron to accurately classify all training data. The model might not learn the right decision boundary if there aren't enough epochs.

What happens when the threshold is changed?: The activation boundary is determined by the threshold (Θ). While lowering the threshold facilitates activation, raising it makes it more difficult for the perceptron to activate (generate output = 1). This affects how input patterns are classified by the perceptron.