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Western New England University
ECE Engineering Department
Neural Networks Fall 2023
Exam 1: In Class Written Part

Print Your Name David Mekinson

At every step in solving the problems explain what you are doing. Label the given figures as required and use descriptive phrases. Show all your work. The final answer is not enough to receive any credit.

2. Consider the OR function (binary inputs and targets).

Input #	Input (X_1,X_2,1(bias))	Output (t)
1	(1,1,1)	1
2	(1,0,1)	1
3	(0,1,1)	1
4	(0,0,1)	0

Using a perceptron Architecture, complete the following table

Epoch # 1

INPUT #	INPUT			Net	out	TARGET	WEIGHT & BIAS CHANGES			WEIGHTS & BIAS		
	X_1	X_2	bias	y_{in}	Y	t	ΔW_1	ΔW_2	Δb	W_1	W_2	b
										0	0	-1
1	1	1	1	0	0	1	+1	+1	+1	1	1	0
2	1	0	1	2	1	1	0	0	0	1	1	0
3	0	1	1	2	1	1	0	0	0	1	1	0
4	0	0	1	1	1	0	0	0	-1	1	1	-1

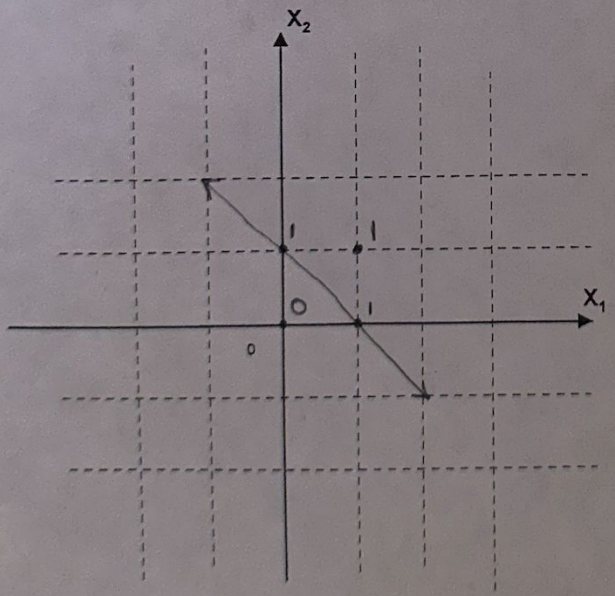
I. Show how Y_{in}, Y, ΔW_1, ΔW_2, and Δb are calculate
II. What is the equation of the decision boundary line?
III. Plot the decision boundary line and the input data.

$w_1 x_1 + w_2 x_2 + w_b b = 0$

$x_1 + x_2 - 1 = 0$

$x_1 - 1 = -x_2$

II. $x_2 = -x + 1$



1. Consider the OR function (bipolar input and target values).

Input #	Input (X_1,X_2,1(bias))	Output (t)
1	(1,1,1)	1
2	(1,-1,1)	1
3	(-1,1,1)	1
4	(-1,-1,1)	-1

I. Using a Hebb neural net architecture complete the following table.

INPUT #	INPUT			Net	out	TARGET	WEIGHT & BIAS CHANGES			WEIGHTS & BIAS		
	X_1	X_2	bias	y_{in}	Y	t	ΔW_1	ΔW_2	Δb	W_1	W_2	b
										0	0	0
1	+1	+1	+1	0	1	+1	+1	+1	1	1	1	1
2	+1	-1	+1	1	1	+1	+1	-1	+1	2	0	2
3	-1	+1	+1	1	1	+1	-1	+1	+1	1	1	3
4	-1	-1	+1	0	1	-1	+1	+1	-1	2	2	2

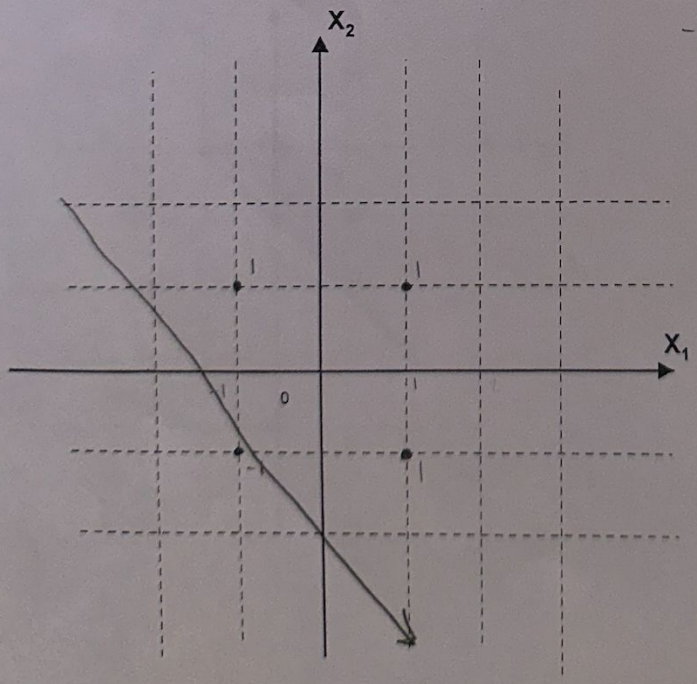
II. What is the equation of the decision boundary line?
III. Plot the decision boundary line and the input data.
IV. Was the learning successful? Yes

$0 = 2x_1 + 2x_2 + 2(1)$

$-2 = 2x_1 + 2x_2$

$-1 = x_1 + x_2$

$x_2 = -x_1 - 1$



Epoch #1:

$$y_{in} = b + \sum_{i=1}^{n} w_i x_i \Rightarrow y_{in} = 1 + x_1 w_1 + x_2 w_2$$
$$= 1 + (1)(0) + (1)(0) = 1$$

$w_1(new) = w_1(old) + x_1 y = 0 + (1)(1) = 1$
$w_2(new) = w_2(old) + x_2 y = 0 + (1)(1) = 1$
$b(new) = b(old) + by = 0 + (1)(1) = 1$

Epoch #2:

$y_{in} = b + w_1 x_1 + w_2 x_2 = 1 + (1)(1) + (1)(-1) = 1$
$w_1(new) = w_1(old) + x_1 y = 1 + (1)(1) = 2$
$w_2(new) = w_2(old) + x_2 y = 1 + (-1)(1) = 0$
$w_b(new) = w_b(old) + by = 1 + (1)(1) = 2$

Epoch #3:

$y_{in} = b + w_1 x_1 + w_2 x_2 = 2 + (2)(-1) + (0)(1) = 0$
$w_1(new) = w_1(old) + x_1 y = 2 + (-1)(1) = 1$
$w_2(new) = w_2(old) + x_2 y = 0 + (1)(1) = 1$
$w_b(new) = w_b(old) + by = 2 + (1)(1) = 3$

Epoch #4:

$w_1(new) = w_1(old) + x_1 y = (1) + (-1)(-1) = 2$
$w_2(new) = w_2(old) + x_2 y = (1) + (-1)(-1) = 2$
$w_b(new) = w_b(old) + by = (3) + (1)(-1) = 2$

Perceptron:

Input #1:

$w_1(new) = w_1(old) + (t - y) x_1 = 0 + (1 - 0) 1 = 1$
$w_2(new) = w_2(old) + (t - y) x_2 = 0 + (1 - 0) 1 = 1$
$w_b(new) = w_b(old) + (t - y) b = -1 + (1 - 0) 1 = 0$

#2:

$y_{in} = b + x_1 w_1 + x_2 w_2 = 1 + (1)(1) + (0)(1) = 2$
no change

#3:

$y_{in} = 1 + (0)(1) + (1)(1) = 2$
no change

#4: $y_{in} = 1 + (0)(1) + (0)(1) = 1$
$w_1(new) = w_1(old) + (t - y) x_1 = 1 + (0 - 1) 0 = 1$
$w_2(new) = w_2(old) + (t - y) x_2 = 1 + (0 - 1) 0 = 1$
$w_b(new) = w_b(old) + (t - y) b = 0 + (0 - 1) 1 = -1$