

اسم الطالب: عثمان صديق عتيق رمضان
 رقم الطالب: 802267541
 اسم المقرر: Neural Networks
 المستوى / الرابع: الرابع / IT

Question (1) Choose the correct answer

- (1) D. Rosenblatt
- (2) C. Neuron
- (3) B. chemical process
- (4) C. Transmission
- (5) A. summing
- (6) A. McCulloch-pitts neuron Model
- (7) A. excitatory input
- (8) B. inhibitory input
- (9) D. weight
- (10) C. learning

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(11) B. no

(12) C. association unit

(13) B. learning enabled

question (2)

1

$$\theta \geq \eta w - p$$

$$\eta = 2$$

$$w = 1$$

$$\theta = 2 \times 1 = 2$$

$$w_1 = w_2 = 1$$

x_1	x_2	y
1	1	1
1	0	0
0	1	0
0	0	0

AND table

$$(1,1) \quad y_{in} = x_1 w_1 + x_2 w_2 = 1 \times 1 + 1 \times 1 = 2 = \theta$$

$$(1,0) \quad y_{in} = x_1 w_1 + x_2 w_2 = 1 \times 1 + 0 \times 1 = 1 < \theta$$

$$(0,1) \quad y_{in} = x_1 w_1 + x_2 w_2 = 0 \times 1 + 1 \times 1 = 1 < \theta$$

$$(0,0) \quad y_{in} = x_1 w_1 + x_2 w_2 = 0 \times 1 + 0 \times 1 = 0 < \theta$$

$$F(y_{in}) = \begin{cases} 0 & y_{in} < \theta \\ 1 & y_{in} \geq \theta \end{cases}$$

$$F(y_{in}) = \begin{cases} 0 & y_{in} < 2 \\ 1 & y_{in} \geq 2 \end{cases}$$

$y_{in}(1,1)$ out 1 $y_{in}(1,0)$ out 0

$y_{in}(0,1)$ out 0 $y_{in}(0,0)$ out 0

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2 $y = x_1 \bar{x}_2 + \bar{x}_1 x_2$

$z_1 = x_1 \bar{x}_2, z_2 = \bar{x}_1 x_2$

$y = z_1 + z_2$

x_1	x_2	y
1	1	0
1	0	1
0	1	1
0	0	0

$z_1 = x_1 \bar{x}_2$

$w_{11} = w_{12} = 1$

x_1	x_2	y
1	1	0
1	0	1
0	1	0
0	0	0

$(1,1) \quad y_{in} = x_1 w_{11} + x_2 w_{12}$
 $= 1 \times 1 + 1 \times 1 = 2$

$(1,0) \quad y_{in} = x_1 w_{11} + x_2 w_{12}$
 $= 1 \times 1 + 1 \times 0 = 1$

$(0,1) \quad y_{in} = x_1 w_{11} + x_2 w_{12}$
 $= 0 \times 1 + 1 \times 1 = 1$

$(0,0) \quad y_{in} = x_1 w_{11} + x_2 w_{12}$
 $= 0 \times 1 + 0 \times 1 = 0$

x_1	x_2	y
1	1	0
1	0	1
0	1	0
0	0	0

$\Theta = NW - P = 2 \times 1 - 0 = 2$

it's not true

$f(y_{in}) = \begin{cases} 0 & 0 < \Theta \\ 1 & 1 \geq \Theta \end{cases}$

output $y_{in}(1,1) = 1$
 output $y_{in}(1,0) = 0$
 output $y_{in}(0,1) = 0$
 output $y_{in}(0,0) = 0$

$f(y_{in}) = \begin{cases} 0 & 0 y_{in} < \Theta \\ 1 & y_{in} \geq \Theta \end{cases}$

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$$w_{11} = 1$$

$$w_{12} = -1$$

$$\Theta = nW - p = 2 \times 1 - 1 = 1$$

$$(1,1) y_{in} = x_1 w_{11} + x_2 w_{12} = 1 \times 1 + 1 \times -1 = 0$$

$$(1,0) y_{in} = x_1 w_{11} + x_2 w_{12} = 1 \times 1 + 0 \times -1 = 1$$

$$(0,1) y_{in} = x_1 w_{11} + x_2 w_{12} = 0 \times 1 + 1 \times -1 = -1$$

$$(0,0) y_{in} = x_1 w_{11} + x_2 w_{12} = 0 \times 1 + 0 \times -1 = 0$$

$A(y_{in})$
 $\begin{cases} 0 & y_{in} < 1 \\ 1 & y_{in} \geq 1 \end{cases}$

$$\text{output } y_{in}(1,1) = 0$$

$$\text{output } y_{in}(1,0) = 1$$

$$\text{output } y_{in}(0,1) = 0$$

$$\text{output } y_{in}(0,0) = 0$$

It's true

$$w_{21} = w_{22} = 1$$

$$Z_2 = \bar{x}_1 x_2$$

$$\Theta = nW - p = 2 \times 1 - 0 = 2$$

x_1	x_2	y
1	1	0
1	0	0
0	1	1
0	0	0

$$(1,1) y_{in} = x_1 w_{21} + x_2 w_{22}$$

$$1 \times 1 + 1 \times 1 = 2$$

$$\text{output} = 1$$

$$(1,0) y_{in} = x_1 w_{21} + x_2 w_{22}$$

$$1 \times 1 + 0 \times 1 = 1$$

$$\text{output} = 0$$

$$(0,1) y_{in} = x_1 w_{21} + x_2 w_{22}$$

$$0 \times 1 + 1 \times 1 = 1$$

$$\text{output} = 0$$

$$(0,0) y_{in} = x_1 w_{21} + x_2 w_{22}$$

$$0 \times 1 + 0 \times 1 = 0$$

$$\text{output} = 0$$

It's not true

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$w_{11} = -1$, $w_{22} = 1$

$Q = NW - P$
 $= 2 \times 1 - 1 = 1$

(1,1) $y_{in} = x_1 w_{11} + x_2 w_{22}$
 $= 1 \times -1 + 1 \times 1 = 0$ out = 0

(1,0) $y_{in} = x_1 w_{11} + x_2 w_{22}$
 $= 1 \times -1 + 0 \times 1 = -1$ out = 0 $F(y_{in}) = \begin{cases} 0 & y_{in} < 1 \\ 1 & y_{in} \geq 1 \end{cases}$

(0,1) $y_{in} = x_1 w_{11} + x_2 w_{22}$
 $= 0 \times -1 + 1 \times 1 = 1$ out = 1

(0,0) $y_{in} = x_1 w_{11} + x_2 w_{22}$
 $= 0 \times -1 + 0 \times 1 = 0$ out = 0

$\therefore y = z_1 \text{ OR } z_2$
 $= z_1 + z_2 = x_1 \bar{x}_2 + \bar{x}_1 x_2$
 $y_{in} = z_1 w_1 + z_2 w_2$



assume that $\Rightarrow w_1 = w_2 = 1$

(0,0) $y_{in} = z_1 w_1 + z_2 w_2$
 $= 0 \times 1 + 0 \times 1 = 0$

(1,0) $y_{in} = z_1 w_1 + z_2 w_2$
 $= 1 \times 1 + 0 \times 1 = 1$

(0,1) $y_{in} = z_1 w_1 + z_2 w_2$
 $= 0 \times 1 + 1 \times 1 = 1$

(0,0) $y_{in} = 0 \times 1 + 0 \times 1 = 0$

x_1	x_2	y	z_1	z_2
1	1	0	0	0
1	0	1	1	0
0	1	1	0	1
0	0	0	0	0

$y = F(y_{in}) = \begin{cases} 0 & y_{in} < 1 \\ 1 & y_{in} \geq 1 \end{cases}$

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3

$$w_1 = w_2 = b = \text{jeep}$$

$$w_{\text{new}} = w_{\text{old}} + x_i y$$

~~Learn~~

$$b_{\text{new}} = b_{\text{old}} + y$$

در این مرحله
b=1 میزنیم
و به آن اضافه میکنیم

یعنی

x_1	x_2	y	b
1	1	1	1
1	-1	1	1
-1	1	1	1
-1	-1	-1	1

(1,1)

$$w_1 = \text{jeep} + 1 \times 1 = 1$$

$$w_2 = \text{jeep} + 1 \times 1 = 1$$

$$b = \text{jeep} + 1 = 1$$

(1,-1)

$$w_1 = 1 + 1 \times 1 = 2$$

$$w_2 = 1 + -1 \times 1 = 0$$

$$b = 1 + 1 = 2$$

(-1,1)

$$w_1 = 2 + 1 \times -1 = 1$$

$$w_2 = 0 + 1 \times 1 = 1$$

$$b = 2 + 1 = 3$$

(-1,-1)

$$w_1 = 1 + 1 \times -1 = 0$$

$$w_2 = 1 + -1 \times -1 = 2$$

$$b = 3 + 1 = 4$$

for
Bipolar

[7]

$$y = x_1 w_1 + x_2 w_2 + b$$

$$w_1 = w_2 = b = 2$$

$(1, 1)$	$y = 1 \times 2 + 1 \times 2 + 2 = 6 > 0$	output: 1
$(-1, 1)$	$y = 1 \times 2 + -1 \times 2 + 2 = 2 > 0$	output: 1
$(1, -1)$	$y = -1 \times 2 + 1 \times 2 + 2 = 2 > 0$	output: 1
$(-1, -1)$	$y = -1 \times 2 + -1 \times 2 + 2 = -2 < 0$	output: -1

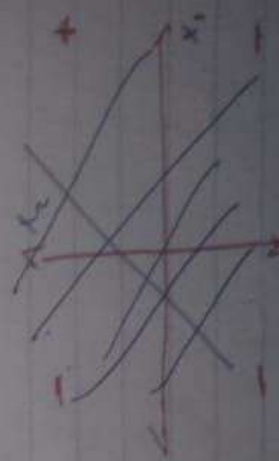
~~Decision~~ Decision Boundary

$$x_1 w_1 + x_2 w_2 + b = \text{pred}$$

$$2x_1 + 2x_2 + 2 = \text{pred}$$

$$\div 2$$

$$x_1 + x_2 + 1 = \text{pred}$$



(8)

For binary :

inputs			target weight changes			new weights		
x_1	x_2	bias	y	Δw_1	Δw_2	Δb	w_1	w_2 bias
1	1	1	1	1	1	1	1	1
1	0	1	1	1	0	1	2	0 2
0	1	1	1	0	1	1	2	2 3
0	0	1	0	0	0	0	2	2 3

1- حجب لا يمكن عمل OR بطريقة Hebb

لأن دور Hebb أنها تقوى الروابط في حالة $x_1 = x_2 = 1$

لو أخذنا $b = 6$ سنجد أن

$w_1 = 1$ $w_2 = 1$ $b = 2$	$w_1 = 2$ $w_2 = 0$ $b = 3$	$w_1 = 1$ $w_2 = 1$ $b = 4$	$w_1 = 2$ $w_2 = 2$ $b = 6$
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و بالتعويض سنجد أن ال output خاطئ

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$$y_{in} = b + x_1 w_1 + x_2 w_2$$

$$w_1 = w_2 = b = 0$$

$$\Delta w = 2xt \quad \Delta b = 2t$$

x_1	x_2	y
1	1	1
1	-1	1
-1	1	1
-1	-1	-1

$$w_{new} = w_{old} + \Delta w \quad b_{new} = b_{old} + \Delta b$$

$$\hat{y} = f(y_{in}) = \begin{cases} 1 & y_{in} > 0 \\ 0 & y_{in} = 0 \\ -1 & y_{in} < 0 \end{cases}$$



$$(1, 1) \quad y_{in} = 0 + (1)(0) + (1)(0) = 0$$

$$\hat{y} = f(0) = 0$$

$$t = 1, \quad z = 1$$

$$\Delta w_1 = 1 \times 1 \times 1 = 1$$

$$\Delta w_2 = 1 \times 1 \times 1 = 1$$

$$\Delta b = 1 \times 1 = 1$$

$$w_{1, new} = 0 + 1 = 1$$

$$w_{2, new} = 0 + 1 = 1$$

$$b_{new} = 0 + 1 = 1$$



$$(1, -1) \quad y_{in} = 1 + (1)(1) + (-1)(1) = 1$$

$$\hat{y} = f(1) = 1$$

$$t = 1$$

$$\Delta w_1 = 1 \times 1 \times 1 = 1$$

$$\Delta w_2 = 1 \times -1 \times 1 = -1$$

$$w_1 = 1 + 1 = 2$$

$$\Delta b = 1 \times 1 = 1$$

$$w_2 = 1 + (-1) = 0$$

$$b = 1 + 1 = 2$$

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$$(-1, 1) y_{in} = 2 + (-1)(2) + (1)(0) = 0 \quad \boxed{\text{zero}}$$

$$\hat{y} = f(y_{in}) = f(0) = 0, t = 1$$

$$\Delta w_1 = 1 \times -1 \times 1 = -1, \Delta w_2 = 1 \times 1 \times 1 = 1, \Delta b = 1 \times 1 \times 1 = 1$$

$$w_1 = 2 + 1 = 3, w_2 = 0 + 1 = 1, b = 2 + 1 = 3$$

$$(-1, -1) y_{in} = 3 + (-1)(1) + (-1)(1) = 1$$

$$\hat{y} = f(y_{in}) = f(1) = 1 \quad \boxed{t = -1}$$

$$\Delta w_1 = 1 \times -1 \times -1 = 1, \Delta w_2 = 1 \times -1 \times -1 = 1$$

$$\Delta b = -1 \times 1 = -1$$

$$w_1 = 3 + 1 = 4, w_2 = 1 + 1 = 2, b = 3 - 1 = 2$$

Epoch 1

Inputs		target	net input	output	weight change			weights		
x_1	x_2	y	y_{in}	\hat{y}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	1	0	0	1	1	1	1	1	1
1	-1	1	1	1	1	-1	1	2	0	2
-1	1	1	0	0	-1	1	1	1	1	3
-1	-1	-1	1	1	1	-1	-1	2	2	2

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Epoch 2

$w_1 = 2$

$w_2 = 0$

bias = 2

inputs		target	net input	output	weight change			weights		
x_1	x_2	y	y_{in}	\hat{y}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	1	6	1	1	1	1	3	3	3
1	-1	1	3	1	1	-1	1	4	2	4
-1	1	1	2	1	-1	1	1	3	3	5
-1	-1	1	-1	-1	-1	1	-1	4	4	4

Epoch 3

inputs		target	net input	output	weight change			weights		
x_1	x_2	y	y_{in}	\hat{y}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	1	12	1	1	1	1	5	5	5
1	-1	1	8	1	1	-1	1	6	4	6
-1	1	1	4	1	-1	1	1	5	5	7
-1	-1	1	-3	-1	1	1	-1	6	6	6

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Epoch 3

inputs		target	net input	output	weight change			weights		
x_1	x_2	y	y_{in}	\hat{y}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	1	12	1	1	1	1	5	5	5
1	1	1	12	1	1	1	1	5	5	5
1	-1	1	5	1	1	-1	1	6	4	6
-1	1	1	4	1	-1	1	1	5	5	7
-1	-1	-1	-3	0	1	1	-1	6	6	6

Epoch 4

x_1	x_2	y	y_{in}	\hat{y}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	1	18	1	1	1	1	7	7	7
1	-1	1	7	1	1	-1	1	8	6	8
-1	1	1	6	1	-1	1	1	7	7	9
-1	-1	-1	-5	0	1	1	-1	8	8	8

$$8 \div 8x_1 + 8x_2 + 8 = \text{just}$$

$$y \neq x_1 + x_2 + 1 = \text{just}$$

$$\leftarrow w_1 x_1 + w_2 x_2 + b = \text{just}$$

Decision Boundary

$$w_1 = w_2 = b = 1$$



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	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	y
A	-1	1	-1	1	-1	1	1	1	1	1	-1	1	1	-1	1	1
E	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	-1

	x	
x		x
x	x	x
x		x
x		x

x	x	x
x		
x	x	x
x		
x	x	x

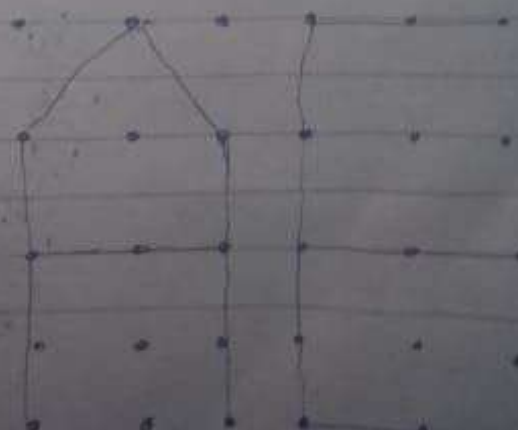
$$\Delta w_i = \sum_j A_{ij} x_j$$

E

	Δw_1	Δw_2	Δw_3	Δw_4	w_5	Δw_6	Δw_7	Δw_8	Δw_9	Δw_{10}	Δw_{11}	Δw_{12}	Δw_{13}	Δw_{14}	Δw_{15}	w_{16}
A	-1	1	-1	1	-1	1	1	1	1	1	-1	1	1	-1	1	1
E	-1	-1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	-1	-1

$$\Delta b(A) = 1$$

$$\Delta b(E) = -1$$



Weights

	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}	w_{11}	w_{12}	w_{13}	w_{14}	w_{15}
A	-1	1	-1	1	-1	1	1	1	1	1	-1	1	1	-1	1
E	-2	0	-2	0	0	2	0	0	0	0	0	2	0	-2	0

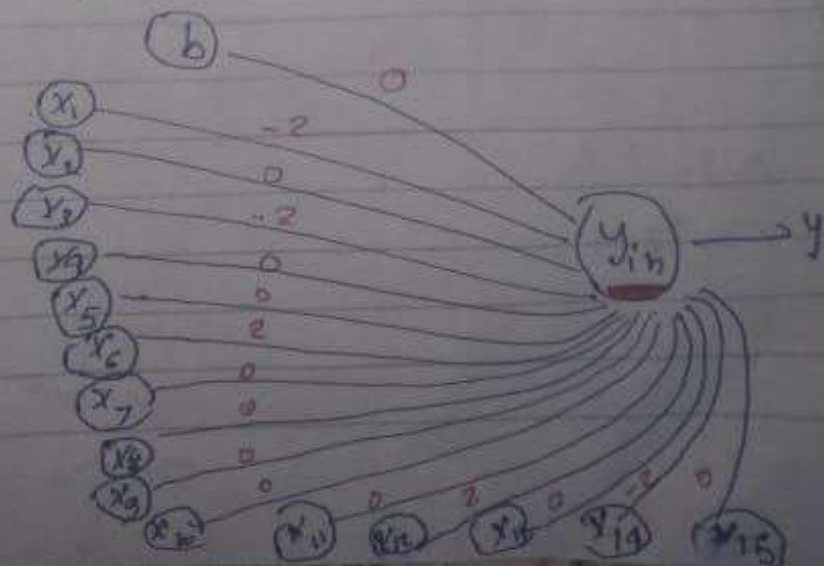
$$w_i = w_{old} + \Delta w_i$$

$$y = -2x_1 - 2x_3 + 2x_6 + 2x_{12} - 2x_{14}$$

Decision Boundary

$$b_A = b_{old} + \Delta b_A = 0 + 1 = 1$$

$$b_E = b_{old} + \Delta b_E = 1 - 1 = 0$$



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حل آخر

$$w_0 = \text{bias}$$

$$b = \text{bias}$$

$$\Delta w_i = x_i y \quad w_i(\text{new}) = w_i(\text{old}) + \Delta w_i$$

A			E		
✓	✓	✓	✓	✓	✓
✓		✓	✓		
✓	✓	✓	✓	✓	✓
✓		✓	✓		
✓		✓	✓	✓	✓

	inputs															target
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	y
A	1	1	1	1	-1	1	1	1	1	1	-1	1	1	-1	1	1
B	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	-1

weight changes

Δw_1	Δw_2	Δw_3	Δw_4	Δw_5	Δw_6	Δw_7	Δw_8	Δw_9	Δw_{10}	Δw_{11}	Δw_{12}	Δw_{13}	Δw_{14}	Δw_{15}	Δb
1	1	1	1	-1	1	1	1	1	1	-1	1	1	-1	1	1
-1	-1	-1	-1	1	-1	-1	-1	-1	-1	1	1	-1	-1	-1	-1

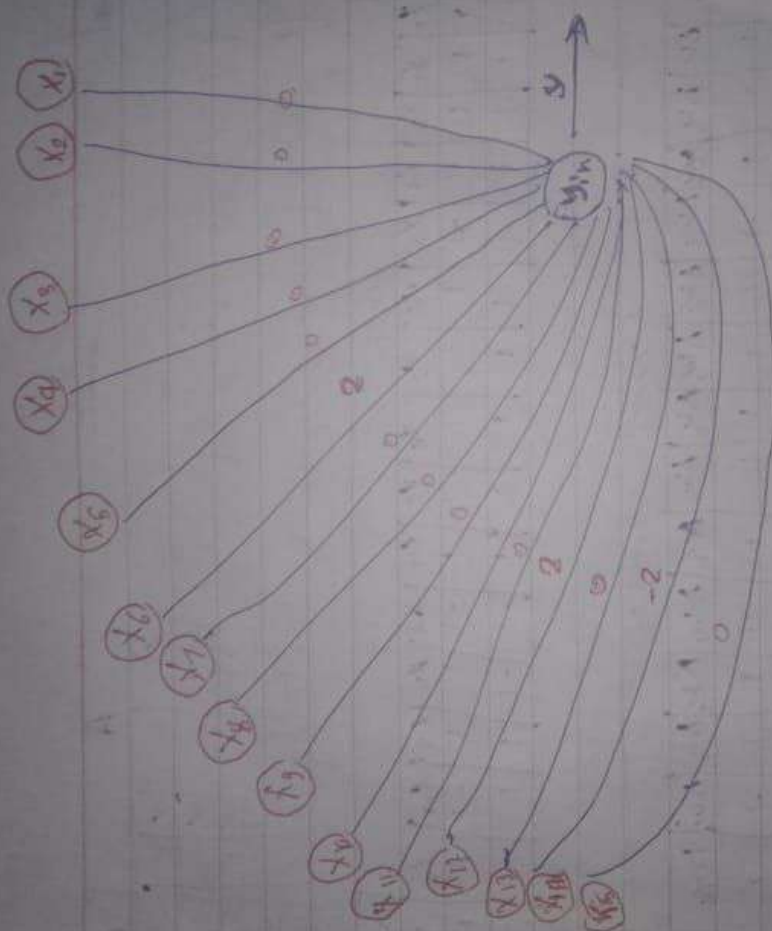
weights

	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}	w_{11}	w_{12}	w_{13}	w_{14}	w_{15}	b
A	1	1	1	1	-1	1	1	1	1	1	-1	1	1	-1	1	1
E	0	0	0	0	0	2	0	0	0	0	0	2	0	-2	0	0

$$2x_6 + 2x_{12} - 2x_{14} = \text{bias}$$

Decision Boundary

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lecture 3

الماتريزات

Quiz 1

$$w = b = 0.2, \eta = 0.2$$

x_1	x_2	y
1	1	-1
1	-1	1
-1	1	1
-1	-1	1

first input

$$y_{in} = \sum x_i w_i + b$$

$$x_1 w_1 + x_2 w_2 + b$$

$$y_{in} = 0.2 \times 1 + 1 \times 0.2 + 0.2 = 0.6$$

$$w_1(\text{new}) = w_1(\text{old}) + \eta (t - y_{in}) x_1$$

$$0.2 + 0.2 (-1 - 0.6) \times 1 = -0.12$$

$$w_2(\text{new}) = 0.2 + 0.2 (-1 - 0.6) \times 1 = -0.12$$

$$b(\text{new}) = b(\text{old}) + \eta (t - y_{in})$$

$$0.2 + 0.2 (-1 - 0.6) = -0.12$$

$$E_1 = (t - y_{in})^2 = (-1 - 0.6)^2 = 2.56$$

second input

$$w_1 = w_2 = b = -0.12$$

$$y_{in} = -0.12 + 0.12 \times 1 + 0.12 = -0.12$$

$$w_1(\text{new}) = -0.12 + 0.2 (1 + 0.12) \times 1 = 0.104$$

$$w_2(\text{new}) = -0.12 + 0.2 (1 + 0.12) \times -1 = -0.344$$

$$b = -0.12 + 0.2 (1 + 0.12) = 0.344$$

$$E_2 = (1 + 0.12)^2 = 1.2544$$

third input

$$y_{in} = 0.104 - 0.344 + 0.344 = 0.104$$

$$w_1(\text{new}) = 0.104 + 0.2 (1 + 0.104) \times 1 = 0.1168$$

$$w_2(\text{new}) = 0.344 + 0.2 (1 + 0.104) \times 1 = -0.1232$$

$$b = 0.344 + 0.2 (1 + 0.104) = 0.5648$$

$$E_3 = (1 + 0.104)^2 = 1.218816$$

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Fourth input

$$y_{in} = 0.1168 + 0.1232 + 0.5648 = 0.8048$$

$$w_1(\text{new}) = -0.1163 + 0.2(1 - 0.8048) \times -1 = -0.15584$$

$$w_2(\text{new}) = -0.1232 + 0.2(1 - 0.8048) \times -1 = -0.16224$$

$$b = 0.5648 + 0.2(1 - 0.8048) = 0.60384$$

$$E_1 = (1 - 0.8048)^2 = 0.03810304$$

Epoch 1

x_1	x_2	y_{in}	y	Δw_1	Δw_2	Δb	w_1	w_2	b	error
1	1	0.6	0	-0.32	-0.32	-0.32	0.12	-0.12	-0.12	2.56
1	-1	-0.12	1	0.224	-0.224	0.448	0.104	-0.344	0.344	1.2644
-1	1	-0.104	1	-0.228	0.2208	-0.1108	-0.1108	-0.1232	0.5648	1.216816
-1	-1	0.8048	0	-0.0324	-0.0324	-0.0648	-0.1558	-0.16224	0.60384	0.03810304

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$$E_T = \sum (1 - y_i)^2 = 2.56 + 1.2519 + 1.218816 + 0.03816379$$

$$= 5.07$$

Epoch 2

x_1	x_2	y	y_{in}	Δw_1	Δw_2	Δb	w_1	w_2	bias
1	1	-1	0.2858	-0.2876	-0.28176	-0.25827	-0.412	-0.414	0.346
1	-1	1	0.35312	0.12938	-0.12938	0.19419	-0.2836	-0.5483	0.476
-1	1	1	0.21688	0.1578	0.1578	0.1578	-0.444	-0.341	0.6327
-1	-1	1	1.9663	0.0433	0.0433	-0.0433	-0.2981	-0.2477	0.5406

$$E_T = \sum (t - y_{in})^2 = 0.61 + 0.4185 + 0.6227 +$$

$$0.2174 = 1.766$$

error

0.51

0.4185

0.6227

0.2174

120

Quiz 2

$$w_1 + w_2 = 0$$

$$b = 0$$

$$w_{\text{new}} = w_{\text{old}} + \Delta w$$

x_1	x_2	b	y
1	1	1	1
1	0	1	-1
0	1	1	-1
0	0	1	-1

$$(1,1) \quad w_1(\text{new}) = 0 + 1 = 1$$

$$w_2(\text{new}) = 0 + 1 = 1$$

$$b(\text{new}) = 0 + 1 = 1$$

$$(1,0)$$

$$w_1 = 1 - 1 = 0$$

$$b = 1 - 1 = 0$$

$$w_2 = 1 + 0 = 1$$

$$(0,1)$$

$$w_1 = 0 + 0 = 0$$

$$b = 0 - 1 = -1$$

$$w_2 = 1 - 1 = 0$$



Decision Boundary $b = \text{not}$

10

$$w_1 = w_2 = 0, b = 0$$

$$(1,1)$$

$$w_1 = 0 + 1 = 1, b = 0 + 1 = 1$$

$$w_2 = 0 + 1 = 1$$

x_1	x_2	b	y
1	1	1	1
1	-1	1	-1
-1	1	1	-1
-1	-1	1	-1

$$(1,-1)$$

$$w_1 = 1 - 1 = 0$$

$$b = 1 - 1 = 0$$

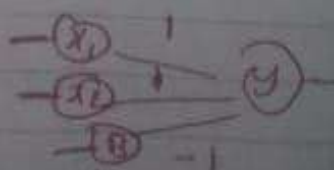
$$w_2 = 1 + 1 = 2$$

$$(-1,1)$$

$$w_1 = 0 + 1 = 1$$

$$b = 0 - 1 = -1$$

$$w_2 = 2 - 1 = 1$$



Decision Boundary $x_1 + x_2 - 1 = \text{not}$