HW 4

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1. (Question 14 Tan chp 4) For each of the Boolean functions given below, state whether the problem is linearly separable.
    a. A and B and C

A	B	C	Out
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

1’s and 0’s can be separated so it is linearly separable

    b. NOT A AND B

A	Not A	B	Not A and B
0	1	0	0
0	1	1	1
1	0	1	0
1	0	0	0

1’s and 0’s can be separated so it is linearly separable

    c. (A or B) AND (A or C)

A	B	X = A OR B
0	0	0
1	0	1
1	1	1
0	1	1

A	C	Y = A OR C
0	0	0
1	0	1
1	1	1
0	1	1

X	Y	X and Y
0	0	0
1	1	1
1	1	1
1	1	1

1’s and 0’s can be separated so it is linearly separable

d. (A XOR B) AND (A OR B)

A	B	X = A XOR B
0	0	0
1	0	1
1	1	0
0	1	1

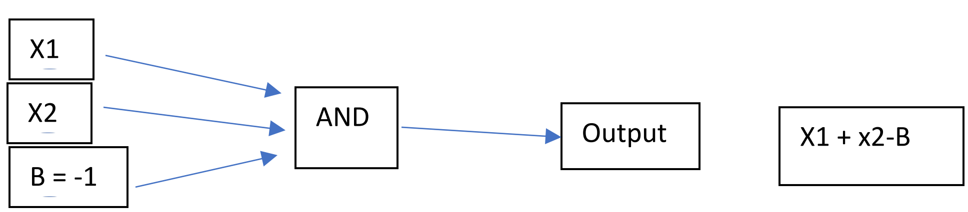
A	C	Y = A OR B
0	0	0
1	0	1
1	1	1
0	1	1

X	Y	X and Y
0	0	0
1	1	1
0	1	0
1	1	1

1’s and 0’s cannot be separated so it is not linearly separable (XOR makes this so)

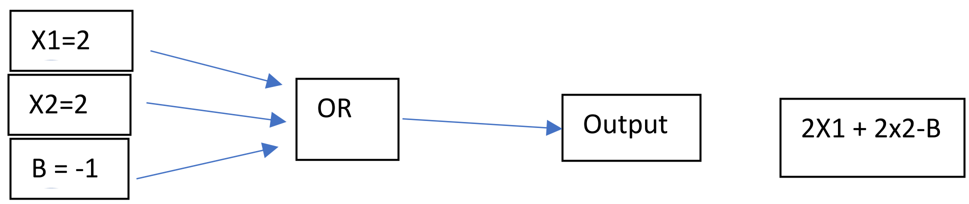
2. (Question 15 part a) Demonstrate how the perceptron model can be used to represent the AND and OR functions between a pair of Boolean variables.
   a. And

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1



b. OR

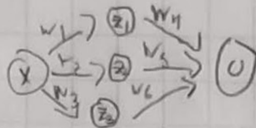
A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1



3. (Question 15 part b) comment on the disadvantage of using linear functions as activation functions for multi-layered neural networks

   For one backpropagation does not really work anymore which is a huge issue and also has limited power and ability to handle complex varying parameters of input.

Data Mining 1.2



a.) $z_1 = x \cdot w_1 = 4 \quad relu(z_1) = 4 = z_1'$

$z_2 = x\, w_2 = 4 \Rightarrow relu(z_2) = 4 = z_2' \Rightarrow z = (z_1' w_4) + (z_2' w_5) + (z_3' w_6)$

$z_3 = x\, w_3 = -4 \quad relu(z_3) = 0 = z_3' \quad = (4 \cdot .5) + (4 \cdot 1) + (0 \cdot 2) = z = 6$

$\phi(z) = \frac{1}{1+e^{-z}} = \frac{1}{1+e^{-6}} = 0.997527$

$\boxed{0.997527}$

b.) $L = (y - \hat{y})^2 = L = (y - .9975)^2 = (0 - .9975)^2 \quad \boxed{0.99506}$

c.) $\frac{dL}{da} \Rightarrow -2(y-a) = -2(0-(0.997527)) = 1.99505$

$\frac{da}{dz} \Rightarrow \frac{d\sigma(z)}{dz} = a(1-a) = 0.997527 \times (1 - 0.997527) = 0.00246$

$\frac{dL}{dz} \Rightarrow \frac{dL}{da} \times \frac{da}{dz} = 0.00246 \times 1.99505$

$\frac{dL}{dw_4} = 0.0049 \times (z_1') = 0.01968$

$\frac{dL}{dw_5} = 0.0049 \times (z_2') = 0.01968$

$\frac{dL}{dw_6} = 0$

$\Rightarrow z = z_1' w_4 + z_2' w_5 + z_3' w_6$

$\frac{dL}{dz_1} = 0.0049 \times 0.5 = 0.00246$

$\frac{dL}{dz_2} = 0.0049 \times 1 = 0.0049$

$\frac{dL}{dz_3} = 0.0049 \times 2 = 0.00984$

$(x = 4)$

$\frac{dL}{w_1} = 0.00246 \cdot (x) = 0.00984$

$\frac{dL}{w_2} = 0.0049 \cdot (x) = 0.01968$

$\frac{dL}{w_3} = 0.00984 \cdot (x) = 0.03936$

↙ new weights

learning rate

$w_n = w_n - \alpha \frac{dL}{dw_n}$

$w_1 = 1 - (1)(0.00984) = \boxed{.99016}$

$w_2 = 1 - (1)(0.01968) = \boxed{.98031}$

$w_3 = -1 - (1)(0.3936) = \boxed{-1.03936}$

$w_4 = 0.5 - (1)(0.01968) = \boxed{0.48031}$

$w_5 = 1 - (1)(0.01968) = \boxed{1.98031}$

$w_6 = 2 - (1) = \boxed{2}$

d.) forward propagation 2.0

$z_1 = xw_1 = 3.9606$ $\quad$ $relu(z_1) = 3.9606 = z_1'$ $\quad$ $z = z_1'w_4 + z_2'w_5 + z_3'w_6$

$z_2 = xw_2 = 3.92126 \Rightarrow relu(z_2) = 3.92126 = z_2' \Rightarrow z = 3.9606 \cdot (0.48) + 3.92126 \cdot (.98051)$

$z_3 = xw_3 = -4.15746$ $\quad$ $relu(z_3) = 0 = z_3'$ $\quad$ $z = 1.90235 + 3.8441 + 0$

$z = 5.74644$

$a = \sigma(z) = \frac{1}{1+e^{-z}} = \boxed{.99681}$ $\quad$ $L(y,a) = (y-a)^2 = .9936$

e.) the second forward propagation led to a closer output and a lower loss so (d) is better