EXAMPLE QUESTIONS FOR ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

EXAMPLE-1:

A model is required for a manufacturing plant in order to record the functional tests carried out on cards as Pass (G) and Fail (K). For passing G=[1 0] the output is 1 while for failing K=[0 1] the output is -1. The initial parameters for the model is given as follows:

Weights: w1=0.3 and w2=0.4

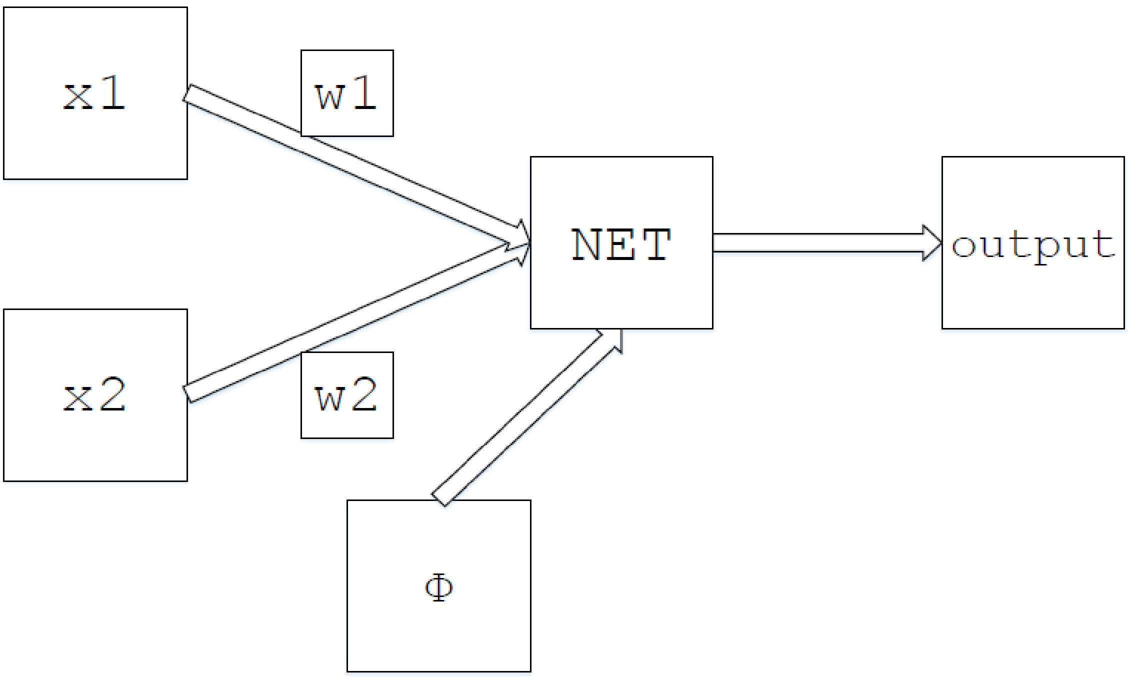
Learning coefficient: a=0.7

Treshold: Φ=0.3

Activation function: net>=0 then 1, net<0 then -1

Calculate the new weight and treshold value for this model to perform correct classification.

Solution-1:



Each of the inputs(x1 and x2) and real output is calculated using the given initial parameters (weights, treshold and learning coefficient). If the expected and real outputs for an input are equal, then the output is calculated for the other input. If the expected and real outputs for an input are not equal, the output for other input is calculated afer calculating new weight and treshold values and using them. These processes continue until the expected and real outputs become equal for both inputs individually using model parameters (weight, treshold, learning coefficient). In the case of their equality, it means that the training of the network is completed and a correct classification is made with the final weight and treshold values.

• If the real output for input [1 0] is calculated;

• NOTE: The expected output is 1 for the input [1 0] .

Net=w1.x1+w2.x2+Φ=(0.3)(1)+(0.4)(0)+0.3=0.6

Net=0.6

Since Net>0 the output (real output) is 1

Since real output = expected output =1 we move on to the calculations for other input without modifying any weight and/or treshold value.

• If the real output for input [0 1] is calculated;

NOTE: The expected output is -1 for the input [0 1] .

$Net=w1.x1+w2.x2+\Phi=(0.3)(0)+(0.4)(1)+0.3=0.7$

$Net=0.7$

Since Net>0 the output (real output) is 1

real output =1 , expected output =-1 , so they are not equal. New weight and treshold values must be found.

$Wnew=Wold+a.E.x$

Wnew, which is new weights is obtained by summation of the multiplication of a, learning coefficient, E, the error and x, the input values with old weight values (Wold).

$\Phi new=\Phi old+a.E$

Φnew which is the new treshold value is obtained by summation of the multiplication of a, learning coefficient and E, the error with the old treshold (Φold) .

E=B-Ç

E which is the error; is equal to the difference of B, the expected output and Ç, the real output .

E=B-Ç=(-1)-(1)=-2

$Wnew=W1old+a.E.x1=(0.3)+(0.7)(-2)(0)=0.3$

$W1=w1new=0.3$

$W2new=W2old+a.E.x2=(0.4)+(0.7)(-2)(1)=-1$

$W2=w2new=-1$

$\Phi new=\Phi old+a.E=(0.3)+(0.7)(-2)=-1.1$

$\Phi=\Phi new=-1.1$

New weight values: w1=0.3 ve w2=-1

New treshold value: Φ=-1.1

•If the real output for input [0 1] is calculated using these new weight and treshold values;

NOTE: The expected output is -1 for the input [0 1] .

$Net=w1.x1+w2.x2+\Phi=(0.3)(0)+(-1)(1)+(-1.1)=-2.1$

Net=-2.1.

Since Net<0 the output (real output) is -1.

Since real output = expected output =1 we move on to the calculations for other input without modifying any weight and/or treshold value.

• If the real output for input [1 0] is calculated;

• NOTE: The expected output is 1 for the input [1 0] .

$Net=w1.x1+w2.x2+\Phi=(0.3)(1)+(-1)(0)+(-1.1)=-0.8$

$Net=-0.8$

Since Net<0 the output (real output) is -1.

real output =-1 , expected output =1 , so they are not equal. New weight and treshold values must be found.

E=B-Ç=(1)-(-1)=2

$W1new=W1old+a.E.x1=(0.3)+(0.7)(2)(1)=1.7$

$W2\ new=W2\ old+a.E.x2=(-1)+(0.7)(2)(0)=-1$

$\Phi\ new=\Phi\ old+a.E=(-1.1)+(0.7)(2)=0.3$

New weight values:w1=1.7 ve w2=-1

New treshold value: Φ=0.3

•If the real output for input [1 0] is calculated using these new weight and treshold values;

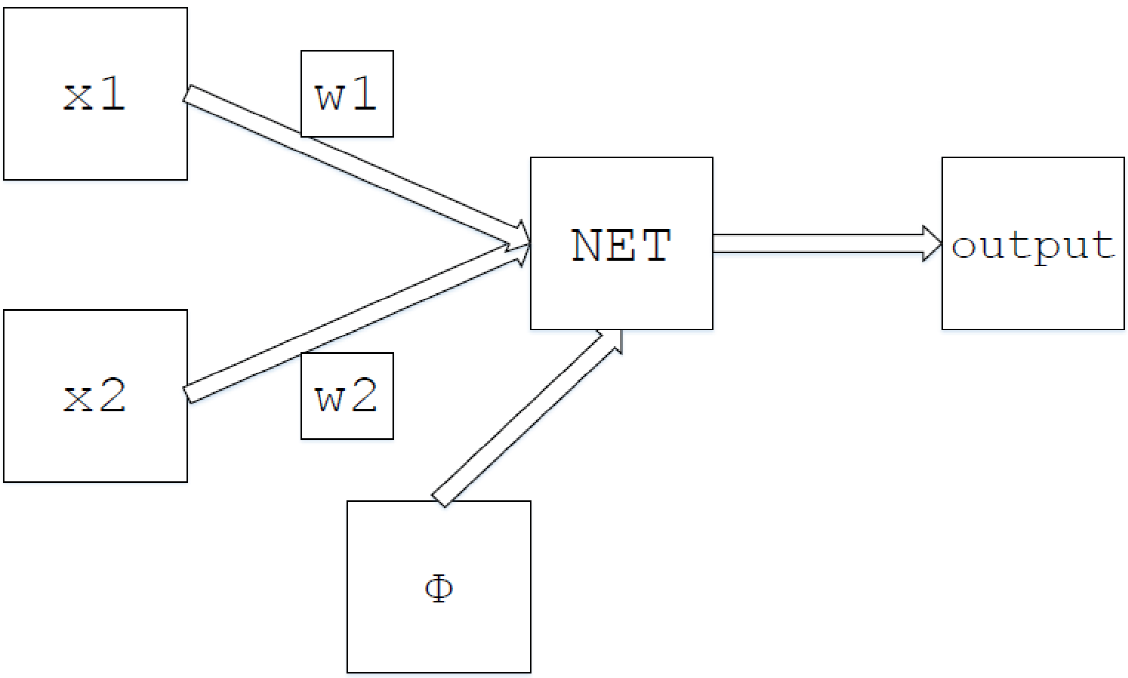
• NOTE: The expected output is 1 for the input [1 0] .

$Net=w1.x1+w2.x2+\Phi=(1.7)(1)+(-1)(0)+(0.3)=2$

$Net=2$

Since Net>0 the output (real output) is 1
Since real output = expected output =1 we move on to the calculations for other input without modifying any weight and/or treshold value.
•If the real output for input [0 1] is calculated using these new weight and treshold values;
NOTE: The expected output is -1 for the input [0 1] .
Net=w1.x1+w2.x2+Φ=(1.7)(0)+(-1)(1)+(0.3)=-0.7
Net=-0.7
Since Net<0 the output (real output) is -1.
Since real output = expected output =1 we move on to the calculations for other input without modifying any weight and/or treshold value.
The weight and treshold values that enable the model to make correct predictions by providing real outputs equal to expected outputs for both inputs are as follows:
Weight values found: w1=1.7 and w2=-1
Treshold value found: Φ=0.3

EXAMPLE-2:
In a firm that produces fruit, a model is desired to be formed to prevent the mixing of apples and pears when they arrive at the warehouse. For orange p=[1 0], output = -1, for apple e=[0 1], output =1. The initial parameters for the model is given as follows:
Weights: w1=0.3 ve w2=0.2
Learning coefficient: a=0.5
Treshold: Φ=0.1
Activation function: net>=0 then 1, net<0 then -1
Calculate the new weight and treshold value for this model to perform correct classification.
Solution-2:



Each of the inputs(x1 and x2) and real output is calculated using the given initial parameters (weights, treshold and learning coefficient). If the expected and real outputs for an input are equal, then the output is calculated for the other input. If the expected and real outputs for an input are not equal, the output for other input is calculated afer calculating new weight and treshold values and using them. These processes continue until the expected and real outputs become equal for both inputs individually using model parameters (weight, treshold, learning coefficient). In the case of their equality, it means that the training of the network is completed and a correct classification is made with the final weight and treshold values.

• If the real output for input [1 0] is calculated;

• NOTE: The expected output is -1 for the input [1 0] .

Net=w1.x1+w2.x2+Φ=(0.3)(1)+(0.2)(0)+0.1=0.4

Net=0.4

Since Net>0 the output (real output) is 1

real output =1 , expected output =-1 , so they are not equal. New weight and treshold values must be found.

Wnew=Wold+a.E.x

Wnew, which is new weights is obtained by summation of the multiplication of a, learning coefficient, E, the error and x, the input values with old weight values (Wold).

Φnew=Φold+a.E

Φnew which is the new treshold value is obtained by summation of the multiplication of a, learning coefficient and E, the error with the old treshold (Φold) .

E=B-Ç

E which is the error; is equal to the difference of B, the expected output and Ç, the real output .

E=(-1)-(1)=-2

W1new=W1old+a.E.x1=-0.7

W2 new =W2 old +a.E.x2= 0.2

Φ new =Φ old +a.E =-0.9

New weight values:w1=0.7 and w2= 0.2

New treshold value: Φ=-0.9

•If the real output for input [1 0] is calculated using these new weight and treshold values;

• NOTE: The expected output is -1 for the input [1 0] .

Net=w1.x1+w2.x2+Φ=(-0.7)(1)+(0.2)(0)+(-0.9)=-1.6

Net=-1.6

Since Net<0 the output (real output) is -1.

Since real output = expected output =-1 we move on to the calculations for other input without modifying any weight and/or treshold value.

•If the real output for input [0 1] is calculated using these new weight and treshold values;

NOTE: The expected output is 1 for the input [0 1] .

Net=w1.x1+w2.x2+Φ=-0.9

Net=-0.9

Since Net<0 the output (real output) is -1.

real output =-1 , expected output =1 , so they are not equal. New weight and treshold values must be found.

E=B-Ç=2

W1new=W1old+a.E.x1=-0.7

W2 new =W2 old +a.E.x2= 1.2

Φ new =Φ old +a.E =0,1

New weight values:w1=-0.7 and w2= 1.2

New treshold value: Φ=0,1

•If the real output for input [0 1] is calculated using these new weight and treshold values;

NOTE: The expected output is 1 for the input [0 1] .

Net=w1.x1+w2.x2+Φ=1.3

Net=1.3

Since Net>0 the output (real output) is 1
Since real output = expected output =1 we move on to the calculations for other input without modifying any weight and/or treshold value.
• If the real output for input [1 0] is calculated;
• NOTE: The expected output is -1 for the input [1 0] .
Net=w1.x1+w2.x2+Φ=-0.6
Net=-0.6
Since Net<0 the output (real output) is -1.
Since real output = expected output =-1 we move on to the calculations for other input without modifying any weight and/or treshold value.
The weight and treshold values that enable the model to make correct predictions by providing real outputs equal to expected outputs for both inputs are as follows:
Weight values found: w1=-0.7 and w2=1,2
Treshold value found: Φ=0.1

ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

WEEK 3
2021 SPRING

CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks

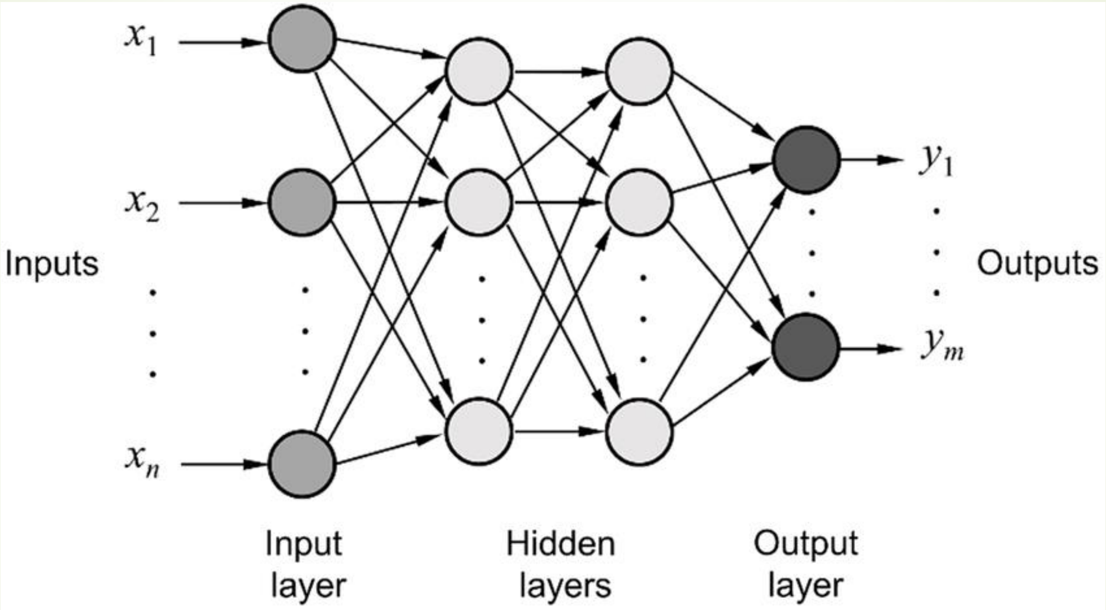
- Artificial neurons come together to form multilayer artificial neural networks (ANN). The gathering of neurons is not randomly. Generally, the neurons form the network by coming together as 3 layers and paralelly within each layer. These layers are as follows:

- Input layer: In this layer the process elements are responsible for accepting information from outside world and transfer them to the hidden layers. In some networks, no information processing is carried out in the input layer.

- Hidden layers: They transfer the information received from input layer after preprocessing. A network may have multiple hidden layers.

- Output layer: The process elements of this layer process the information received from hidden layers and determine the output to be produced for the input set (sample) presented at the input layer of the network.

CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks



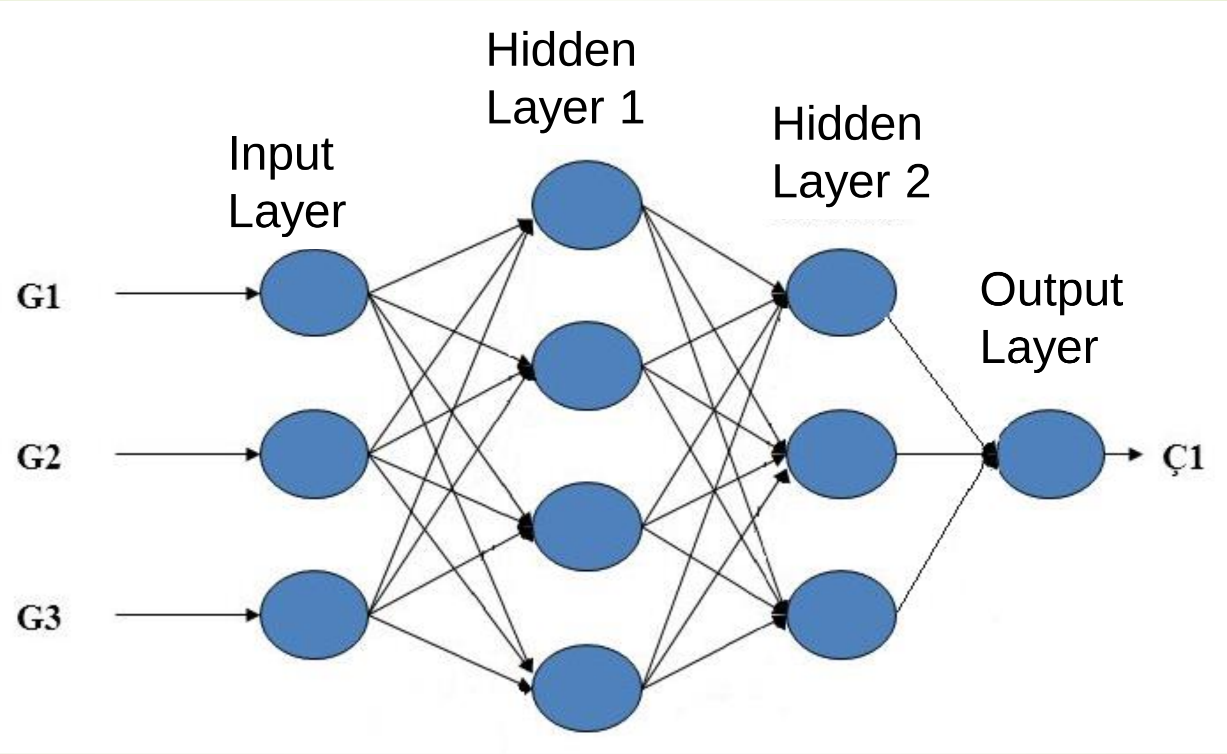
CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks

Example : A multilayer ANN consists of input, hidden and output layers. The hidden layer of the given ANN consists of 2 layers and each of these layers contain 3 neurons. The input layer accepts 3 inputs and the output layer of this ANN has a single output.

a.) Draw the diagram of this ANN.

b.) Inputs G1=1, G2=2, G3=-1; Weights between input and input Wg-1=1, Wg-2=1; Wg-3=1 weights between input and first hidden layer Wg-a(1)-11=3.5, Wg-a(1)-12=2, Wg-a(1)-13=2 Wg-a(1)-21=1, Wg-a(1)-22=-1, Wg-a(1)-23=2, Wg-a(1)-31=2.5, Wg-a(1)-32=2, Wg-a(1)-33=1, Wg-a(1)-41=1, Wg-a(1)-42=0, Wg-a(1)-43=1; The weights between first and second hidden layersWa(1)-a(2)-11=1, Wa(1)-a(2)-12=-1, Wa(1)-a(2)-13=1, Wa(1)-a(2)-14=1, Wa(1)-a(2)-21=2, Wa(1)-a(2)-22=1, Wa(1)-a(2)-23=2, Wa(1)-a(2)-24=0 Wa(1)-a(2)-31=-1.5, Wa(1)-a(2)-32=1, Wa(1)-a(2)-33=0, Wa(1)-a(2)-34=1; The weights between second hidden layer and output layer are given as Wa(2)-ç-1=-3, Wa(2)-ç-2=3, Wa(2)-ç-3=-1. There are no transfer function used at the output of input layer and the outputs are used directly. At the hidden layer outputs, the activation function of Output= 1, if net $\geq$ 0 and Output = 0, if net $<$ 0 is used. At the output layer, the activation function given as Output = 1, if net $\geq$ 1 and Output = -1, if net $<$ 1 is used. Under these circumstances, calculated the output of the given multilayer ANN.

CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks



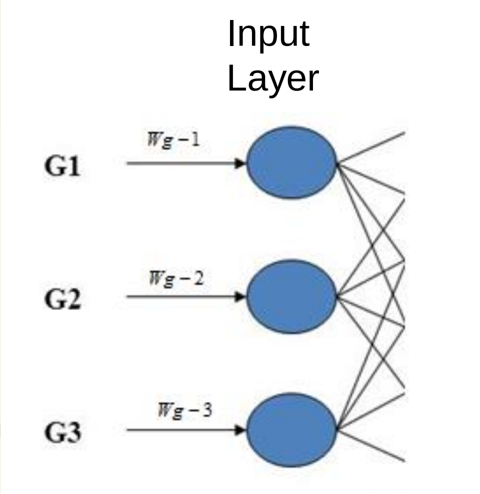
CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks

$$\begin{bmatrix} G1 \\ G2 \\ G3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix} \quad \begin{bmatrix} Wg-1 & Wg-2 & Wg-3 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} \quad \begin{bmatrix} Wg-a(1)-11 & Wg-a(1)-12 & Wg-a(1)-13 \\ Wg-a(1)-21 & Wg-a(1)-22 & Wg-a(1)-23 \\ Wg-a(1)-31 & Wg-a(1)-32 & Wg-a(1)-33 \\ Wg-a(1)-41 & Wg-a(1)-42 & Wg-a(1)-43 \end{bmatrix} = \begin{bmatrix} 3,5 & 2 & 2 \\ 1 & -1 & 2 \\ 2.5 & 2 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} Wa(1)-a(2)-11 & Wa(1)-a(2)-12 & Wa(1)-a(2)-13 & Wa(1)-a(2)-14 \\ Wa(1)-a(2)-21 & Wa(1)-a(2)-22 & Wa(1)-a(2)-23 & Wa(1)-a(2)-24 \\ Wa(1)-a(2)-31 & Wa(1)-a(2)-32 & Wa(1)-a(2)-33 & Wa(1)-a(2)-34 \end{bmatrix} = \begin{bmatrix} 1 & -1 & 1 & 1 \\ 2 & 1 & 2 & 0 \\ -1,5 & 1 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} Wa(2)-ç-1 & Wa(2)-ç-2 & Wa(2)-ç-3 \end{bmatrix} = \begin{bmatrix} -3 & 3 & -1 \end{bmatrix}$$

CHAPTER 2: Machine Learning and Artificial Neural Networks
1.3 Multilayer Artificial Neural Networks



$$\begin{bmatrix} G1 \\ G2 \\ G3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix} \qquad \begin{bmatrix} Wg-1 & Wg-2 & Wg-3 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix}$$

Result= $\begin{bmatrix} GG1 \\ GG2 \\ GG3 \end{bmatrix} = \begin{bmatrix} 1*1 \\ 2*1 \\ -1*1 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$

At the output of input layer the results are directly used since there is no transfer function here.

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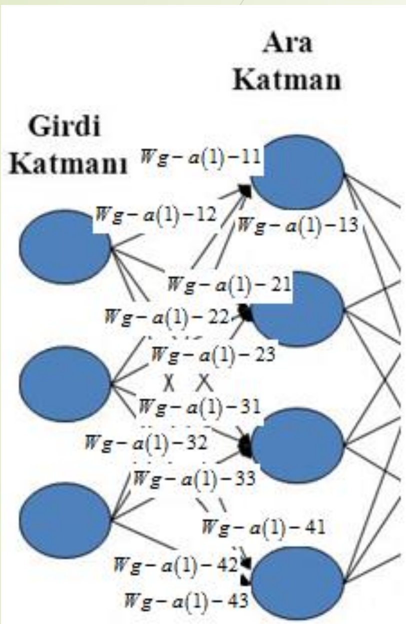
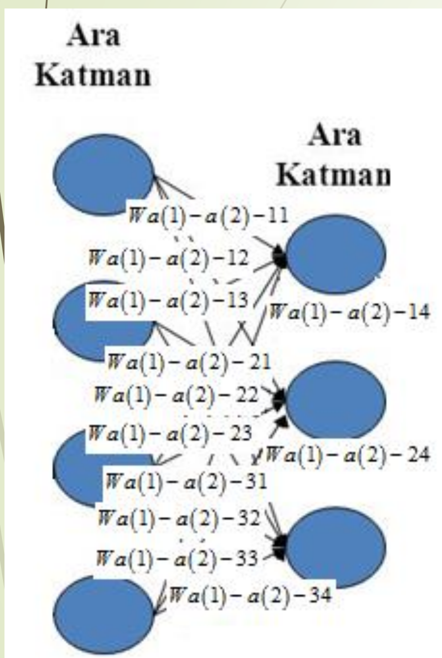


$$\begin{bmatrix} GG1 \\ GG2 \\ GG3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix} \qquad \begin{bmatrix} Wg-a(1)-11 & Wg-a(1)-12 & Wg-a(1)-13 \\ Wg-a(1)-21 & Wg-a(1)-22 & Wg-a(1)-23 \\ Wg-a(1)-31 & Wg-a(1)-32 & Wg-a(1)-33 \\ Wg-a(1)-41 & Wg-a(1)-42 & Wg-a(1)-43 \end{bmatrix} = \begin{bmatrix} 3,5 & 2 & 2 \\ 1 & -1 & 2 \\ 2.5 & 2 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$

$$\text{Result} = \begin{bmatrix} GGG1 \\ GGG2 \\ GGG3 \\ GGG4 \end{bmatrix} = \begin{bmatrix} (1*3,5)+(2*2)+(-1*2) \\ (1*1)+(2*-1)+(-1*2) \\ (1*2,5)+(2*2)+(-1*1) \\ (1*1)+(2*0)+(-1*1) \end{bmatrix} = \begin{bmatrix} 5,5 \\ -3 \\ 5,5 \\ 0 \end{bmatrix}, F_{Transfer} \begin{bmatrix} 5,5 \\ -3 \\ 5,5 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \\ 1 \end{bmatrix}$$

At the hidden layer outputs, the activation function of Output= 1, if net ≥ 0 and Output = 0, if net < 0 is used

1.3 Multilayer Artificial Neural Networks



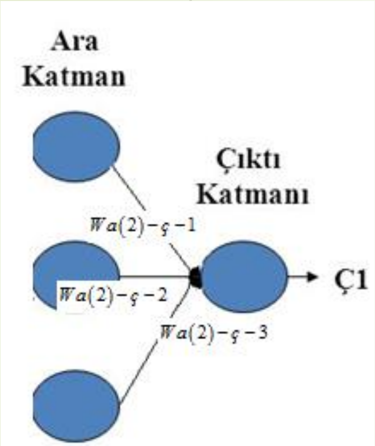
$$\begin{bmatrix} \text{GGG1} \\ \text{GGG2} \\ \text{GGG3} \\ \text{GGG4} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} Wa(1)-a(2)-11 & Wa(1)-a(2)-12 & Wa(1)-a(2)-13 & Wa(1)-a(2)-14 \\ Wa(1)-a(2)-21 & Wa(1)-a(2)-22 & Wa(1)-a(2)-23 & Wa(1)-a(2)-24 \\ Wa(1)-a(2)-31 & Wa(1)-a(2)-32 & Wa(1)-a(2)-33 & Wa(1)-a(2)-34 \end{bmatrix} = \begin{bmatrix} 1 & -1 & 1 & 1 \\ 2 & 1 & 2 & 0 \\ -1{,}5 & 1 & 0 & 1 \end{bmatrix}$$

$$\text{Result} = \begin{bmatrix} \text{GGGG1} \\ \text{GGGG2} \\ \text{GGGG3} \end{bmatrix} = \begin{bmatrix} (1*1)+(0*\text{-}1)+(1*1)+(1*1) \\ (1*2)+(0*1)+(1*2)+(1*0) \\ (1*\text{-}1{,}5)+(0*1)+(1*0)+(1*1) \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ -0{,}5 \end{bmatrix}, F_{Transfer}\begin{bmatrix} 3 \\ 4 \\ -0{,}5 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}$$

At the hidden layer outputs, the activation function of Output= 1, if net ≥ 0 and Output = 0, if net < 0 is used

1.3 Multilayer Artificial Neural Networks



$$\begin{bmatrix} GGGG1 \\ GGGG2 \\ GGGG3 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} Wa(2)-ç-1 & Wa(2)-ç-2 & Wa(2)-ç-3 \end{bmatrix} = \begin{bmatrix} -3 & 3 & -1 \end{bmatrix}$$

Sonuç = $[(1*-3)+(1*3)+(0*-1)]=[0], F_{Transfer}[0]=[-1]$

At the output layer, the activation function given as Output = 1, if net ≥ 1 and Output = -1, if net < 1 is used.