# ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

Prof. Dr. Fırat Hardalaç

## WEEK 4 QUESTIONS

## Classification using a single layer Perceptron model

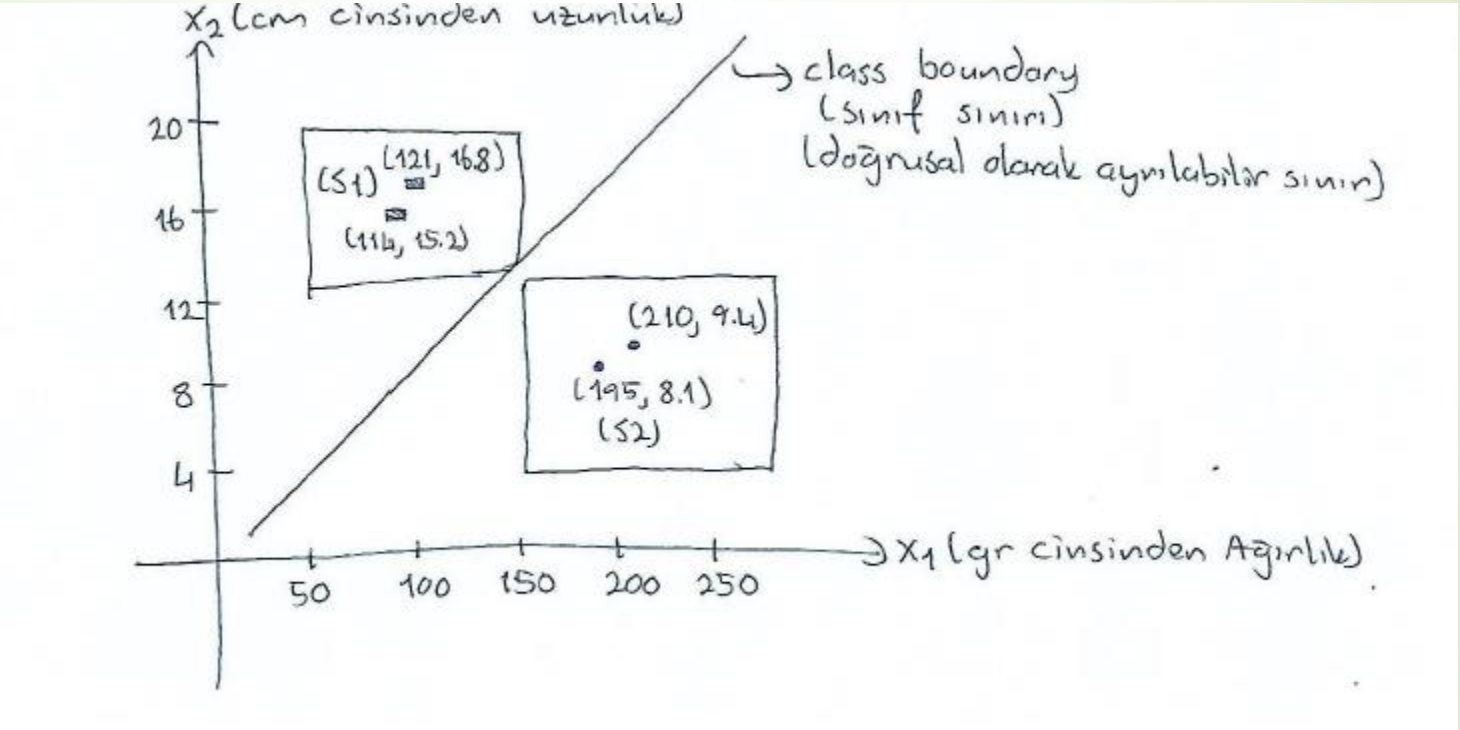
| | Weight (gr) | Length (cm) |
|---|---|---|
| Fruit 1 (Class1) (S1) | 121 | 16,8 |
| | 114 | 15,2 |
| Fruit 2 (Class 2) | 210 | 9,4 |
| | 195 | 8,1 |

In the table above 2 fruit's weight and lengtth information is given.

Train a single layer Perceptron model to classify these two fruits using the parameters (weight & length) given above.

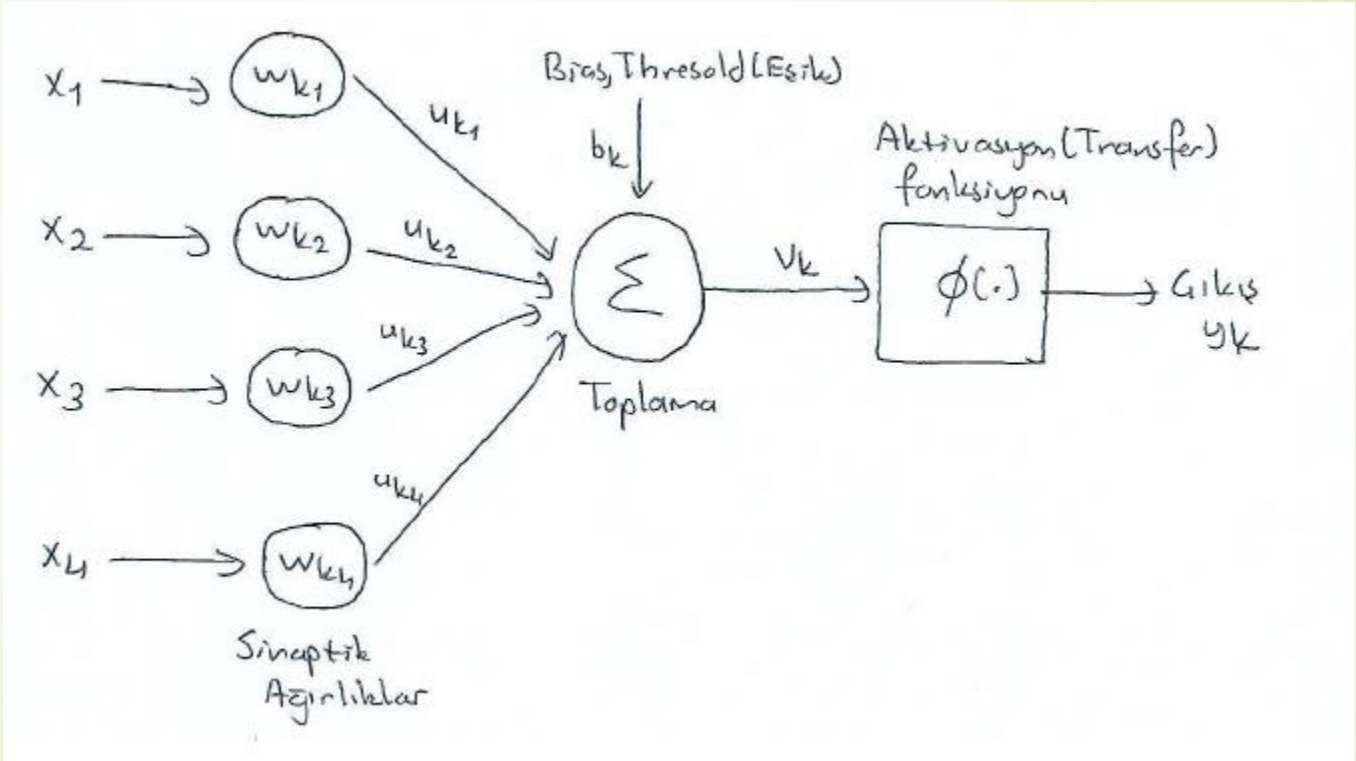
- By using these model parameters we can determine which class does a 140 gr Weighted and 17,9 cm lenght fruit belong to.

If we Show the model parameters on x,y coordinate plane;



***A neuron (neural cell) Model:**

Input Signals



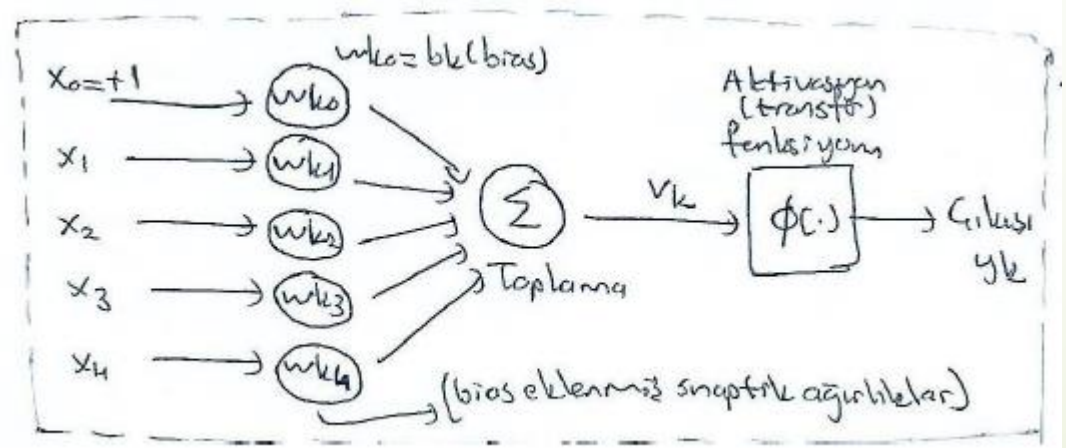
X1,2,3,4 = Input Signals
Wk1,2,3,4 = Synaptic Weights
Uk1,2,3,4 = Multiplication of Input Signals With Synaptic Weights
bk= Bias, Treshold value
Vk= (Multiplication of Input Signals With Synaptic Weights) + (Bias)
Φ(.) = Activation (Transfer) function
yk= output

$$u_k = \sum_{j=1}^{m} x_j w_{kj} = x_1 . w_{k1} + x_2 . w_{k2} + \cdots + x_m . w_{km} \quad ; \quad v_k = u_k + b_k$$

$$y_k = \phi(v_k) = \phi(u_k + b_k)$$

$$v_k = \sum_{j=0}^{m} x_j w_{kj} = \underbrace{x_0 w_{k0}}_{b_k} + \underbrace{x_1 w_{k1} + x_2 w_{k2} + \cdots + x_m w_{km}}_{u_k}; \quad b_k = x_0 w_{k0}$$

$x_0 = 1$ ; $w_{k0} = b_k$ (bias)




Bias = an outer parameter of artificial neural network (ANN)

***Example:** In a two input and single output neuron model, the input parameters are the weight and length of a fruit in gr and cm. The Synaptic weights, bias and activation function given with the neuron model, the type of fruit given at input with its weight and length values can be deterined. The Synaptic weight associated with 1st input parameter which is weight in gr is wk1=30. The Synaptic weight associated with 2st input parameter which is length in cm is wk2=300. The output parameter corresponding input=xo=+1 and Synaptic weight wk0=bias=bk=50. Learning rate parameter is η=0,01.

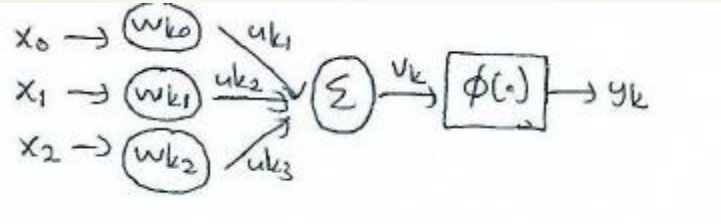
**Activation function;**

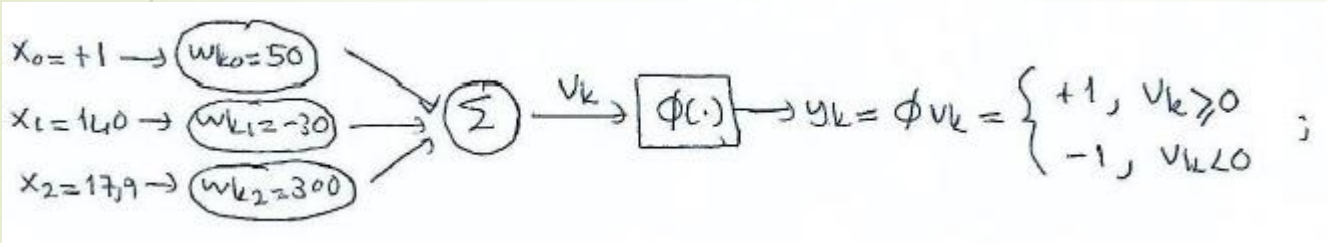
$$\phi(v_k) = \begin{cases} +1, & v_k \geq 0 \\ -1, & v_k < 0 \end{cases}$$

**+1** output denotes 1st fruit type,
**-1** output denotes 2nd fruit type.

Find the type of the fruit that is given with weight 140 gr (x1) and length 17,9 cm (x2) using the given neuron model.

Solution:




(+1): 1st fruit type

(-1): 2nd fruit type

$$v_k = \sum_{j=0}^{m} x_j w_{kj} = x_0 w_{k0} + x_1 w_{k1} + \cdots + x_m w_{km}$$

m: number of input parameters

m=2;

$$v_k = \sum_{j=0}^{2} x_j w_{kj} = x_0 w_{k0} + x_1 w_{k1} + x_2 w_{k2}$$

$$v_k = (+1).50 + 140.(-30) + 17{,}9.(300) = 1220$$

Since $y_k = \phi(v_k) = \phi(1220) \Rightarrow 1220 \geq 0$ , $y_k = \phi(v_k) = +1$ => type 1 fruit

$$x = [1 \quad 140 \quad 17{,}9] \; ; \; w = [50 \quad -30 \quad 300] \; ; \; v = w^T . x$$

$$v = w^T . x = [1 \quad 140 \quad 17{,}9]_{1\times 3} \begin{bmatrix} 50 \\ -30 \\ 300 \end{bmatrix}_{3\times 1} = [1.50 + 140.(-30) + 17{,}9.300)] = 1220$$

$y = \phi(v) = \phi(1220) = +1$ => type 1 fruit

If the calculation is performed on Matlab and shown graphically;

```
%input parameters of neuron
X=[140 17,9]
%Synaptic weights corresponding to input parameters
W=[-30;300]
%outer parameter's corresponding synaptic weight = bias
b=50
%input parameter of the activation function
V=x*w+b
%output of the activation function = output of the neuron
Func='logsig';
y=logsig(v)
%if the input parameters are shown in graph between 0-300 with 1 unit spacing
[x1,x2]=meshgrid(0:1:300);
z=feval(func,[x1(:) x2(:)]*w+b;
z=reshape(z, length(x1), length(x2));
```

```
%plotting the three-axis graph
plot3(x1,x2,z)
grid on
%naming x axis
xlabel('x1 input = weight (gr)')
%naming y axis
ylabel('x2 input = length (cm)')
%naming z axis
zlabel('y output = neuron output')
```

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**Current Folder**

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**Details**

**Workspace**

| Name | Value |
|---|---|
| b | 50 |
| func | 'logsig' |
| v | 1220 |
| w | [-30;300] |
| x | [140,17.9000] |
| x1 | *301x301 double* |
| x2 | *301x301 double* |
| y | 1 |
| z | *301x301 double* |

Editor - C:\Users\user\Documents\MATLAB\Untitled.m

Untitled.m

```
1 -    x=[140 17.9];
2 -    w=[-30;300];
3 -    b=50;
4 -    v=x*w+b;
5 -    func='logsig';
6 -    y=logsig(v);
7 -    [x1,x2]=meshgrid(0:1:300);
8 -    z=feval(func,[x1(:) x2(:)]*w+b);
9 -    z=reshape(z,length(x1),length(x2));
10 -   plot3(x1,x2,z);
11 -   xlabel('x1 girişi=ağırlık(gr)');
12 -   ylabel('x2 girişi=uzunluk(cm)');
13 -   zlabel('y çıkışı=nöron(sinir hücresi) çıkışı');
```

**Command Window**

New to MATLAB? See resources for Getting Started.

```
>> Untitled
>>
```

Figure 1

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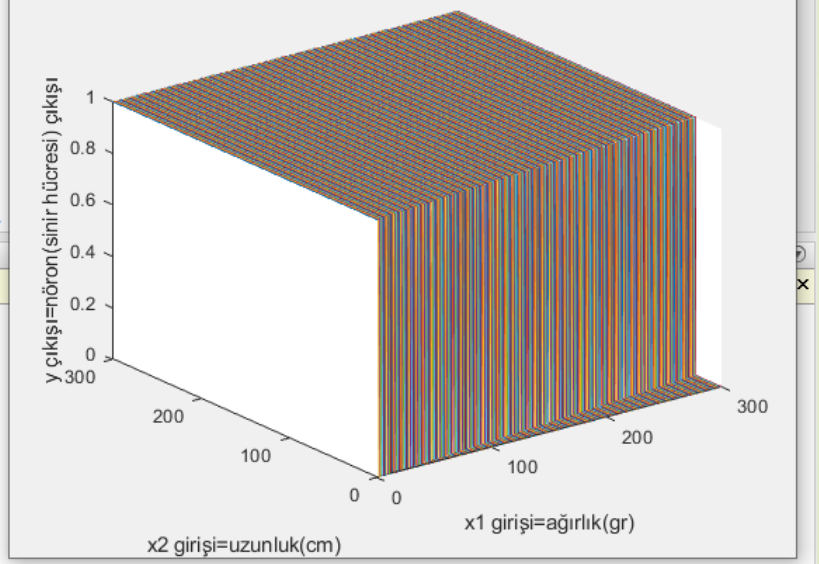
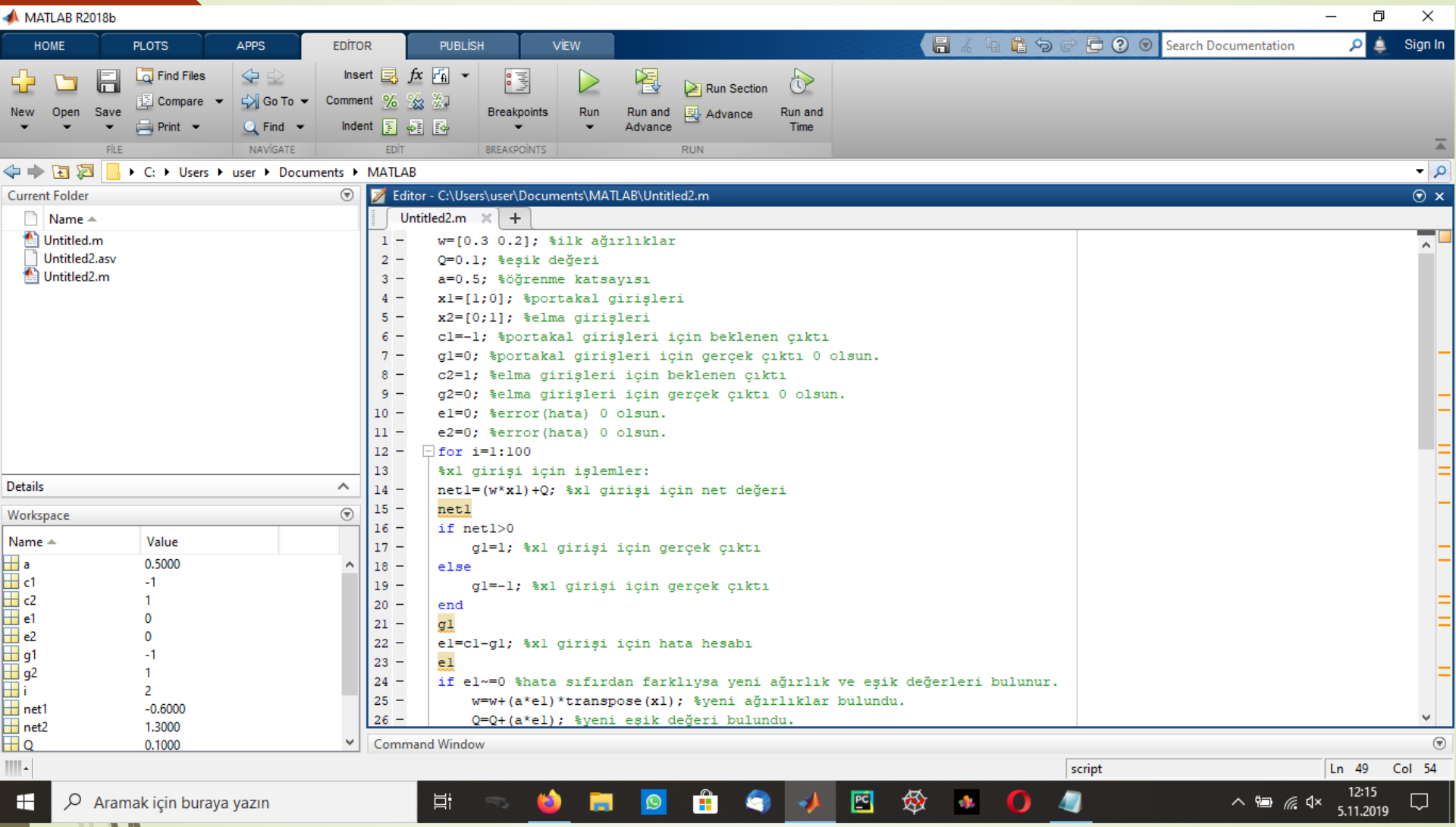


## Example

**-** 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 in Matlab.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Current Folder
Name
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Untitled2.m
Details
Workspace
Name
Value
a 0.5000
c1 -1
c2 1
e1 0
e2 0
g1 -1
g2 1
i 2
net1 -0.6000
net2 1.3000
Q 0.1000
Editor - C:\Users\user\Documents\MATLAB\Untitled2.m
Untitled2.m
1 w=[0.3 0.2]; %ilk ağırlıklar
2 Q=0.1; %eşik değeri
3 a=0.5; %öğrenme katsayısı
4 x1=[1;0]; %portakal girişleri
5 x2=[0;1]; %elma girişleri
6 c1=-1; %portakal girişleri için beklenen çıktı
7 g1=0; %portakal girişleri için gerçek çıktı 0 olsun.
8 c2=1; %elma girişleri için beklenen çıktı
9 g2=0; %elma girişleri için gerçek çıktı 0 olsun.
10 e1=0; %error(hata) 0 olsun.
11 e2=0; %error(hata) 0 olsun.
12 for i=1:100
13 %x1 girişi için işlemler:
14 net1=(w*x1)+Q; %x1 girişi için net değeri
15 net1
16 if net1>0
17 g1=1; %x1 girişi için gerçek çıktı
18 else
19 g1=-1; %x1 girişi için gerçek çıktı
20 end
21 g1
22 e1=c1-g1; %x1 girişi için hata hesabı
23 e1
24 if e1~=0 %hata sıfırdan farklıysa yeni ağırlık ve eşik değerleri bulunur.
25 w=w+(a*e1)*transpose(x1); %yeni ağırlıklar bulundu.
26 Q=Q+(a*e1); %yeni eşik değeri bulundu.
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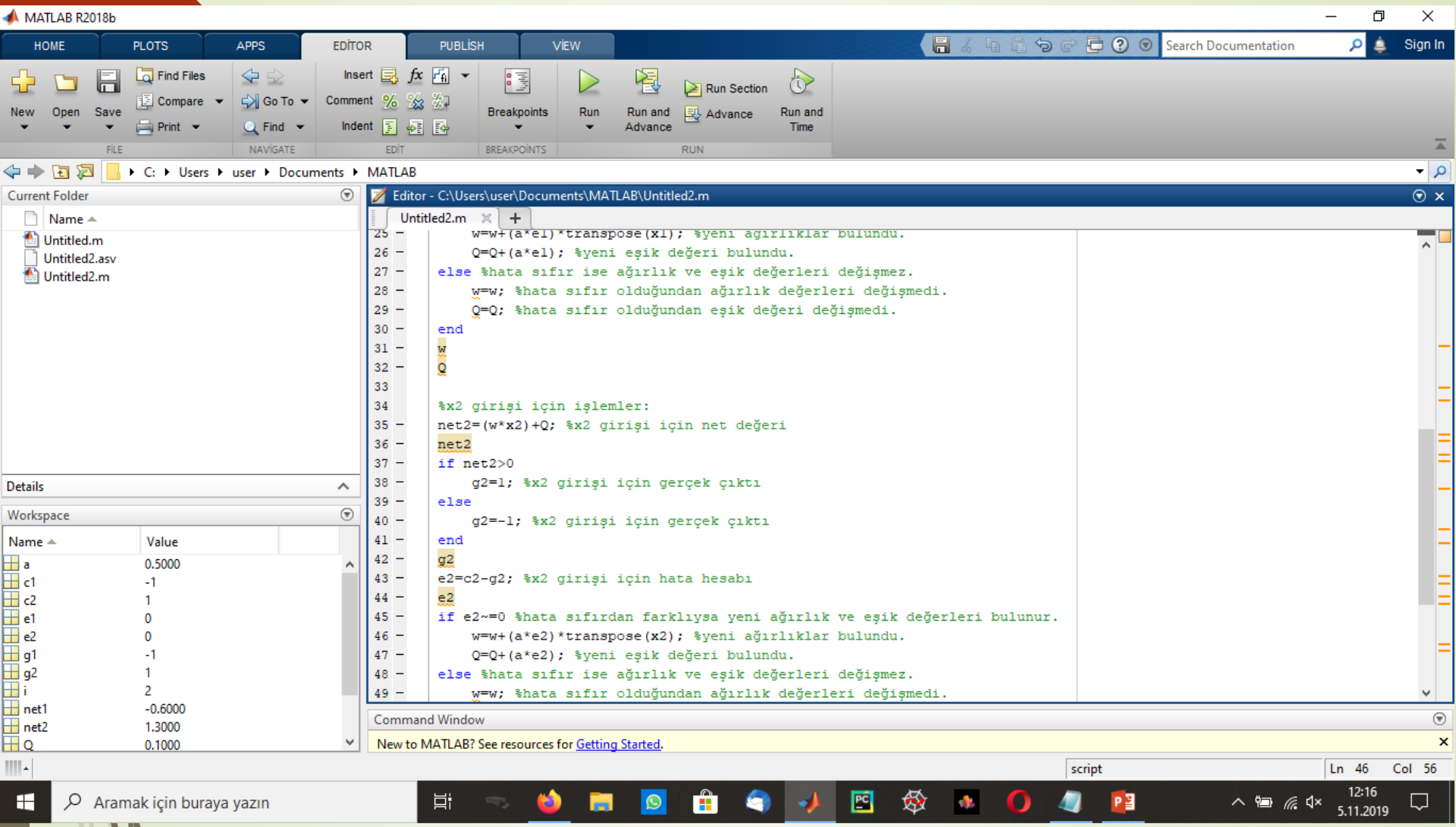
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net2 1.3000
Q 0.1000
Editor - C:\Users\user\Documents\MATLAB\Untitled2.m
Untitled2.m
w=w+(a*e1)*transpose(x1); %yeni ağırlıklar bulundu.
Q=Q+(a*e1); %yeni eşik değeri bulundu.
else %hata sıfır ise ağırlık ve eşik değerleri değişmez.
w=w; %hata sıfır olduğundan ağırlık değerleri değişmedi.
Q=Q; %hata sıfır olduğundan eşik değeri değişmedi.
end
w
Q
%x2 girişi için işlemler:
net2=(w*x2)+Q; %x2 girişi için net değeri
net2
if net2>0
g2=1; %x2 girişi için gerçek çıktı
else
g2=-1; %x2 girişi için gerçek çıktı
end
g2
e2=c2-g2; %x2 girişi için hata hesabı
e2
if e2~=0 %hata sıfırdan farklıysa yeni ağırlık ve eşik değerleri bulunur.
w=w+(a*e2)*transpose(x2); %yeni ağırlıklar bulundu.
Q=Q+(a*e2); %yeni eşik değeri bulundu.
else %hata sıfır ise ağırlık ve eşik değerleri değişmez.
w=w; %hata sıfır olduğundan ağırlık değerleri değişmedi.
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New to MATLAB? See resources for Getting Started.
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Col 56
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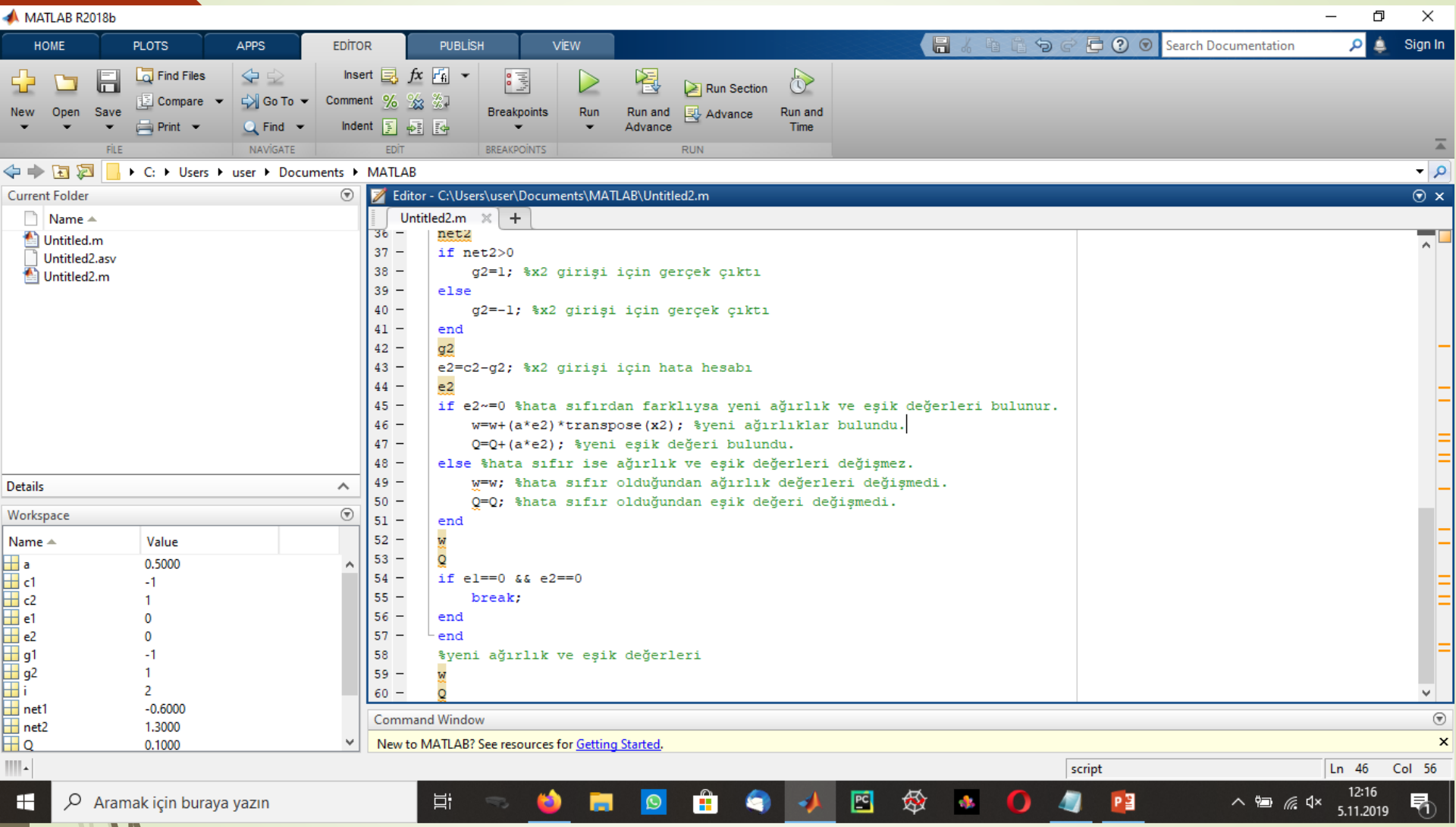
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e2 0
g1 -1
g2 1
i 2
net1 -0.6000
net2 1.3000
Q 0.1000
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Untitled2.m
net2
if net2>0
g2=1; %x2 girişi için gerçek çıktı
else
g2=-1; %x2 girişi için gerçek çıktı
end
g2
e2=c2-g2; %x2 girişi için hata hesabı
e2
if e2~=0 %hata sıfırdan farklıysa yeni ağırlık ve eşik değerleri bulunur.
w=w+(a*e2)*transpose(x2); %yeni ağırlıklar bulundu.
Q=Q+(a*e2); %yeni eşik değeri bulundu.
else %hata sıfır ise ağırlık ve eşik değerleri değişmez.
w=w; %hata sıfır olduğundan ağırlık değerleri değişmedi.
Q=Q; %hata sıfır olduğundan eşik değeri değişmedi.
end
w
Q
if e1==0 && e2==0
break;
end
end
%yeni ağırlık ve eşik değerleri
w
Q
Command Window
New to MATLAB? See resources for Getting Started.
script
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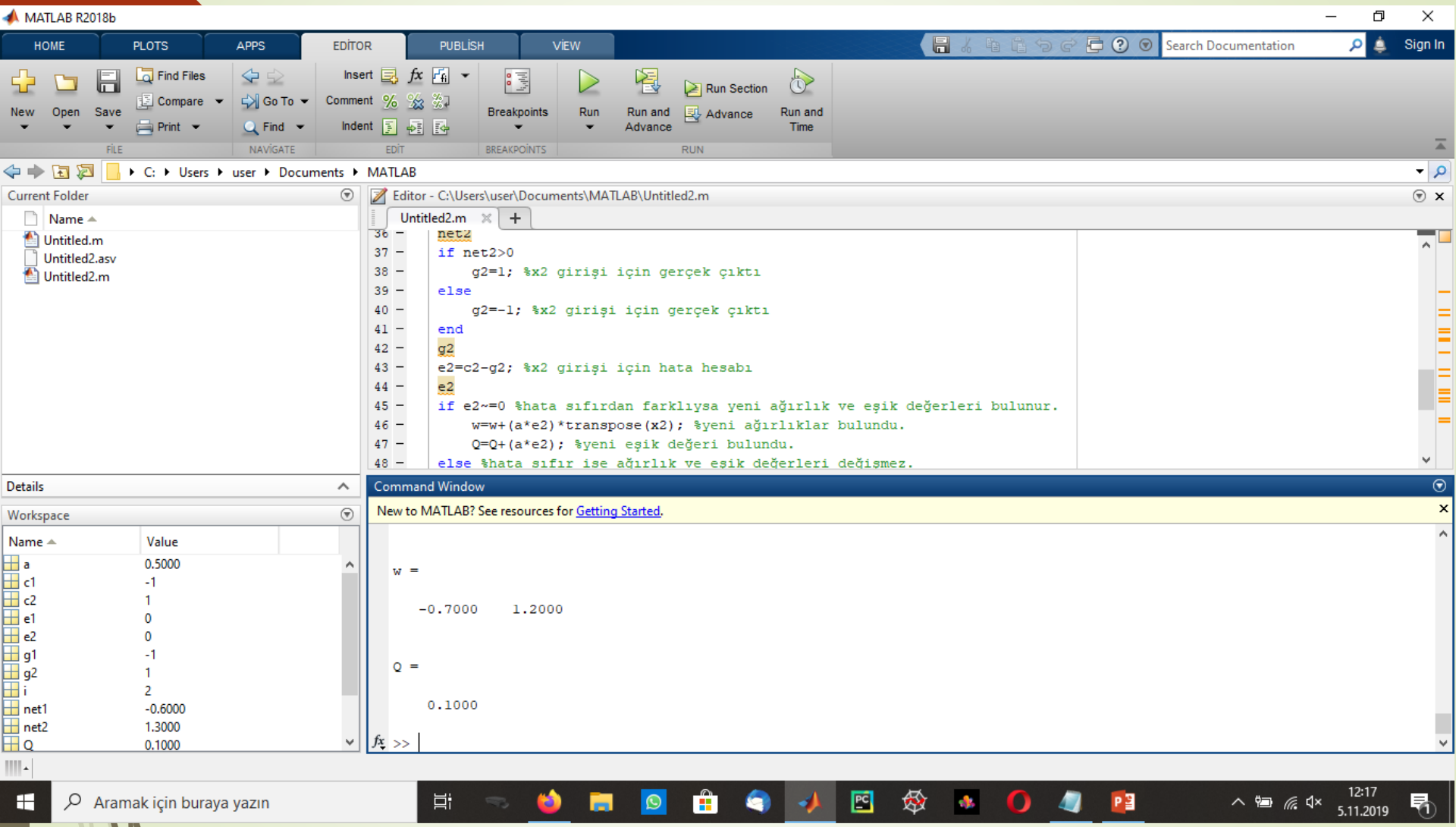
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Untitled2.m
net2
if net2>0
g2=1; %x2 girişi için gerçek çıktı
else
g2=-1; %x2 girişi için gerçek çıktı
end
g2
e2=c2-g2; %x2 girişi için hata hesabı
e2
if e2~=0 %hata sıfırdan farklıysa yeni ağırlık ve eşik değerleri bulunur.
w=w+(a*e2)*transpose(x2); %yeni ağırlıklar bulundu.
Q=Q+(a*e2); %yeni eşik değeri bulundu.
else %hata sıfır ise ağırlık ve eşik değerleri değişmez.
Details
Workspace
Name
Value
a 0.5000
c1 -1
c2 1
e1 0
e2 0
g1 -1
g2 1
i 2
net1 -0.6000
net2 1.3000
Q 0.1000
Command Window
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w =
-0.7000 1.2000
Q =
0.1000
>>
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12:17
5.11.2019

# ARTIFICIAL INTELLIGENCE AND DEEP LEARNING


WEEK 4
2021 SPRING

# Artificial Intelligence

- ***Machine Learning:*** *Artificial intelligence and its applications directly cover machine learning which can be described as making intelligent predictions using past information and experiences.*
- ***A*** problem can be solved starting from existing examples. There are a number of learning strategies within the context of machine learning. These learning strategies can be provided under three main categories as; *supervised learning , un-supervised learning and reinforcement learning.*
- *Different algorithms are developed according to the learning strategies (Example: k-nearest neighbor, decision trees, artificial neural networks, k-means clustering etc.).Machine learning can also be described as a set consisting of these algorithms.*

# Artificial Intelligence

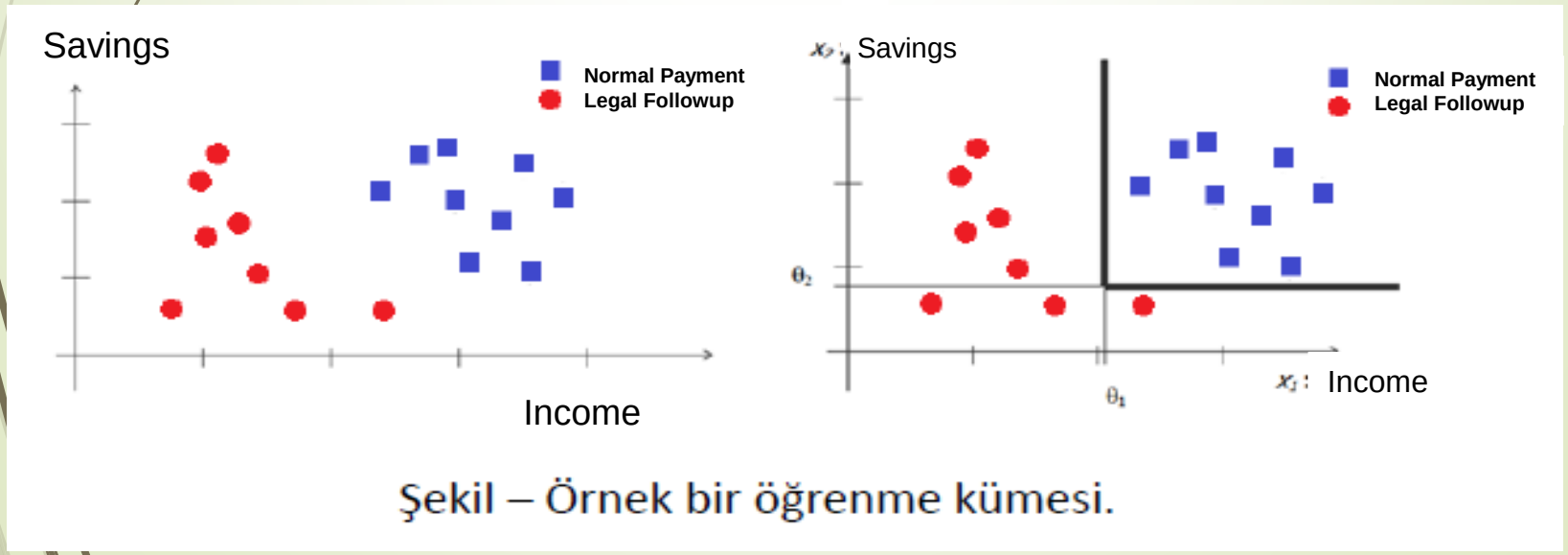
- ***Machine Learning - Classification:*** The main Objective of supervised learning algorithms to perform classification. Classification can be made if properties of past data and the categories associated with these data are known.
- It is assumed that new data will be similar to earlier data.
- For example, a bank can infer a relation between customer data and credit score by looking at earlier records. In this example, there are two classes/categories (eligible/ineligible for credit)
- The customer data will be the input for the model while the output of the system is either of these classes.

# Artificial Intelligence

- ***Machine Learning – Classification:*** Examples consisting of data from two classes as «Normal Payment» and «Legal Follow-up» can be seen in figure below. The samples in question are placed using two attributes (features); savings and yearly income. These samples could be Seperated from each other linearly and the broad line segments seperate the two classes. Therefore, we can express the algorithm necessary for classification as follows;

**Rule:** (if **Income>$\theta_1$** and **Savings>$\theta_2$** ise "Normal Payment" else "Legal Followup" )

- After the rule is formed, a prediction could be made by using the savings and income information of the new customer.




Şekil – Örnek bir öğrenme kümesi.

# Artificial Intelligence

- ***Machine Learning – Classification: :***
- Recognition of letters and numbers is a widely used classification task. In this scenario, there are as many classes as letters or numbers that we want to be recognized and a large sample dataset is required.
- Facial recognition is also a classification problem. In this applications, the aim is to seek the new data among old data. This process is more difficult than character recognition since there are many more classes and the face image is more complex (additional features such as glasses, beard or hat etc. might make the recognition task more difficult).
- In medical field, detection of cancerous tissue (a problem with two classes) or detection of ilness using the symptoms of the patient are commonly used classification tasks.

# Artificial Intelligence

- ***Machine Learning - Clustering***

  It's among the main topics of unsupervised learning. In unsupervised learning there is no supervisor, the only input is the data itself. The objective is to group the similar ones in these data.

- For example, a company might want to find similar customer profiles by observing the previous behaviors. Such a study also helps to find customer groups who are acting contrary to other customers.

- Clustering algorithms are also frequently employed in image compressing tasks. Image points (pixel) with similar colors are grouped into the same cluster.

# Artificial Intelligence

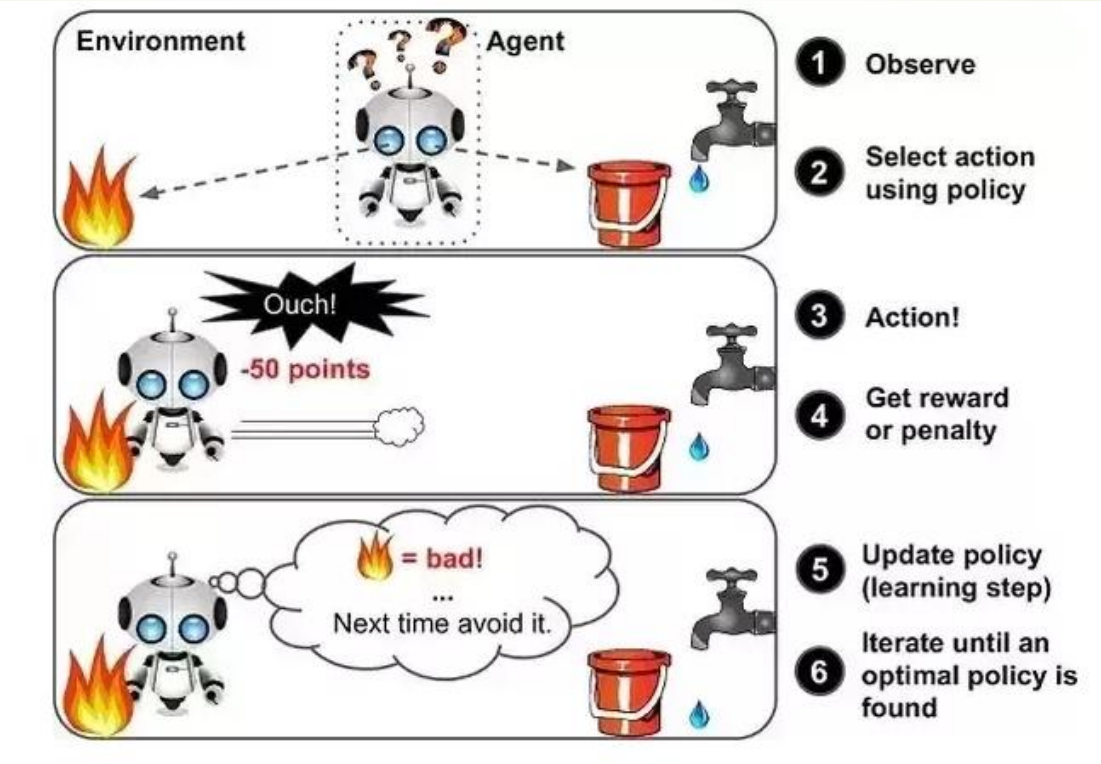
- ***Machine Learning - Clustering:*** These points denote the colors commonly observed in the image. If there are different shades of a low number of colors in an image, pixels falling into the same cluster can be represented by a single Color.
- In the example below, the image is compressed using the clustering technique named "k-means". Employing an average value instead of shades of a Color causes loss of detail of the image, however in some cases this loss is lower than the perception level of our eyes. As a result of this process the size of the image is reduced while our eyes cannot notice this change.

# Artificial Intelligence

- ***Machine Learning – Reinforcement Learning:*** Continuous feedback is provided for the algorithm to learn a behavior . In some applications the system output is an array of actions (such as chess). In that case, what matters is not the action but the policy, that is the correct sequence of actions to reach the goal.
- In such an applications, machine learning should evaluate the policies and produce a successful policy from the good actions in the past. This type of learning is called «Reinforcement learning». All the game programs are examples to reinforcement learning. No matter how easy the game rules are, correct moves are essential for a good game.

# Artificial Intelligence

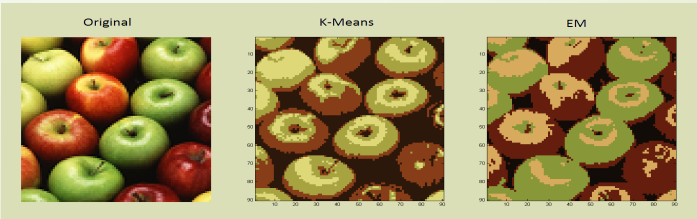
- ***Machine Learning – Reinforcement Learning*** : In the figure, reward or penalty is given to the artificial intelligence element defined as "agent" depending on the sequence of decisions it makes. As a result of these feedbacks, it will start learning what the correct sequence of decisions is after many trials. Feedback and penalty/reward mechanism will be discussed in detail in deep learning topic.
- Reinforcement learning has brought a new perspective to artificial intelligence studies with the tasks that were unthinkable to be performed by robots and machines (computers) in the past can now be realized. Artificial Neural Networks and Deep Learning, which consists of multi-layered neural networks form the basis of these studies.



# Week 4 Questions

- Give two examples to unsupervised learning applications
- What are the three main learning strategies in machine learning?
- Explain how unsupervised learning could be used for credit card fraud detection
- What are the common and different properties of supervised and reinforcement learning in terms of training process?
- Refer to slide 7, note that you can actually tell the difference between the images. Explain how you would modify the k-means clustering process to make the visual difference unnoticable by human eye.

İmage:



# Week 4 Answers

- 1-Facial recognition and character recognition
- 2-supervised learning , un-supervised learning and reinforcement learning.
- 3- Activities of a customer can be summarized in a dataset with each purchase/payment comprising a sample. The dataset could then be clustered considering its features (such as amount, type or payment location) to detect inconsistent behavior among the samples.
- 4-Both methods provide feedback during the training stage. While supervised learning provides feedback at each step, reinforcement learning provides feedback only at the end, therefore the correctness of the steps leading to the final decision must be learned by the model itself.
- 5-By using sufficiently high number of clusters (k) we could improve the representation of shades so that only very similar shades could be transformed into a single average shade, making it impossible to detect with naked eye.