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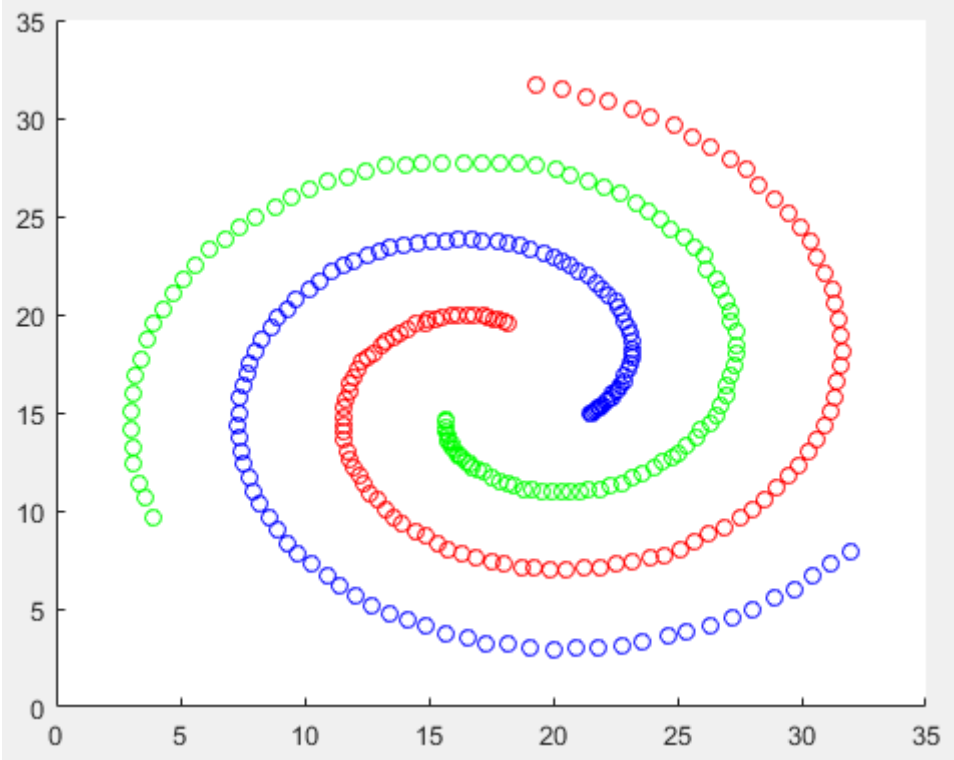
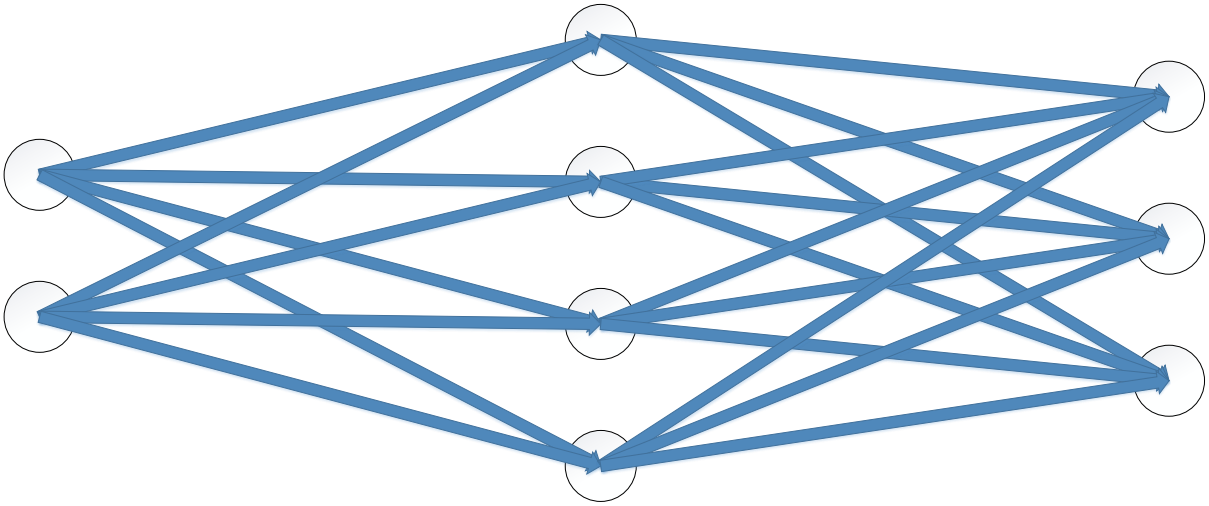
(50 POINTS) IN THIS PROBLEM WE IMPLEMENT MULTI-LAYER PERCEPTRON (MLP) FOR CLASSIFICATION USING BACKPROPAGATION AS A LEARNING ALGORITHM.

(A) LOAD THE SELECTED DATA SET. VISUALIZE ALL DATA POINTS USING SCATTER PLOT. FROM YOUR SCATTER PLOT, ONE COULD EASILY DISTINGUISH EACH CLASS. (HINT: USE ATTRIBUTE 1 AS X -AXIS, ATTRIBUTE 2 AS Y -AXIS. USE DIFFERENT COLOR AND/OR DIFFERENT SYMBOL FOR EACH CLASS LABEL.[5 POINTS]



(B) GIVE A FIGURE ON YOUR REPORT ILLUSTRATING THE MLP ARCHITECTURE THAT YOU APPLY FOR THIS EXERCISE. DESCRIBE ALSO THE ACTIVATION FUNCTION. [5 POINTS]



Neuron input : 2

Hidden layer : 1

Neuron hidden layer 1 : 4

Neuron output : 3

Aktvivtion function : sigmoid biner

Learning rate : 0.001

(C) (C) APPLY MULTI-LAYER PERCEPTRON AS A CLASSIFIER ON THE SELECTED DATA SET. YOUR CODES HAVE TO CLEARLY CONTAIN

I. FUNCTION FOR LEARNING THAT IMPLEMENTS THE BACKPROPAGATION ALGORITHM. [10 POINTS]

```
function [ bobot1Baru bobot2Baru c] = propagasiMajuMundur( inputan ,
bobot1i , bobot2i ,lr)
target = eye(3);
dataA1 = [];
dataA2 = [];
dataW2 = [];
dataE  = [];
bobot1 = bobot1i;
bobot2 = bobot2i;
[panjang lebar] = size(inputan);

for j=1 : panjang
    inp     = [inputan(j,1) inputan(j,2)];
    V1      = inp * bobot1;
    A1      = [];

    for i=1:length(V1)
        A1  = [A1 ,(1 / ( 1 + exp(-V1(1,i))))];
    end

    V2      = A1 * bobot2;
    A2      = [];
    for i=1:length(V2)
        A2 = [A2 ,(1 / ( 1 + exp(-V2(1,i))))];
    end

    dataE   = [dataE ;(target(inputan(1,3),:) - A2)];
    dataA2  = [dataA2 ; A2];
    dataA1  = [dataA1 ; A1];
end
c = mean(dataE);

[panjang1 lebar1] = size(bobot1);
[panjang2 lebar2] = size(bobot2);
DW2 = [];
DW1 = [];
d2  = [];
d1  = [];
for i=1 : length(inputan)
    xd2 = [];
    for j=1 : lebar2
        xd2 = [xd2 dataA2(i,j) * (1 -dataA2(i,j)) * dataE(i,j)];
    end
    d2 = [ d2; xd2];
end
for i=1 :length(inputan)
    xd1 = [];
    for j=1 : lebar1
```

```
        xd1 = [xd1 dataA1(i,j) * (1 - dataA1(i,j)) * bobot2(:,j) *
d2(:,j)'];
    end
    d1 = [ d1; xd1];
end
for i=1 : panjang2
    a = [];
    for j=1 : lebar2
        b = 0;
        for k=1 : lebar2
            b = b + d2(i,k) * dataA1 (i,j);
        end
        a = [a b];
    end
    DW2 = [DW2 ; a];
end
for i=1 : panjang1
    a = [];
    for j=1 : lebar1
        b = 0;
        for k=1 : lebar1
            b = b + d1(i,k) * inputan (i,j);
        end
        a = [a b];
    end
    DW1 = [DW1 ; a];
end


bobot1Baru = bobot1;
bobot2Baru = bobot2;


end
```

II. FUNCTION FOR PREDICTING/CLASSIFYING DATA. [10 POINTS]

```
function [ hasilclass ] = getClass( dataTrain )
target = eye(3);
a = 0;
if(dataTrain == target(1,:))
    a = 1;
elseif(dataTrain == target(2,:))
    a = 2;
elseif(dataTrain == target(3,:))
    a = 3;
end
hasilclass = a;
end
```

III. CLASSIFY EACH DATA POINT USING THE TRAINED MLP. PLOT THE RESULTS USING SCATTER PLOT. FROM YOUR SCATTER PLOT, ONE COULD EASILY DISTINGUISH EACH CLASS. (HINT: USE DIFFERENT COLOR AND/OR DIFFERENT SYMBOL).[5 POINTS] IV. BY VISUALLY COMPARING FIGURES CREATED FROM POINT 3(A) AND 3(B)

```
epoch=1 : 100
hasilTest  = [];
    for i=1: banyakData
        [a] = propagasiMaju( dataTrain(i,:) , bobot1 , bobot2);
        hasilTest  = [hasil1 ; a];
    end
epoch

hasilTesting = [];
hasilClass = [];
for i=1: banyakData
    a = [];
    for j=1 : panjangData
        if(hasilTest(i,j) > 0.90)
            b = 1;
        else
            b = 0;
        end
        a = [ a b];
    end

    hasilTesting = [hasilTesting ; a];
    hasilClass = [hasilClass; getClass( hasilTesting(i,:) )];
end


function plotinHasil (datas)
a = datas;
b = (datas(:,1:2));
for i=1:size(a,1)
    if a(i,3) == 1
        scatter(b(i,1), b(i,2), 'o', '.r');
        hold on;
    elseif a(i,3) == 2
        scatter(b(i,1), b(i,2), 'o', '.g');
```

```
        hold on;
    elseif a(i,3) == 3
        scatter(b(i,1), b(i,2), 'o','.b');
        hold on;
    end
end
```

III, WHAT DO YOU THINK OF THE CLASSIFICATION RESULTS USING MLP. [5 POINTS]

(D) USE THE FUNCTION OF EXERCISE 1 TO EVALUATE PERFORMANCE OF MLP AS A CLASSIFIER. WHAT IS THE F1-MICRO AVERAGE OF MLP AS A CLASSIFIER ON THE DATA SET. [5 POINTS]

(E) PLOT THE DECISION BOUNDARY RESULTED FROM MLP AS A CLASSIFIER ON THE FIGURE THAT HAS BEEN CREATED BY POINT 3(A). (HINTS: GENERATE DATA POINTS USING RANGE OF MINIMUM AND MAXIMUM VALUE OF EACH ATTRIBUTE, THEN CLASSIFY EACH GENERATED DATA POINTS USING TRAINED MLP. USE ATTRIBUTE 1 AND ATTRIBUTE 2 AS BOTH X -AXIS AND Y -AXIS OF DECISION BOUNDARY LOCATION, WHILE THE PREDICTED CLASS LABEL FOR COLORING).[5 POINTS