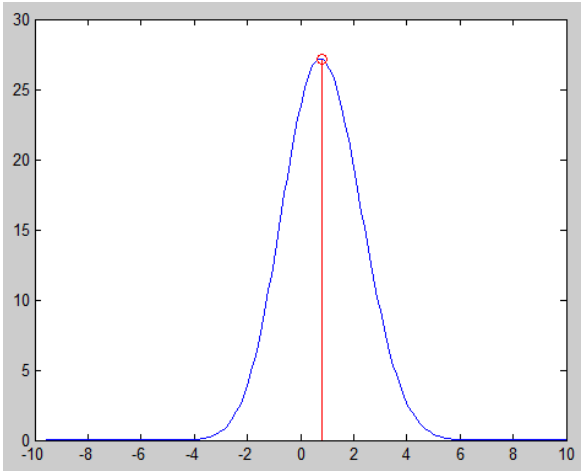
Yalova Universitesi
Fen Bilimleri Enstitusu
Bilgisayar Muhendisligi Ana Bilim Dali

Örüntü Tanıma Dersi

Sevdanur GENC - 135105008

Örüntü Tanıma - Assignment II

QA1) Maksimum olabilirlik kestrimi cozumleri;



A Sikki)

Matlab Kodu;

```
clear all;
close all;
clc;

veri=1+randn(1,100);
standartSapma=1;

degerAraligi=-10:0.1:10;
L=zeros(1,length(degerAraligi));

for i=1:length(degerAraligi)
L(i) = sum(1/sqrt(2*pi*standartSapma^2)*exp(-(veri-
degerAraligi(i)).^2/(2*standartSapma^2)));
end

[maxL,index]=max(L);
display(degerAraligi(index));

plot(degerAraligi,L);
hold on;
stem(degerAraligi(index),L(index),'r');
```

Cozum;

```
Command Window
New to MATLAB? Watc

ans =

    0.8000

veri =

  Columns 1 through 15

    0.0719    1.7919    0.7563   -0.8343    1.5976    2.8614    1.4948    0.5865   -0.1377    1.0654    0.2718    0.0221    0.3978   -0.6928    0.8054

  Columns 16 through 30

    1.2596    1.1864    1.2614   -0.0132   -0.1997   -0.2697    0.6758    0.2660    1.1301    3.3963    0.0245    1.2751   -0.5412    0.5363    1.5295

  Columns 31 through 45

   -1.1103    2.0126    2.1591    1.4728    0.2152    2.3266    1.1313    0.3926   -0.3268    0.6877    1.2541    1.9786    0.3702    1.4234   -0.0572

  Columns 46 through 60

   -0.1844    2.1542   -0.4479    1.8903    2.2197    0.5350    0.4092   -0.3227    0.3536    1.7668    1.8246    0.8545   -0.4250    0.5737    0.5178

  Columns 61 through 75

    0.3128    0.4542    2.8258    1.1684    0.4991    3.0112    1.2206    3.0992    2.2238   -1.3943   -0.7142   -0.8054   -0.0263    1.1756    1.2770

  Columns 76 through 90

    2.1000    0.2842    2.0467    1.1550    0.9051    1.2481    2.1019    0.6715    0.1920    0.6228    2.4380    1.7135   -0.0723    1.4059    0.0759

  Columns 91 through 100

    2.5438   -0.9950   -0.6161    1.8196    0.4645    1.3953    0.4627    1.1541   -1.0830    0.2419
```

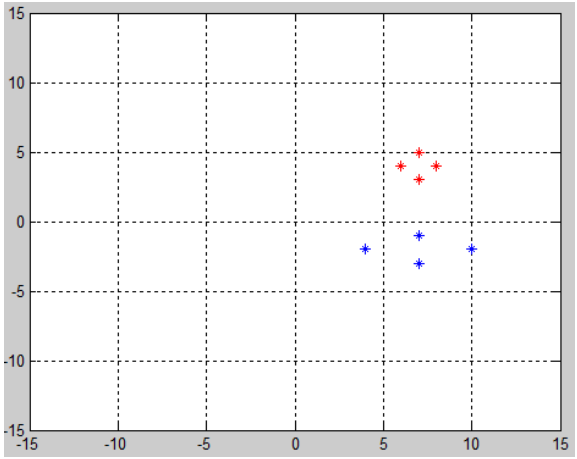
QA2) w1 = [8;4]; [6;4]; [7;5]; [7;3]; w2 = [10;-2]; [4;-2]; [7;-1]; [7;-3];

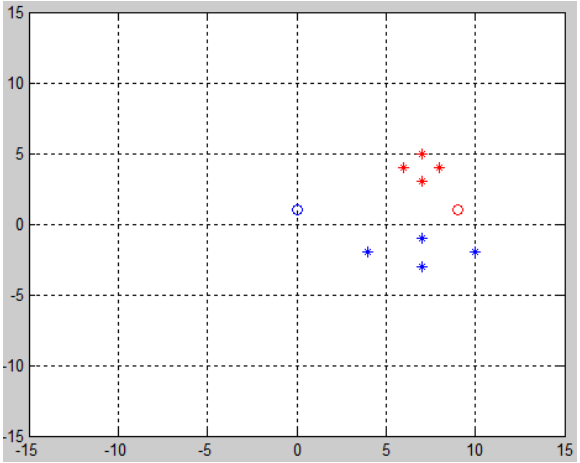
Matlab Kodu;

```
clear all;
close all;
clc;

W1 = [ 8,4; 6,4; 7,5; 7,3; ]
W2 = [ 10,-2; 4,-2; 7,-1; 7,-3;]

%% A Sikki %%
nokta_w1 = [ 8,6,7,7; 4,4,5,3; ];
figure;
plot(nokta_w1(1,:),nokta_w1(2,:),'*r');
nokta_w2 = [ 10,4,7,7; -2,-2,-1,-3;]
hold on;
plot(nokta_w2(1,:),nokta_w2(2,:),'*b');
axis([-15 15 -15 15 -15 15]);
grid on;

%% B Sikki %%
ortalamaW1 = mean(W1)
ortalamaW2 = mean(W2)

kovaryansW1 = cov(W1)
kovaryansW2 = cov(W2)

%% C Sikki %%
E1 = [1/2 , 0; 0, 1/2];
E2 = [4.5, 0; 0 0.5];

Wb1 = - (1/2) * E1';
Wb2 = - (1/2) * E2';

wk1 = E1' * ortalamaW1(1,1);
wk2 = E2' * ortalamaW1(1,1);

wk10 = [- (1/2) * ortalamaW1(1,1)' * E1' * ortalamaW1(1,1)] - [ (1/2) *
(log(det(E1)) + log(exp(1))) ];
wk20 = [- (1/2) * ortalamaW2(1,1)' * E2' * ortalamaW2(1,1)] - [ (1/2) *
(log(det(E2)) + log(exp(1))) ];

for i=1:length(W1)
    G11 = W1(i,1)' * Wb1 * W1(i,1) + wk1' * W1(i,1) + wk10;
    G12 = W1(i,2)' * Wb1 * W1(i,2) + wk1' * W1(i,2) + wk10;
end

for i=1:length(W1)
    G21 = W2(i,1)' * Wb2 * W2(i,1) + wk2' * W2(i,1) + wk20;
    G22 = W2(i,2)' * Wb2 * W2(i,2) + wk2' * W2(i,2) + wk20;
end

%% E Sikki %%
```

```
prototype = [9,1]

for i=1:length(W1)
sonuc(i,:) = [(prototype(1,1) - W1(i,1))^2  + (prototype(1,2) - W1(i,2))^2];
end

NNMatrixW1 = sonuc(:,:)
vektorAraligi1 = min(NNMatrixW1)

for i=1:length(W2)
sonuc(i,:) = [(prototype(1,1) - W2(i,1))^2  + (prototype(1,2) - W2(i,2))^2];
end

NNMatrixW2 = sonuc(:,:)
vektorAraligi2 = min(NNMatrixW2)

prototype = [0,1]      %% 2.satir'a ait.

for i=1:length(W1)
sonuc(i,:) = [(prototype(1,1) - W1(i,1))^2  + (prototype(1,2) - W1(i,2))^2];
end

NNMatrixW1 = sonuc(:,:)
vektorAraligi1 = min(NNMatrixW1)

for i=1:length(W2)
sonuc(i,:) = [(prototype(1,1) - W2(i,1))^2  + (prototype(1,2) - W2(i,2))^2];
end

NNMatrixW2 = sonuc(:,:)
vektorAraligi2 = min(NNMatrixW2)

hold on;
prototypeNokta1 = [9; 1];
plot(prototypeNokta1(1,:),prototypeNokta1(2,:),'Or');

hold on;
prototypeNokta2 = [0; 1];
plot(prototypeNokta2(1,:),prototypeNokta2(2,:),'Ob');
```

Cozum;





QA3) w1 = [8;4]; [6;4]; [7;5]; [7;3]; w2 = [10;-2]; [4;-2]; [7;-1]; [7;-3];

A Sikki)

Matlab Kodu;

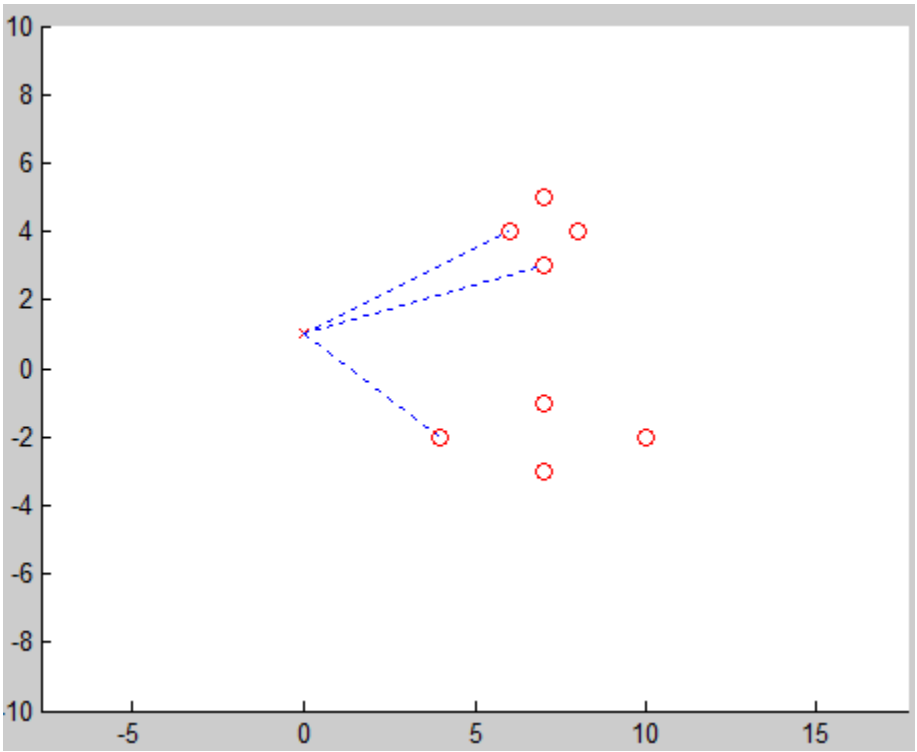
```
clear all;
close all;
clc;

W1 = [ 8,4; 6,4; 7,5; 7,3; ]
W2 = [ 10,-2; 4,-2; 7,-1; 7,-3;]
x = [0,1];
varyans = 1;

for i=1:length(W1)
solutionA(i,1) = 1 / sqrt(2*pi) * exp(-((W1(i,1)- x(1,1))^2) / 2 *
varyans^2);
solutionA(i,2) = 1 / sqrt(2*pi) * exp(-((W1(i,2)- x(1,2))^2) / 2 *
varyans^2);
end
Cozum1 = solutionA(:,:)
p=0;
for i=1:length(solutionA)
p = p + solutionA(i,:);
end
p / length(W1)

for i=1:length(W2)
solutionB(i,1) = 1 / sqrt(2*pi) * exp(-((W2(i,1)- x(1,1))^2) / 2 *
varyans^2);
solutionB(i,2) = 1 / sqrt(2*pi) * exp(-((W2(i,2)- x(1,2))^2) / 2 *
varyans^2);
end
Cozum2 = solutionB(:,:)
p=0;
for i=1:length(solutionB)
p = p + solutionB(i,:);
end
p / length(W2)
```

B Sikki)

Matlab Kodu;

```
clear all;
close all;
clc;

x = [ 8 4; 6 4; 7 5; 7 3; 10 -2; 4 -2; 7 -1; 7 -3;]
knn = 3;
c1 = [0,1]

axis([-5 15 -10 10]);
axis equal;
hold on;

plot(c1(1,1),c1(1,2),'rX');
for i=1:8
    plot(x(i,1),x(i,2),'rO');
    distanceX(i)=norm(c1(1,:)- x(i,:));
end;

  [xd,id] = sort(distanceX);

for i=1:knn
  plot([c1(1,1) x(id(i),1)],[c1(1,2) x(id(i),2)],'b:');
end;
```

Cozum;

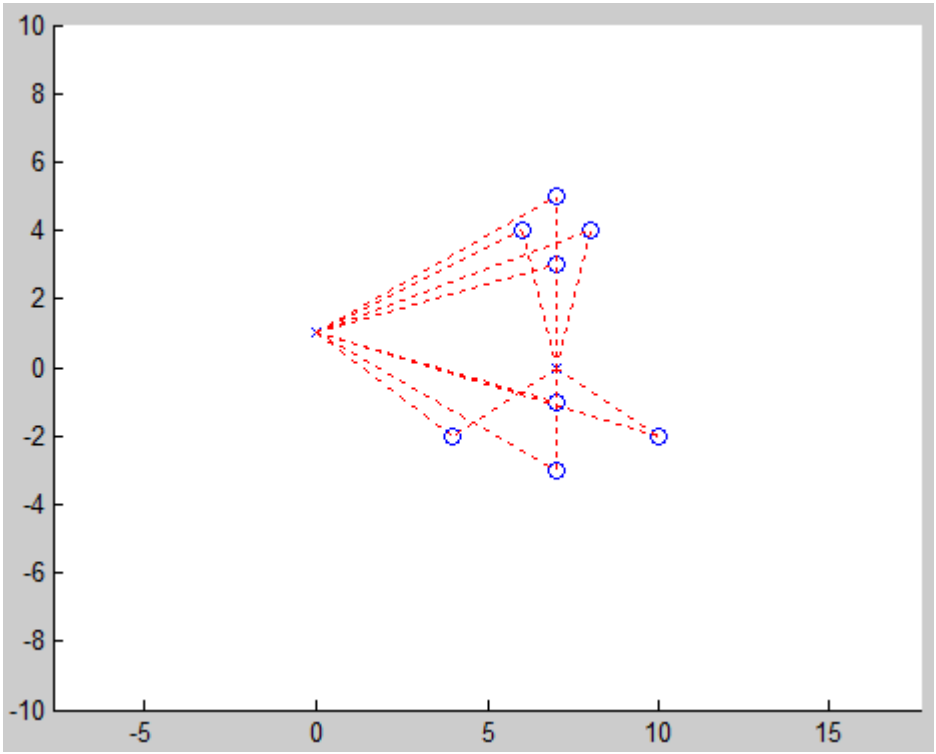


C Sikki)

Matlab Kodu;

```
clear all;
close all;
clc;

x = [ 8 4; 6 4; 7 5; 7 3; 10 -2; 4 -2; 7 -1; 7 -3;]
c1 = [7,0]
c2 = [0,1]

axis([-5 15 -10 10]);
axis equal;
hold on;

plot(c1(1,1),c1(1,2),'X');
plot(c2(1,1),c2(1,2),'X');
for i=1:8;
    plot(x(i,1),x(i,2),'O');
end;

for i=1:8;
    plot([c1(1,1) x(i+5*(1-1),1)] , [c1(1,2) x(i+5*(1-1),2)],'r:');
    plot([c2(1,1) x(i+5*(1-1),1)] , [c2(1,2) x(i+5*(1-1),2)],'r:');
end;
```

Cozum;



QA4)

Matlab Kodu;

```
clear all;
close all;
clc;

x = [ 8 4; 6 4; 7 5; 7 3;
      10 -2; 4 -2; 7 -1; 7 -3;]

varyans = 1;
c = [x(1,:); x(2,:); x(5,:); x(6,:)]

axis([0 15 -10 10]);
hold on;
for i=1:4;
    plot(x(i,1),x(i,2),'o');
    y(i)=0;
end;
for i=5:8 ;
    plot(x(i,1),x(i,2),'x');
    y(i)=1;
end;

for i=1:8;
    phi1(i) = exp(- ((x(i,1)-c(1,1))^2 + (x(i,2)-c(1,2))^2 )/2 * varyans^2 );
    phi2(i) = exp(- ((x(i,1)-c(2,1))^2 + (x(i,2)-c(2,2))^2 )/2 * varyans^2 );
    phi3(i) = exp(- ((x(i,1)-c(3,1))^2 + (x(i,2)-c(3,2))^2 )/2 * varyans^2 );
    phi4(i) = exp(- ((x(i,1)-c(4,1))^2 + (x(i,2)-c(4,2))^2 )/2 * varyans^2 );
end;

 P = [phi1' phi2' phi3' phi4']
 w = inv(P'*P )*P'*y';
 ty = sign(P*w);

  for i=1:64;
     for j=1:64;
         x1(i,j)=i/64;
         y1(i,j)=j/64;
         p1 = exp(- ((x1(i,j)-c(1,1))^2 + (y1(i,j)-c(1,2))^2)/2 * varyans^2);
         p2 = exp(- ((x1(i,j)-c(2,1))^2 + (y1(i,j)-c(2,2))^2)/2 * varyans^2);
         p3 = exp(- ((x1(i,j)-c(3,1))^2 + (y1(i,j)-c(3,2))^2)/2 * varyans^2);
         p4 = exp(- ((x1(i,j)-c(4,1))^2 + (y1(i,j)-c(4,2))^2)/2 * varyans^2);
         z(i,j)= w(1)*p1 + w(2)*p2 + w(3)*p3 + w(4)*p4;
     end;
 end;

 contour(x1,y1,z, [0 -10]);
```

QA5)
```
W1 = [-5.01, -8.12, -3.68; -5.43, -3.48, -3.54; 1.08, -5.52,  1.66;
0.86, -3.78, -4.11; -2.67,  0.63,  7.39; 4.94,  3.29,  2.08; -2.51,  2.09, -
2.59; -2.25, -2.13, -6.94; 5.56,  2.86, -2.26; 1.03, -3.33,  4.33; ]

W2 = [-0.91, -0.18, -0.05; 1.30, -2.06, -3.53; -7.75, -4.54, -0.95; -5.47,
0.50,  3.92; 6.14,  5.72, -4.85; 3.60,  1.26,  4.36; 5.37, -4.63, -3.65;
7.18,  1.46, -6.66; -7.39,  1.17,  6.30; -7.50, -6.32, -0.31; ]

W3 = [ 5.35,  2.26,  8.13; 5.12,  3.22, -2.66; -1.34, -5.31, -9.87; 4.48,
3.42,  5.19; 7.11,  2.39,  9.21; 7.17,  4.33, -0.98; 5.75,  3.97,  6.65;
0.77,  0.27,  2.41; 0.90, -0.43, -8.71; 3.52, -0.36,  6.43 ]
```

Matlab Kodu;

```
clear all;
close all;
clc;

%% E Sikki %%
W1 = [-5.01, -8.12, -3.68;
      -5.43, -3.48, -3.54;
       1.08, -5.52,  1.66;
       0.86, -3.78, -4.11;
      -2.67,  0.63,  7.39;
       4.94,  3.29,  2.08;
      -2.51,  2.09, -2.59;
      -2.25, -2.13, -6.94;
       5.56,  2.86, -2.26;
       1.03, -3.33,  4.33; ]

nokta_w1 = [ -5.01,-5.43,1.08,0.86,-2.67,4.94,-2.51,-2.25,5.56,1.03;
    -8.12,-3.48,-5.52,-3.78,0.63,3.29,2.09,-2.13,2.86,-3.33;
    -3.68,-3.54,1.66,-4.11,7.39,2.08,-2.59,-6.94,-2.26,4.33; ];

figure;
plot3(nokta_w1(1,:),nokta_w1(2,:),nokta_w1(3,:),'*r');

W2 = [-0.91, -0.18, -0.05;
       1.30, -2.06, -3.53;
      -7.75, -4.54, -0.95;
      -5.47,  0.50,  3.92;
       6.14,  5.72, -4.85;
       3.60,  1.26,  4.36;
       5.37, -4.63, -3.65;
       7.18,  1.46, -6.66;
      -7.39,  1.17,  6.30;
      -7.50, -6.32, -0.31; ]

nokta_w2 = [ -0.91,1.30,-7.75,-5.47,6.14,3.60,5.37,7.18,-7.39,-7.50;
          -0.18,-2.06,-4.54,0.50,5.72,1.26,-4.63,1.46,1.17,-6.32;
          -0.05,-3.53,-0.95,3.92,-4.85,4.36,-3.65,-6.66,6.30,-0.31; ]
hold on;
plot3(nokta_w2(1,:),nokta_w2(2,:),nokta_w2(3,:),'*b');
```

```
W3 = [ 5.35,  2.26,  8.13;
       5.12,  3.22, -2.66;
      -1.34, -5.31, -9.87;
       4.48,  3.42,  5.19;
       7.11,  2.39,  9.21;
       7.17,  4.33, -0.98;
       5.75,  3.97,  6.65;
       0.77,  0.27,  2.41;
       0.90, -0.43, -8.71;
       3.52, -0.36,  6.43 ]

nokta_w3 = [ 5.35,5.12,-1.34,4.48,7.11,7.17,5.75,0.77,0.90,3.52;
             2.26,3.22,-5.31,3.42,2.39,4.33,3.97,0.27,-0.43,-0.36;
             8.13,-2.66,-9.87,5.19,9.21,-0.98,6.65,2.41,-8.71,6.43; ]

hold on;
plot3(nokta_w3(1,:),nokta_w3(2,:),nokta_w3(3,:),'*g');

axis([-15 15 -15 15 -15 15]);
grid on;

%% A Sikki %%
mW1 = mean(W1)
mW2 = mean(W2)
mW3 = mean(W3)

sigmaW1 = cov(W1)
sigmaW2 = cov(W2)
sigmaW3 = cov(W3)

%% B ve D Sikki %%
x1 = [1 2 1]';
x2 = [5 3 2]';
x3 = [0 0 0]';
x4 = [1 0 0]';

Wi1 = -0.5 * inv(sigmaW1)
wi1 = inv(sigmaW1)* mW1'
w01 = -0.5 * (sigmaW1') * inv(sigmaW1) * mW1' -
0.5*(log(det(sigmaW1))/log(exp(1)))
g1x1 = x1' * Wi1 * x1 + wi1' * x1 + w01

Wi2 = -0.5 * inv(sigmaW2)
wi2 = inv(sigmaW2)* mW2'
w02 = -0.5 * (sigmaW2') * inv(sigmaW2) * mW2' -
0.5*(log(det(sigmaW2))/log(exp(1)))
g2x1 = x1' * Wi2 * x1 + wi2' * x1 + w02

Wi3 = -0.5 * inv(sigmaW3)
wi3 = inv(sigmaW3)* mW3'
w03 = -0.5 * (sigmaW3') * inv(sigmaW3) * mW3' -
0.5*(log(det(sigmaW3))/log(exp(1)))
g3x1 = x1' * Wi3 * x1 + wi3' * x1 + w03

%%%%%%%%%%%%%%%%%%%%%%%
```

```
Wi1 = -0.5 * inv(sigmaW1)
wi1 = inv(sigmaW1)* mW1'
w01 = -0.5 * (sigmaW1') * inv(sigmaW1) * mW1' -
0.5*(log(det(sigmaW1))/log(exp(1)))
g1x2 = x2' * Wi1 * x2 + wi1' * x2 + w01

Wi2 = -0.5 * inv(sigmaW2)
wi2 = inv(sigmaW2)* mW2'
w02 = -0.5 * (sigmaW2') * inv(sigmaW2) * mW2' -
0.5*(log(det(sigmaW2))/log(exp(1)))
g2x2 = x2' * Wi2 * x2 + wi2' * x2 + w02

Wi3 = -0.5 * inv(sigmaW3)
wi3 = inv(sigmaW3)* mW3'
w03 = -0.5 * (sigmaW3') * inv(sigmaW3) * mW3' -
0.5*(log(det(sigmaW3))/log(exp(1)))
g3x2 = x2' * Wi3 * x2 + wi3' * x2 + w03

%%%%%%%%%%%%%%%%%%%%%%%
Wi1 = -0.5 * inv(sigmaW1)
wi1 = inv(sigmaW1)* mW1'
w01 = -0.5 * (sigmaW1') * inv(sigmaW1) * mW1' -
0.5*(log(det(sigmaW1))/log(exp(1)))
g1x3 = x3' * Wi1 * x3 + wi1' * x3 + w01

Wi2 = -0.5 * inv(sigmaW2)
wi2 = inv(sigmaW2)* mW2'
w02 = -0.5 * (sigmaW2') * inv(sigmaW2) * mW2' -
0.5*(log(det(sigmaW2))/log(exp(1)))
g2x3 = x3' * Wi2 * x3 + wi2' * x3 + w02

Wi3 = -0.5 * inv(sigmaW3)
wi3 = inv(sigmaW3)* mW3'
w03 = -0.5 * (sigmaW3') * inv(sigmaW3) * mW3' -
0.5*(log(det(sigmaW3))/log(exp(1)))
g3x3 = x3' * Wi3 * x3 + wi3' * x3 + w03

%%%%%%%%%%%%%%%%%%%%%%%
Wi1 = -0.5 * inv(sigmaW1)
wi1 = inv(sigmaW1)* mW1'
w01 = -0.5 * (sigmaW1') * inv(sigmaW1) * mW1' -
0.5*(log(det(sigmaW1))/log(exp(1)))
g1x4 = x4' * Wi1 * x4 + wi1' * x4 + w01

Wi2 = -0.5 * inv(sigmaW2)
wi2 = inv(sigmaW2)* mW2'
w02 = -0.5 * (sigmaW2') * inv(sigmaW2) * mW2' -
0.5*(log(det(sigmaW2))/log(exp(1)))
g2x4 = x4' * Wi2 * x4 + wi2' * x4 + w02

Wi3 = -0.5 * inv(sigmaW3)
wi3 = inv(sigmaW3)* mW3'
w03 = -0.5 * (sigmaW3') * inv(sigmaW3) * mW3' -
0.5*(log(det(sigmaW3))/log(exp(1)))
g3x4 = x4' * Wi3 * x4 + wi3' * x4 + w03
```

```
%% C Sikki %%

W = [-5.01, -8.12,  -3.68;
      -5.43, -3.48, -3.54;
       1.08, -5.52,  1.66;
       0.86, -3.78, -4.11;
      -2.67,  0.63,  7.39;
       4.94,  3.29,  2.08;
      -2.51,  2.09, -2.59;
      -2.25, -2.13, -6.94;
       5.56,  2.86, -2.26;
       1.03, -3.33,  4.33;
      -0.91, -0.18, -0.05;
       1.30, -2.06, -3.53;
      -7.75, -4.54, -0.95;
      -5.47,  0.50,  3.92;
       6.14,  5.72, -4.85;
       3.60,  1.26,  4.36;
       5.37, -4.63, -3.65;
       7.18,  1.46, -6.66;
      -7.39,  1.17,  6.30;
      -7.50, -6.32, -0.31;
       5.35,  2.26,  8.13;
       5.12,  3.22, -2.66;
      -1.34, -5.31, -9.87;
       4.48,  3.42,  5.19;
       7.11,  2.39,  9.21;
       7.17,  4.33, -0.98;
       5.75,  3.97,  6.65;
       0.77,  0.27,  2.41;
       0.90, -0.43, -8.71;
       3.52, -0.36,  6.43 ]

knn = 3;

c1 = [1 2 1];
c2 = [5 3 2];
c3 = [0 0 0];
c4 = [1 0 0];

axis([-5 15 -10 10]);
axis equal;
hold on;

plot3(c1(1,1),c1(1,2),c1(1,3),'rX');
plot3(c2(1,1),c2(1,2),c2(1,3),'rX');
plot3(c3(1,1),c3(1,2),c3(1,3),'rX');
plot3(c4(1,1),c4(1,2),c4(1,3),'rX');

for i=1:30
    plot3(W(i,1),W(i,2),W(i,3),'rO');

    distanceX1(i)=norm(c1(1,:)- W(i,:));
    distanceX2(i)=norm(c2(1,:)- W(i,:));
    distanceX3(i)=norm(c3(1,:)- W(i,:));
```

```
    distanceX4(i)=norm(c4(1,:)- W(i,:));
end;

  [xd1,id1] = sort(distanceX1);
  [xd2,id2] = sort(distanceX2);
  [xd3,id3] = sort(distanceX3);
  [xd4,id4] = sort(distanceX4);

for i=1:knn
  plot3([c1(1,1) W(id1(i),1)],[c1(1,2) W(id1(i),2)], [c1(1,3)
W(id1(i),3)],'b:');
  plot3([c2(1,1) W(id2(i),1)],[c2(1,2) W(id2(i),2)], [c2(1,3)
W(id2(i),3)],'b:');
  plot3([c3(1,1) W(id3(i),1)],[c3(1,2) W(id3(i),2)], [c3(1,3)
W(id3(i),3)],'b:');
  plot3([c4(1,1) W(id4(i),1)],[c4(1,2) W(id4(i),2)], [c4(1,3)
W(id4(i),3)],'b:');

end;
```

Cozum;