CECS 463 System On Chip II
FALL 2020

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Assignment #08 – Correlation and Shape Identification

12/03/2020

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% CECS 463 Fall20
% Assignment #08 Due: 12/03/2020
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Distance Function

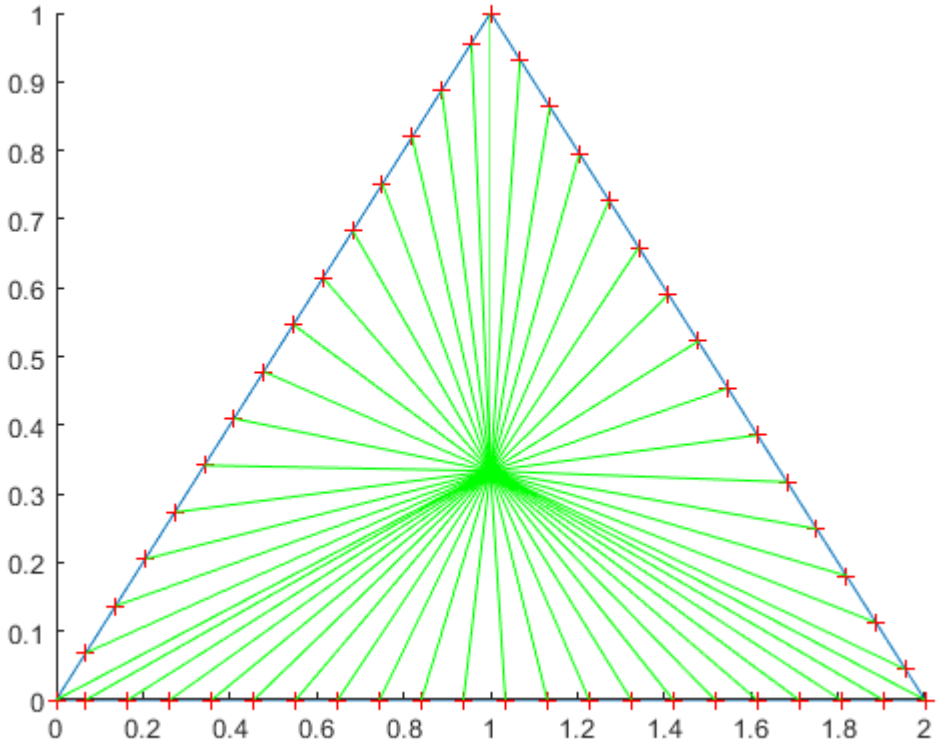
```
clc; close all;
N=50; % steps

figure(1); hold on;  % figure
x = [0, 1, 2, 0];
y=[0, 1, 0, 0];
plot(x, y);
C = [ sum( x(1 : 3)), sum( y( 1:3 )) ]/ 3;

plot(C( 1 ),C( 2 ),'k*'); % centroid
p= 0;

%for loop
for n = 1 : length(x)-1
    p = p + sqrt((y( n + 1)-y( n ))^2+ ((x( n + 1)-x( n ))^2 ));
end
dels = p/N;
d= zeros( 1, 100 );
k=0;

%for loop to get step size and zero distance array
for n = 1 : length( x )-1 %Step around perimeter of figure to find distances
    m = (y( n + 1) - y( n ))/(x( n + 1) - x( n )); %Slope of side of figure
    dx = sign(x( n + 1)-x( n ))*dels*cos(atan(m)); %Find increments for x and y
    dy = dels * sin(atan(m));
    x1 = x(n);
    y1 = y(n); %Get vertex point and step down each side of figure
    while (sqrt((x1 - x( n + 1))^2 + (y1 - y( n + 1))^2) > 0.5*dels)
        k = k + 1; d(k)= sqrt( (C(1) - x1)^2+(C(2) - y1)^2); %Find distance function
        pause(0.05); %Pause and display results
        plot(x1, y1, 'r+'); plot([C(1), x1],[C(2), y1],'g-');
        x1 = x1 + dx;
        y1 = y1 + dy; %Update to new point on side of figure
    end
end
```


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Prob8.1

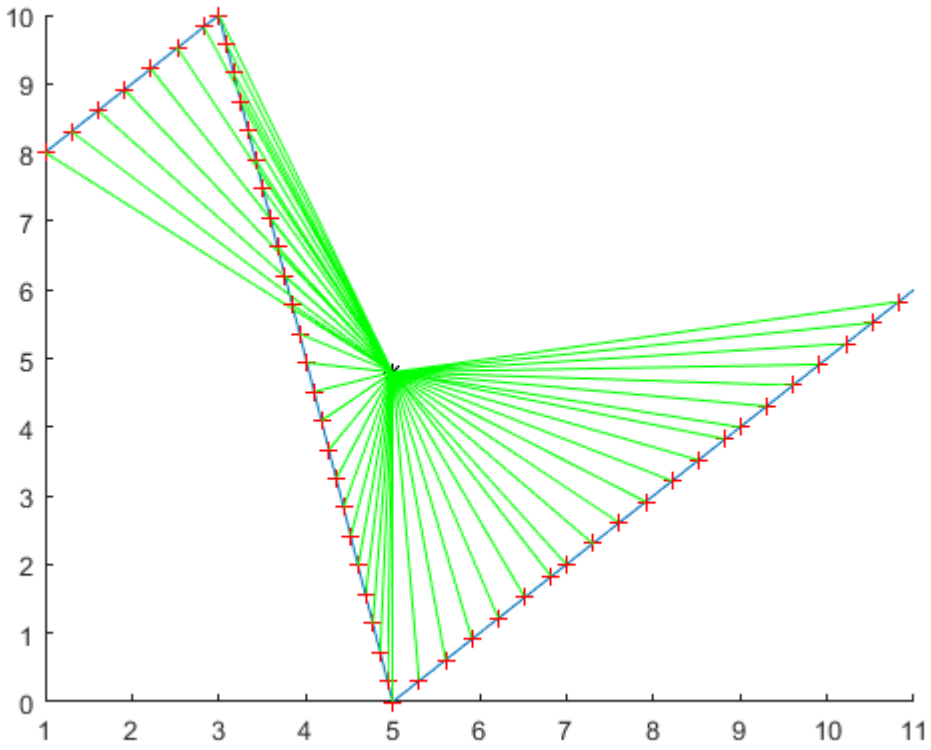
```
clear all; close all; clc;
N = 50; % steps
figure(2); hold on; %figure
x = [1 3 5 7 9 11];
y = [8 10 0 2 4 6];
plot(x,y);
c = [sum(x(1:5)),sum(y(1:5))]/5;
plot(c(1),c(2),'k*'); %Find centroid
p = 0; %Find perimeter of figure
for n = 1 : length(x) - 1
    p = p + sqrt((y(n + 1)-y(n))^2+ ((x(n + 1) - x(n))^2 ));
end
dels = p/N;
d=zeros(1,100);
k = 0; %Get step size and zero distance array
for n = 1:length(x)-1 %Step around perimeter of figure to find distances
    m=(y( n + 1) - y(n))/(x(n + 1) - x(n)); %Slope of side of figure
    delx = sign(x(n + 1)-x(n)) * dels * cos(atan(m)); %Find increments for x and y
    dely = dels * sin(atan(m));
    x1 = x(n);
    y1 = y(n); %Get vertex point and step down each side of figure
    while (sqrt((x1 - x(n + 1))^2 + (y1 - y(n + 1))^2) > 0.5*dels)
        k = k + 1;
        d(k)= sqrt( (c(1) - x1)^2 + (c(2) - y1)^2); %Find distance function
        pause(0.05); %Pause and display results
        plot(x1,y1,'r+');
        plot([c(1),x1],[c(2),y1],'g-');
        x1 = x1 + delx;
        y1 = y1 + dely; %Update to new point on side of figure
    end
end

for k = 1 : length(x)
    rhos(k) = correlate(k,x,y);
end
disp('Problem 8.1')
[max_value,index] = max(rhos);
fprintf('Max Correlation Coeff: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n\n',index)
```

```
Problem 8.1

Max Correlation Coeff: 1.0000

K at which the maximum value of correlation between the two inputs occurs: 2
```


10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11

Plotting figures

```
clear all;
xfig1 = [0 0 4 4];
yfig1 = [0 1 1 0];
xfig2 = [-1 -1 1 1];
yfig2 = [2 -1 -1 2];
xfig3 = [0 0 1];
yfig3 = [0 2 0];
xfig4 = [0 2 3 4 6 4 3 2];
yfig4 = [2 3 6 3 2 1 -2 1];

[Fig1Distance] = draw_shape(xfig1,yfig1,100,3);
[Fig2Distance] = draw_shape(xfig2,yfig2,100,4);
[Fig3Distance] = draw_shape(xfig3,yfig3,100,5);
[Fig4Distance] = draw_shape(xfig4,yfig4,100,6);
d1 = [0:length(Fig1Distance)-1];
d2 = [0:length(Fig2Distance)-1];
d3 = [0:length(Fig3Distance)-1];
d4 = [0:length(Fig4Distance)-1];
pts = 1:length(d4)/length(d1):length(d4)+1;
d5 = d4(round(pts(1:length(d1))));

figure(7); hold on;
plot(d1 , Fig1Distance, 'k*')
figure(8); hold on;
plot(d2 , Fig2Distance, 'k*')
figure(9); hold on;
plot(d3 , Fig3Distance, 'k*')
figure(10); hold on;
plot(d4 , Fig4Distance, 'k*')
hold off;

for k = 1:100
    rhos12(k) = correlate(k, Fig1Distance, Fig2Distance);
    rhos13(k) = correlate(k, Fig1Distance, Fig3Distance);
    rhos14(k) = correlate(k, Fig1Distance, Fig4Distance);
    rhos23(k) = correlate(k, Fig2Distance, Fig3Distance);
    rhos24(k) = correlate(k, Fig2Distance, Fig4Distance);
    rhos34(k) = correlate(k, Fig3Distance, Fig4Distance);
end
fprintf("MAXES\n\n")
[max_value,index] = max(rhos12);
fprintf('Max Correlation Coeff Fig 1 and 2: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[max_value,index] = max(rhos13);
fprintf('Max Correlation Coeff Fig 1 and 3: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[max_value,index] = max(rhos14);
fprintf('Max Correlation Coeff Fig 1 and 4: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[max_value,index] = max(rhos23);
fprintf('Max Correlation Coeff Fig 2 and 3: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[max_value,index] = max(rhos24);
fprintf('Max Correlation Coeff Fig 2 and 4: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
```

```
[max_value,index] = max(rhos34);
fprintf('Max Correlation Coeff Fig 3 and 4: %5.4f\n',max_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n\n',index)

fprintf("MINS\n\n")

[min_value,index] = min(rhos12);
fprintf('Min Correlation Coeff Fig 1 and 2: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[min_value,index] = min(rhos13);
fprintf('Min Correlation Coeff Fig 1 and 3: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[min_value,index] = min(rhos14);
fprintf('Min Correlation Coeff Fig 1 and 4: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[min_value,index] = min(rhos23);
fprintf('Min Correlation Coeff Fig 2 and 3: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[min_value,index] = min(rhos24);
fprintf('Min Correlation Coeff Fig 2 and 4: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)
[min_value,index] = min(rhos34);
fprintf('Min Correlation Coeff Fig 3 and 4: %5.4f\n',min_value)
fprintf('K at which the maximum value of correlation between the two inputs occurs:
%d\n',index)

% Find where the Max and Min are and print it again
fprintf('Max Correlation at Figure 1 and 2 with correlation of %5.2f\n', max(rhos12))
fprintf('Min Correlation at Figure 2 and 4 with correlation of %5.2f\n', min(rhos24))


function [rho] = correlate(k, x, orig_y)
% correlate.m - How much are 2 sequences alike?
% Usage: [rho] = correlate(k, x, y);
% inputs: k = shift (integer between 0 and length(y)-1)
% x, y = the sequences to correlate
% output: rho = the correlation coefficient -1..0..1
% Note: This function assumes length(x) = length(y).
N = length(x);
y = [orig_y(k+1:length(orig_y)), orig_y(1:k)]; % Shift y by k units
sxx = x*x.' - sum(x)*sum(x)/N;
syy = y*y.' - sum(y)*sum(y)/N;
sxy = x*y.' - sum(x)*sum(y)/N;
rho = sxy / sqrt(sxx*syy); % Correlation coefficient for lag k
end


function [Distance] = draw_shape(x,y,N,figA)
    figure(figA);
    hold on;
    xlabel('X');
    ylabel('Y');
    v = length(x);
    xFill = [x x(1)];
    yFill = [y y(1)];
    plot(xFill, yFill);
    xlim([min(x)-1,max(x)+1])
```

```
    ylim([min(y)-1,max(y)+1])
    c = [sum(x(1:length(x))), sum(y(1:length(y)))]/v;
    plot(c(1),c(2),'k*');
    p = 0;
    for n=1:v
        p = p + sqrt((yFill(n + 1) - yFill(n))^2+ ((xFill(n + 1) - xFill(n))^2 ));
    end
    dels = p/N;
    d = zeros(1,100);
    k = 0;
    for n = 1:v
        m=(yFill(n + 1) - yFill(n))/(xFill(n + 1) - xFill(n));
        delx = sign(xFill(n + 1)-xFill(n))*dels*abs(cos(atan(m)));
        dely = sign(yFill(n + 1)-yFill(n))*dels*abs(sin(atan(m)));
        x1 = xFill(n);
        y1 = yFill(n);
        while (sqrt((x1-xFill(n + 1))^2 + (y1-yFill(n + 1))^2) > 0.5*dels)
            k= k + 1; d(k)=sqrt((c(1)-x1)^2+(c(2)-y1)^2);
            pause(0.005); %Pause and display results
            plot(x1,y1,'r+');
            plot([c(1),x1],[c(2),y1],'g-');
            x1 = x1 + delx;
            y1 = y1 + dely;
        end
    end
    Distance = d;
    hold off
end
```

```
MAXES



Max Correlation Coeff Fig 1 and 2: 0.8428

K at which the maximum value of correlation between the two inputs occurs: 35

Max Correlation Coeff Fig 1 and 3: 0.8742

K at which the maximum value of correlation between the two inputs occurs: 33

Max Correlation Coeff Fig 1 and 4: 0.5448

K at which the maximum value of correlation between the two inputs occurs: 69

Max Correlation Coeff Fig 2 and 3: 0.7571

K at which the maximum value of correlation between the two inputs occurs: 49

Max Correlation Coeff Fig 2 and 4: 0.5066

K at which the maximum value of correlation between the two inputs occurs: 75

Max Correlation Coeff Fig 3 and 4: 0.4777

K at which the maximum value of correlation between the two inputs occurs: 89
```

MINS

Min Correlation Coeff Fig 1 and 2: -0.7961

K at which the maximum value of correlation between the two inputs occurs: 10

Min Correlation Coeff Fig 1 and 3: -0.8693

K at which the maximum value of correlation between the two inputs occurs: 8

Min Correlation Coeff Fig 1 and 4: -0.6317

K at which the maximum value of correlation between the two inputs occurs: 45

Min Correlation Coeff Fig 2 and 3: -0.6868

K at which the maximum value of correlation between the two inputs occurs: 72

Min Correlation Coeff Fig 2 and 4: -0.9211

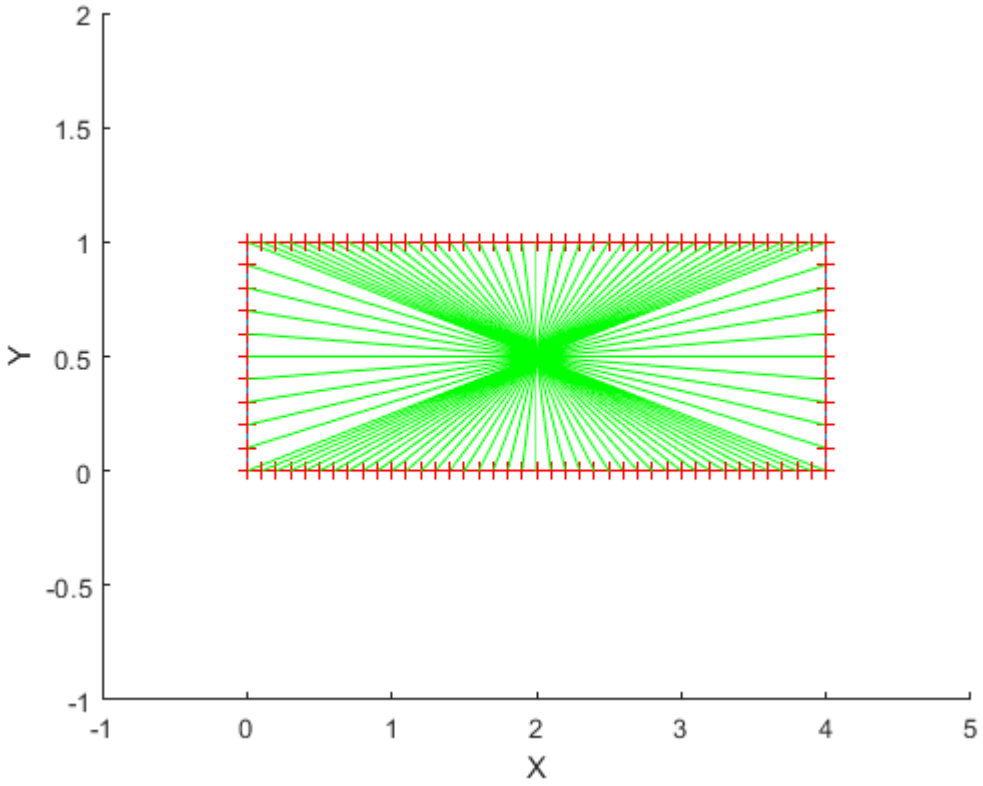
K at which the maximum value of correlation between the two inputs occurs: 60

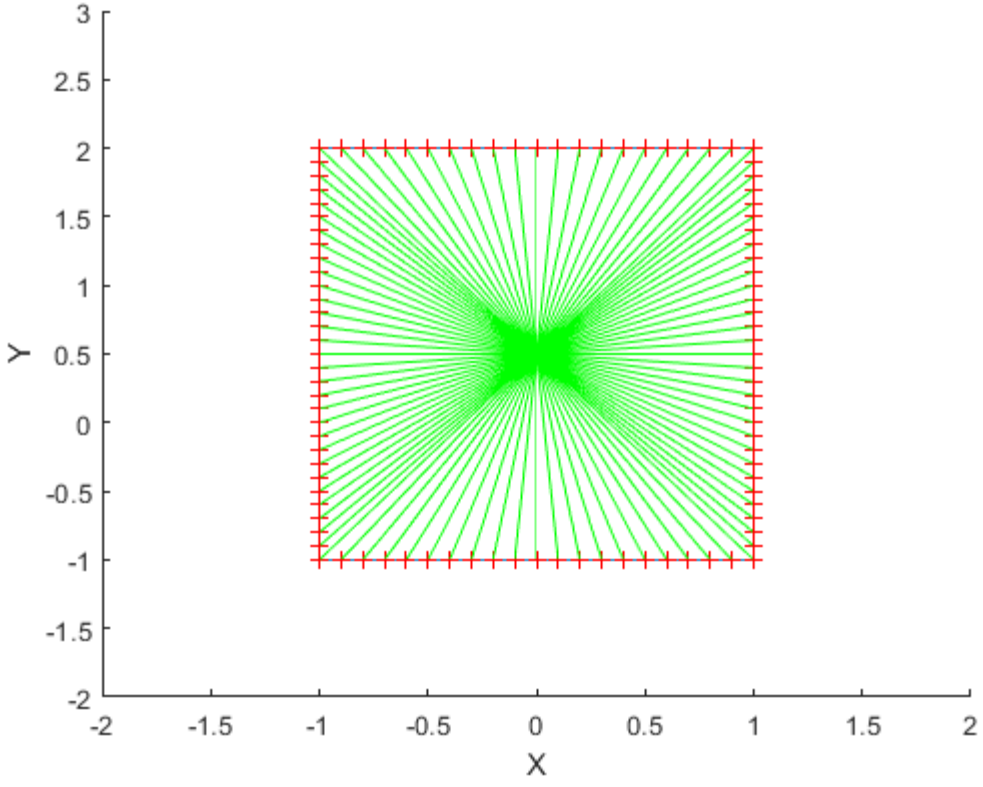
Min Correlation Coeff Fig 3 and 4: -0.5815

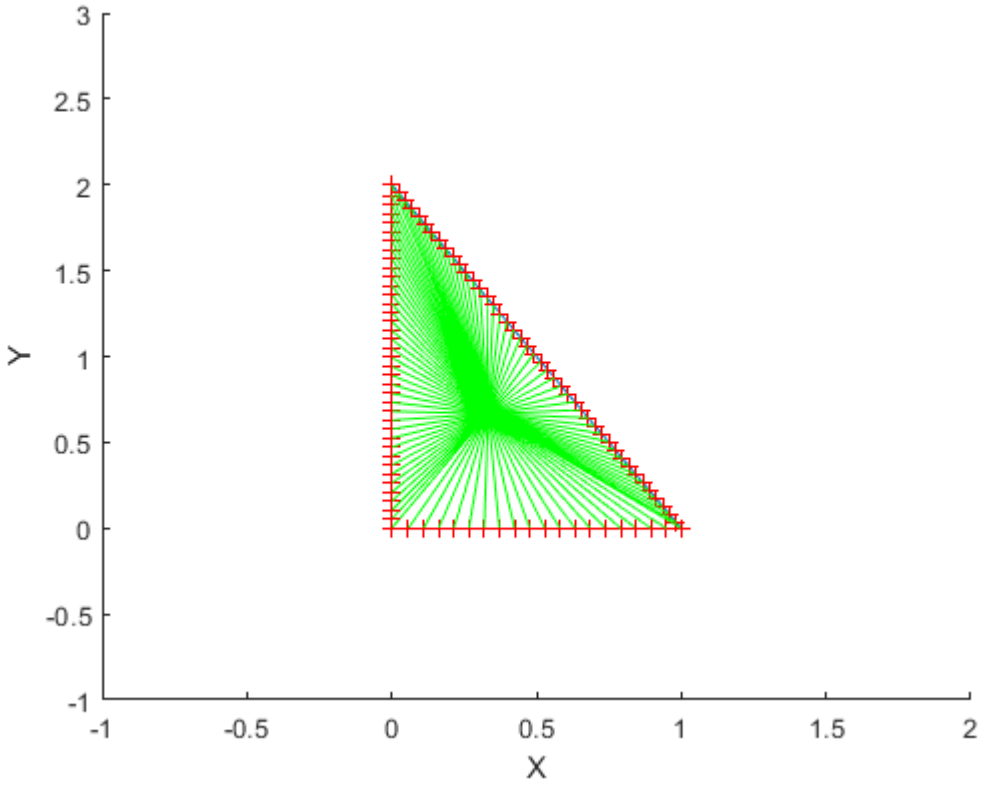
K at which the maximum value of correlation between the two inputs occurs: 60

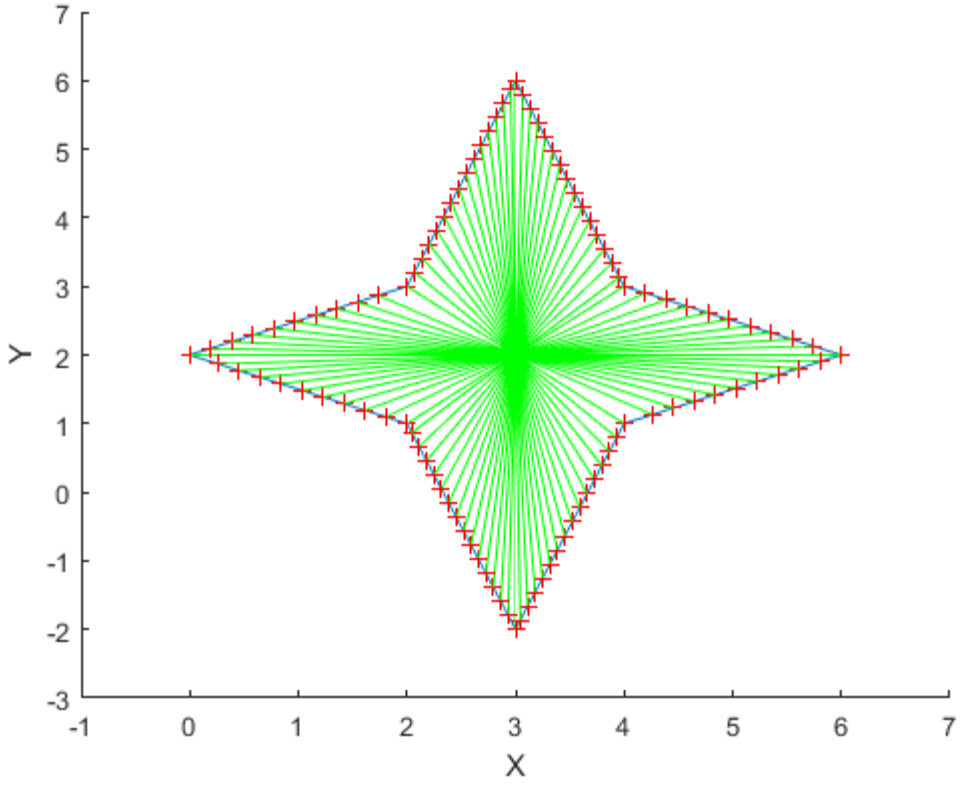
Max Correlation at Figure 1 and 2 with correlation of 0.84

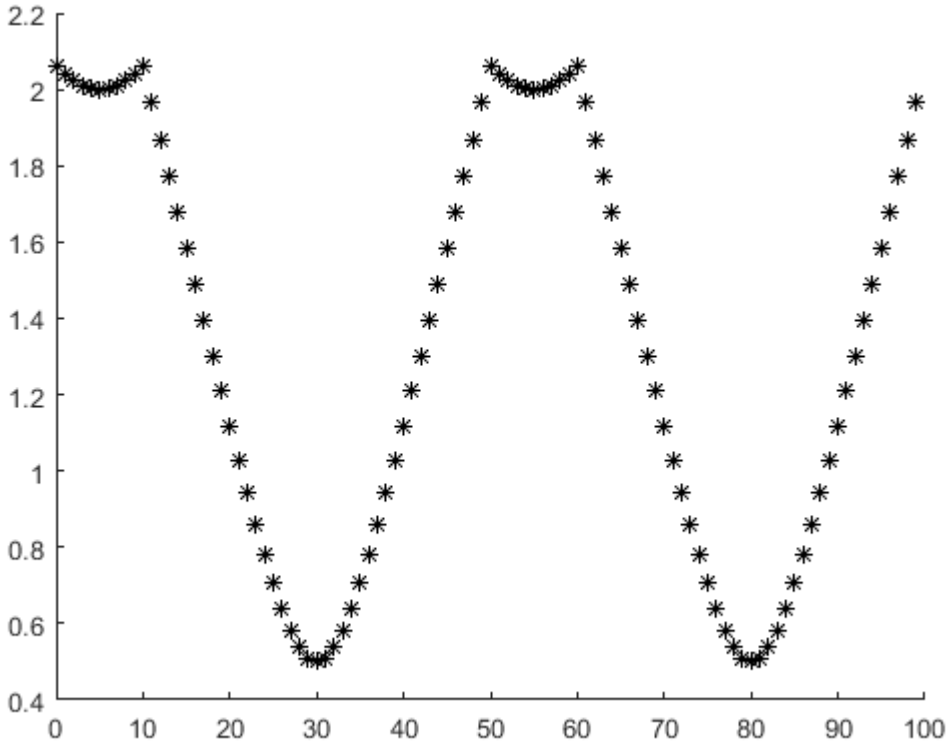
Min Correlation at Figure 2 and 4 with correlation of -0.92

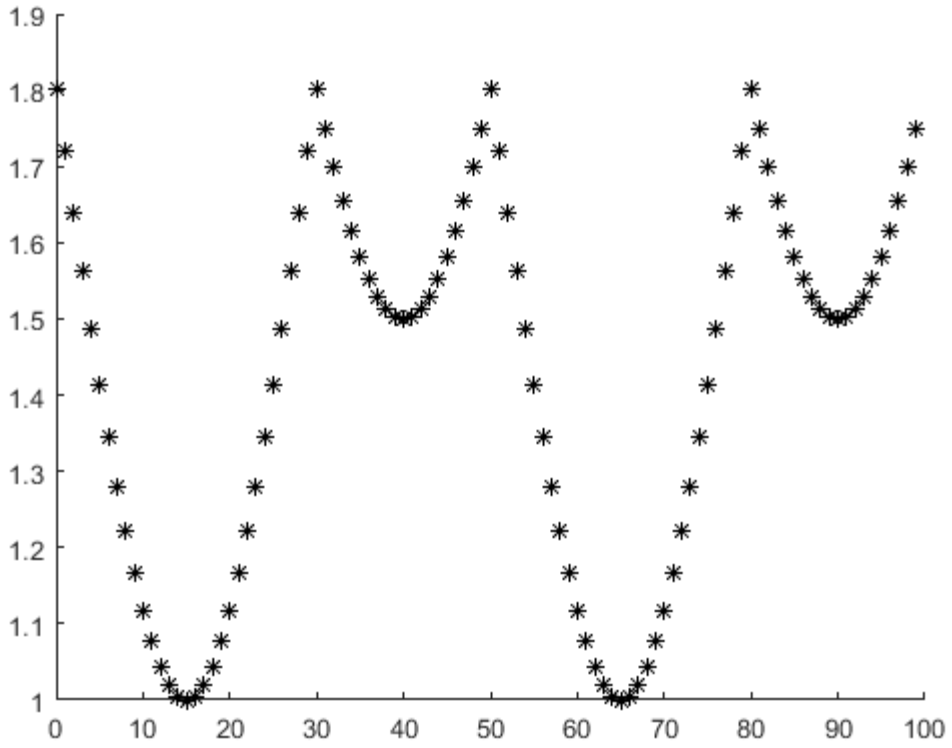

2
1.5
1
0.5
0
-0.5
-1
Y
-1
0
1
2
3
4
5
X

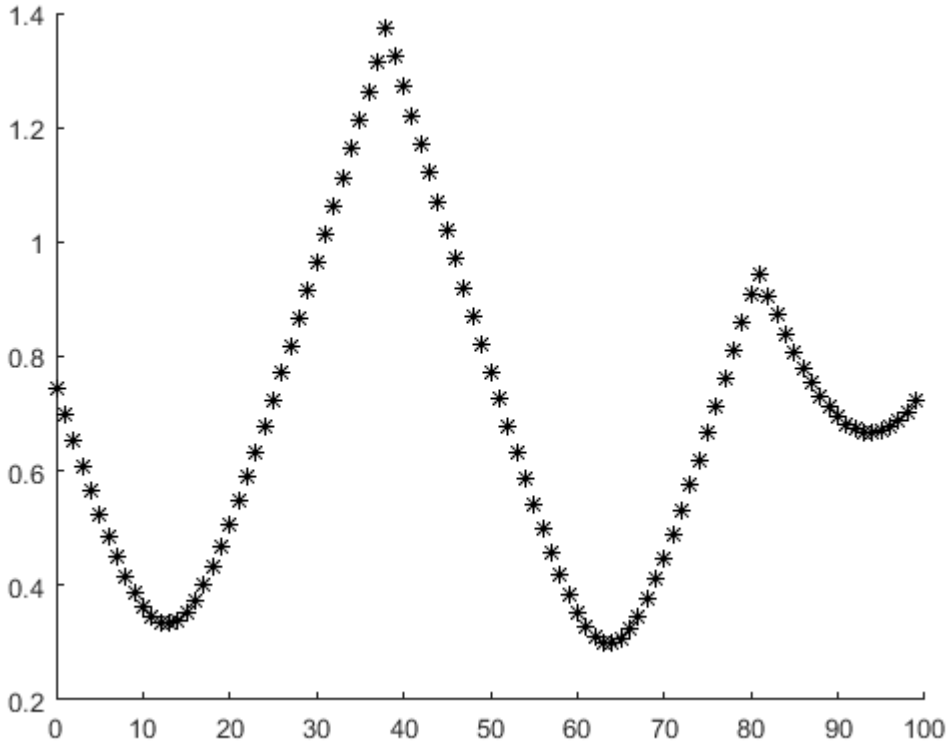

3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Y
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
X

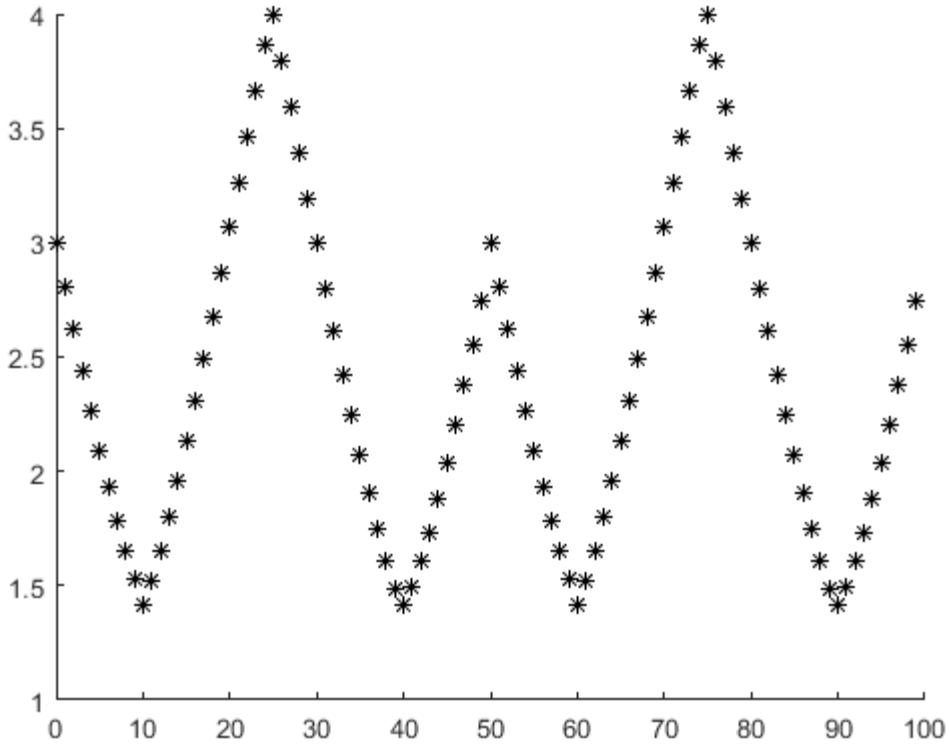

3
2.5
2
1.5
1
0.5
0
-0.5
-1
Y
-1
-0.5
0
0.5
1
1.5
2
X


7
6
5
4
3
2
1
0
-1
-2
-3
Y
-1
0
1
2
3
4
5
6
7
X


2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0
10
20
30
40
50
60
70
80
90
100


1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0
10
20
30
40
50
60
70
80
90
100


1.4
1.2
1
0.8
0.6
0.4
0.2
0
10
20
30
40
50
60
70
80
90
100


4
3.5
3
2.5
2
1.5
1
0
10
20
30
40
50
60
70
80
90
100