Homework 1

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Problem 1 - Develop a script (and a function) for sine signal identification.

clear all; close all; clc

```
ExpData = xlsread('SineWaveData.xlsx');
x1 = ExpData(:,1);
x2 = ExpData(:,2);
M = 5;
f = 10;
phi = 0;


for i = 1:length(x1)
    for j = 1:length(x2)
        x = [x1(i) x2(j)];
        Error(i,j) = SineQuadraticError(x); % This creates a 13x13
 matrix
        TotalError = diag(Error);% We take advantage that the diagonal
 values of this matrix has matching indices, which corresponds to the
 original matching values we want to calculate together
        TotalError = sum(TotalError); % This is the sum of those
 thirteen entries
    end
end
```

Problem 2 - Create nested for loops which vary x(1) and x(2) within their given ranges with 100 linearly spaced increments:

After discussing the homework problem with my peers I learned that it is better in this case to use the .* command to go element by element instead of trying to use 4 for loops. Old code can be found in the appendix along with function MinimumSineQuadraticError.

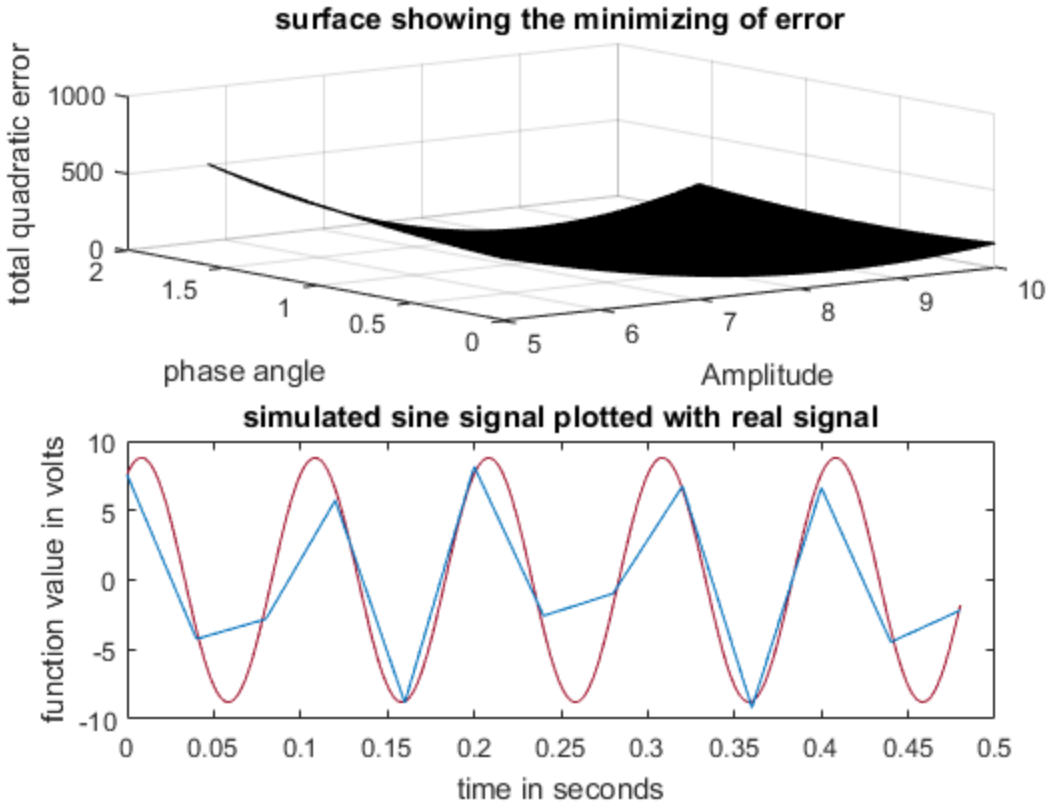
```
ExpData = xlsread('SineWaveData.xlsx');
h1 = ExpData(:,1);
h2 = ExpData(:,2);
f2 = 10;
A = (5:5/99:10);
phi2 = (0:pi/198:pi/2);

for i = 1:length(A)
    for j = 1:length(phi2)
        x = [A(i) phi2(j)];
        AccumulatedError(i,j) = MinErrorFunction(x);
        VectorError = AccumulatedError(:);

    end
end
%
 ------------------------------------------------------------------------
```

Problem 2 Continued: Write a piece of code that finds the minimum value of CumError and corresponding x1 and x2 values (x1_opt and x2_opt).

```
tic
ExpData = xlsread('SineWaveData.xlsx');
h1 = ExpData(:,1);
h2 = ExpData(:,2);
f2 = 10;
A = (5:5/99:10);
phi2 = (0:pi/198:pi/2);
A_opt = 0;
phi_opt = 0;
LowestOutput = 1000;

for i = 1:length(A)
    for j = 1:length(phi2)
        x = [A(i) phi2(j)];
        AccumulatedError(i,j) = MinErrorFunction(x);
         if AccumulatedError(i,j) < LowestOutput
```

```
                A_opt = A(i);
                phi_opt = phi2(j);
                LowestOutput = AccumulatedError(i,j);
            end
           VectorError = AccumulatedError(:);

    end
end
toc
disp(['Estimated amplitude is: ' num2str(A_opt) '[V]'])
disp(['Estimated phase shift is: ' num2str(phi_opt) '[Radians]'])
disp(['Estimated minimum error is: ' num2str(LowestOutput) '[units]'])

figure(1)
subplot(2,1,1)
surf(A,phi2,AccumulatedError)
title('surface showing the minimizing of error')
xlabel('Amplitude')
ylabel('phase angle')
zlabel('total quadratic error')
hold on
t_sim = [0:0.001:(ExpData(end,1))];
y_sim = A_opt*sin(2*pi*10*t_sim + phi_opt);
% y_sim = y_sim(:);
subplot(2,1,2)
plot(t_sim,y_sim)
hold on
plot(h1,h2)
title('simulated sine signal plotted with real signal')
xlabel('time in seconds')
ylabel('function value in volts')
```

```
Elapsed time is 2.543963 seconds.
Estimated amplitude is: 8.7879[V]
Estimated phase shift is: 1.0472[Radians]
Estimated minimum error is: 6.2391[units]
```



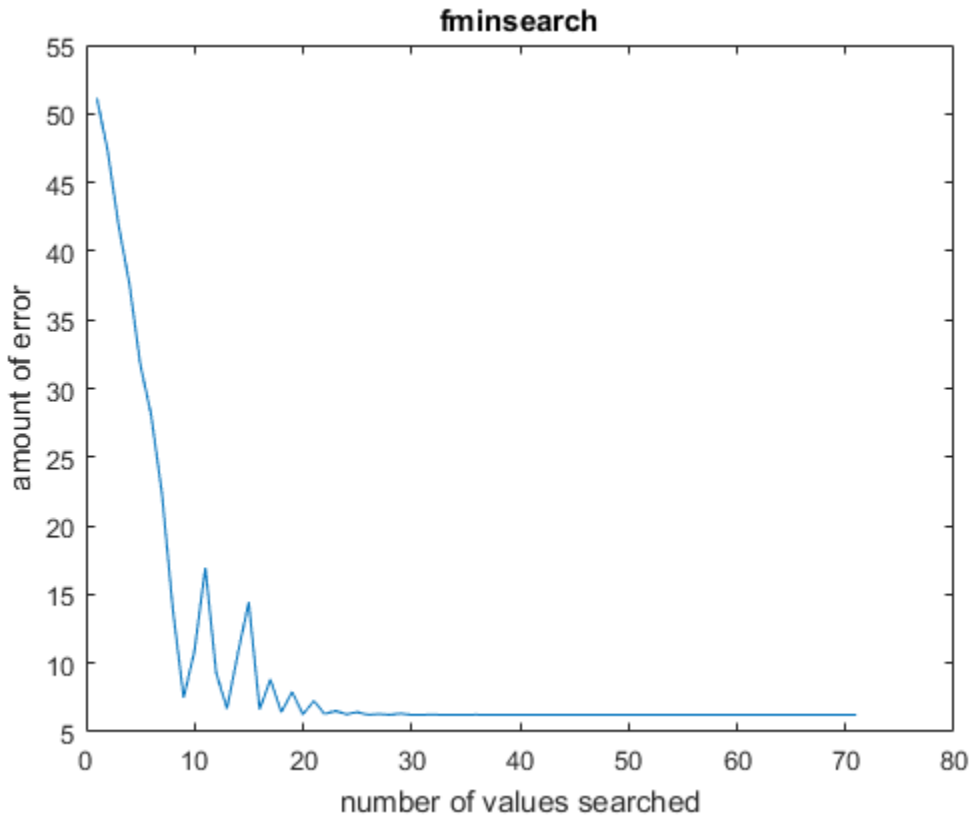
Problem 3 - Using the built in optimization function

```
A_opt2 = 8.7879;
phi_opt2 = phi_opt;
x1_initial = 7.5;
x2_initial = pi/4;


[A_opt2,phi_opt2] = fminsearch('MinErrorFunction',[x1_initial
 x2_initial]);
A_opt2 = A_opt2(end);%before i was using only the variables A_opt and
 phi_opt but for some reason the second num2strng command turned A_opt
 into a 1x2 matrix so my temporary solution was to create A_opt2 and
 let that become concatenated and then take its last value.

disp(['Estimated amplitude is: ' num2str(A_opt2) '[V]'])
disp(['Estimated phase shift is: ' num2str(phi_opt2) '[Radians]'])

Estimated amplitude is: 1.0492[V]
Estimated phase shift is: 6.2368[Radians]
```

Problem 4 -

```
tic
CumErrorTrace = [];
A_opt2 = 8.7879;
phi_opt2 = phi_opt;
x1_initial = 7.5;
x2_initial = pi/4;

[A_opt2,phi_opt2] = fminsearch('MinErrorFunction',[x1_initial
 x2_initial]);
A_opt2 = A_opt2(end);
toc
figure(2); plot(CumErrorTrace);
title('fminsearch')
xlabel('number of values searched')
ylabel('amount of error')
```

Elapsed time is 0.021153 seconds.



Appendix of functions

SineQuadraticError

Function File : Sine Quadratic Error

```
% function Error = SineQuadraticError(x)
%
%     M = evalin('base','M');
%     f = evalin('base','f');
%     phi = evalin('base','phi');
%
%     ym = x(2);
%     yk = M*sin(2*pi*f*(x(1)) + phi);
%     Error = (ym - yk)^2;
% end
```

MinErrorFunction

```
% function  AccumulatedError = MinErrorFunction(x)
% t = evalin ('base','h1');
% Volts = evalin ('base','h2');
% f = evalin('base','f2');
%
% yk = x(1)*sin(t.*2*pi*f + x(2));
% Error = (Volts - yk).^2;
% AccumulatedError = sum(Error);
% CumErrorTrace = evalin('base','CumErrorTrace');
% CumErrorTrace = [CumErrorTrace AccumulatedError];
% assignin('base','CumErrorTrace',CumErrorTrace);
%
% end
```

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