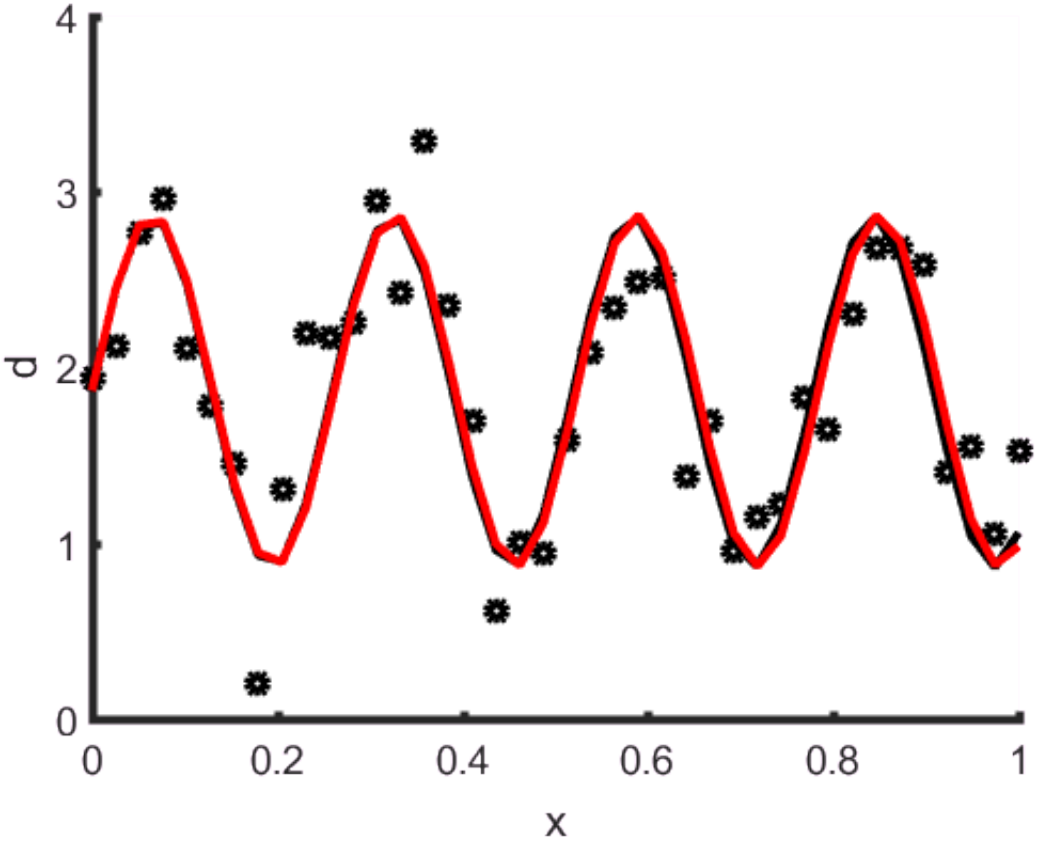
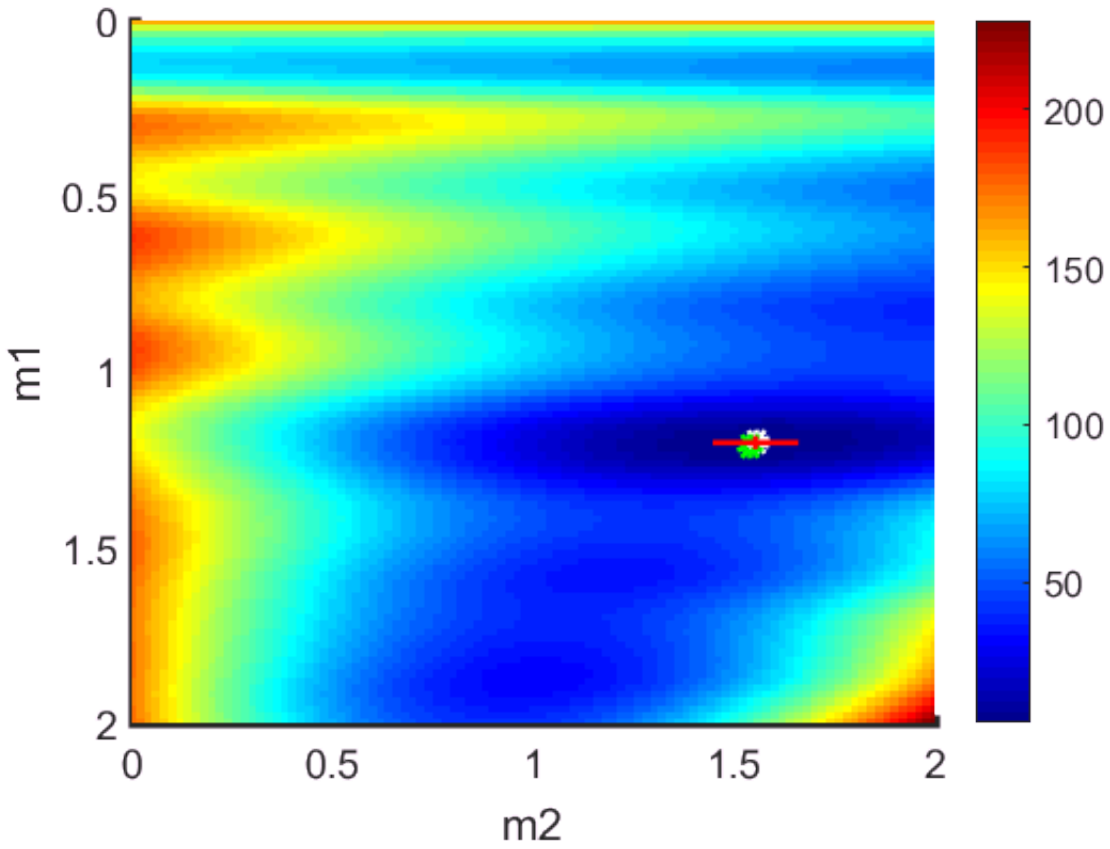
```
% gda09_07
% Grid Search method applied to inverse problem
% d(x)=g(x, m1, m2) with g = sin(w0*m(1)*x) + m(1)*m(2)
% Supports Figure 9.5

clear all;

% data are in a simple auxillary variable, x
N=40;
xmin=0;
xmax=1.0;
Dx=(xmax-xmin)/(N-1);
x = Dx*[0:N-1]';

% two model parameters
M=2;

% true model parameters
mt = [1.21, 1.54]';

% d(x)=g(x, m1, m2) with g = sin(w0*m(1)*x) + m(1)*m(2);
w0=20;
dtrue = sin(w0*mt(1)*x) + mt(1)*mt(2); % true data
sd=0.4;
dobs = dtrue + random('Normal',0,sd,N,1); % observed data

% plot data
figure(1);
clf;
set(gca,'LineWidth',3);
set(gca,'FontSize',14);
hold on;
axis( [0, xmax, 0, 4 ] );
plot(x,dtrue,'k-','LineWidth',3);
plot(x,dobs,'ko','LineWidth',3);
xlabel('x');
ylabel('d');

% Define 2D grid
L = 101;
Dm = 0.02;
m1min=0;
m2min=0;
m1a = m1min+Dm*[0:L-1]';
m2a = m2min+Dm*[0:L-1]';
m1max = m1a(L);
m2max = m2a(L);

% tabulate error E on grid.
% Note m1 varies along rows of E and m2 along columns
E = zeros(L,L);
for j = [1:L]
for k = [1:L]
    dpre = sin(w0*m1a(j)*x) + m1a(j)*m2a(k);
    E(j,k) = (dobs-dpre)'*(dobs-dpre);
end
end

% Example of use of Esurface() function
```

```
% It refines the minimum using a quadratic approximation
% and provides an error estimate using the 2nd derivative
% note that the "column" variable is sent and returned
% before the "row" variable in this function
[ m2est, m1est, E0, cov21, status ] = gda_Esurface( m2a, m1a, E, sd^2 );
sigmam1 = sqrt( cov21(2,2) );
sigmam2 = sqrt( cov21(1,1) );

% evaluate prediction and plot it
dpre = sin(w0*m1est*x) + m1est*m2est;
plot(x,dpre,'r-','LineWidth',3);
```




```
% Figure 9.5  A grid search is used to solve the non-linear curve fitting problem, d(x_i )
% 〖=sin〗#(ω_0 m_1 x_i+m_1 m_2 ).  (A) The true data (black curve) are for m_1=1.21, m_2=1.54.
% The observed data (black circles) have additive noise with variance σ_d^2=(0.4)^2.  The
% predicted data (red curve) are based results of the grid search.

figure(2);
clf;
set(gca,'LineWidth',3);
set(gca,'FontSize',14);
colormap('jet');
hold on;
axis( [m2min, m2max, m1min, m1max] );
axis ij;
imagesc( [m2min, m2max], [m1min, m1max], E);
colorbar;
xlabel('m2');
ylabel('m1');
% plot true and estimate model
plot( m2est, m1est, 'wo', 'LineWidth', 3 );
```

```
plot( mt(2), mt(1), 'go', 'LineWidth', 3 );
% plot error bars
plot( [m2est, m2est]', [m1est-2*sigmam1, m1est+2*sigmam1]', 'r-', 'LineWidth', 2 );
plot( [m2est-2*sigmam2, m2est+2*sigmam2]', [m1est, m1est]', 'r-', 'LineWidth', 2 );
```




```
% Figure 9.5  A grid search is used to solve the non-linear curve fitting problem, d(x_i )
% 〚=sin〛#(ω_0 m_1 x_i+m_1 m_2 ).  (B) Error surface (colors),
% showing true solution (green circle),estimated solution (white circle) and refined estimated
% solution with 95% confidence intervals (red bars).  MatLab script gda09_07.
```