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% gda05_03

% Likelihood surface for mean/variance
% supports Figure 5.3

clear all;

% random data
N = 100;
d = random('Normal',2.5,1.5,N,1);

% m=mean variable
Nm = 51;
mmin = 1.5;
mmax = 5.0;
Dm = (mmax-mmin)/(Nm-1);
m = mmin + Dm*[0:Nm-1]';

% s=sqrt(variance) variable
Ns = 51;
smin = 1;
smax = 2;
Ds = (smax-smin)/(Ns-1);
s = smin + Ds*[0:Ns-1]';

% (m,s) grid
[X,Y]=meshgrid( m, s);

% likelihood surface
L=zeros(Nm,Ns);

% tabulate likelihood surface
% Normal  $P = (1/\sqrt{2\pi}) * (1/s) * \exp(-0.5 (d-m)^2 / s^2)$ 
%  $L = -0.5\log(2\pi) - \log(s) - (-0.5 (d-m)^2 / s^2)$ 
for i=1:Nm
for j=1:Ns
    mp=X(i,j);
    sp=Y(i,j);
    L(i,j) = -N*log(2*pi)/2 - N*log(sp) - 0.5*sum((d-mp).^2)/(sp^2);
end
end

% find (i,j) of point of maximum
[tmp, itmp] = max(L);
[Lmax, Lj] = max(tmp);
Li=itmp(Lj);

% maximum likelihood point
mbest = X(Li,Lj);
sbest = Y(Li,Lj);
disp(sprintf('mean %f sigma %f',mbest,sbest));

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mean 2.690000 sigma 1.420000

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% minimum for plotting purposes
Lmin = min(min(L));

% 3D plot

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figure(1);
clf;
set(gca, 'LineWidth', 3);
set(gca, 'FontSize', 14);
hold on;
pmmmin=mmin;
pmmmax=mmmax;
psmin=smin;
psmax=smax;
pLmin = -500;
pLmax = -100;
axis( [pmmmin, pmmmax, psmin, psmax, pLmin, pLmax]');

% clip parts of grid by setting L to NaN
for i=[1:Nm]
for j=[1:Ns]
    if( L(i,j) < pLmin )
        L(i,j)=NaN(1);
    end
end
end

% draw the mesh
mesh(X,Y,L);

% sides of a 3D box
pxmin=pmmmin+0.01; pxmax=pmmmax-0.01;
pymin=psmin+0.01; pymax=psmax-0.01;
pzmin=pLmin+1; pzmax=pLmax-1;

% improvise 3D box on the plot
plot3( [pxmin,pxmin], [pymin,pymin], [pzmin,pzmax], 'k-', 'LineWidth', 2 );
plot3( [pxmin,pxmin], [pymin,pymax], [pzmin,pzmin], 'k-', 'LineWidth', 2 );
plot3( [pxmin,pxmax], [pymin,pymin], [pzmin,pzmin], 'k-', 'LineWidth', 2 );

plot3( [pxmax,pxmax], [pymax,pymax], [pzmax,pzmin], 'k-', 'LineWidth', 2 );
plot3( [pxmax,pxmax], [pymax,pymin], [pzmax,pzmax], 'k-', 'LineWidth', 2 );
plot3( [pxmax,pxmin], [pymax,pymax], [pzmax,pzmax], 'k-', 'LineWidth', 2 );

plot3( [pxmax,pxmin], [pymin,pymin], [pzmax,pzmax], 'k-', 'LineWidth', 2 );
plot3( [pxmax,pxmax], [pymin,pymin], [pzmax,pzmin], 'k-', 'LineWidth', 2 );

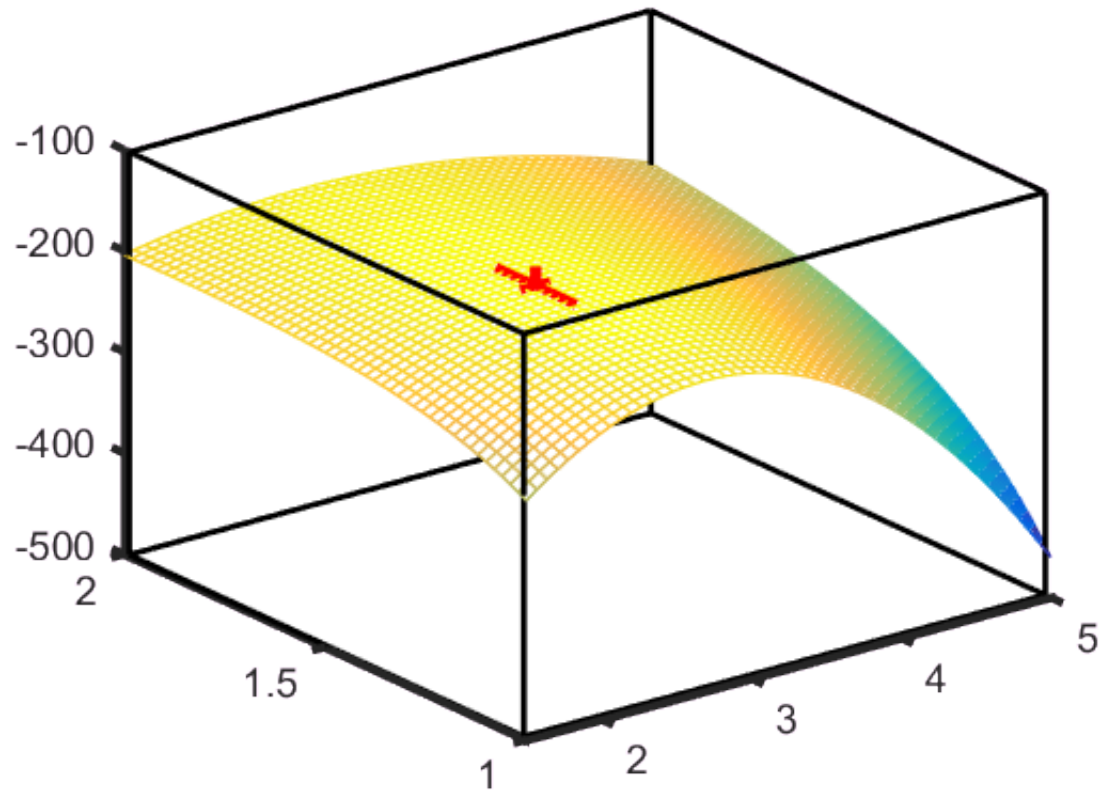
plot3( [pxmin,pxmin], [pymax,pymin], [pzmax,pzmax], 'k-', 'LineWidth', 2 );
plot3( [pxmin,pxmin], [pymax,pymax], [pzmax,pzmin], 'k-', 'LineWidth', 2 );

plot3( [pxmax,pxmax], [pymax,pymin], [pzmin,pzmin], 'k-', 'LineWidth', 2 );
plot3( [pxmax,pxmin], [pymax,pymax], [pzmin,pzmin], 'k-', 'LineWidth', 2 );

DL = (pLmax-pLmin)/20;
plot3( [mbest, mbest], [sbest, sbest], [Lmax-DL, Lmax+DL], 'r-', 'LineWidth', 4 );
plot3( [mbest-0.1, mbest+0.1], [sbest, sbest], [Lmax, Lmax], 'r-', 'LineWidth', 4 );
plot3( [mbest, mbest], [sbest-0.1, sbest+0.1], [Lmax, Lmax], 'r-', 'LineWidth', 4 );

% set view angle
view(3);

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% Figure 5.3 Likelihood surface for 100 realizations of random variables with equal mean $m_1 =$
 % and uniform variance $\sigma^2 = (1.5)^2$. The curvature in the direction of m_1 is greater than the m
 % in the direction of the σ , indicating that the former can be determined to greater certainty