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% gda03_12
%
% two examples of variance
% supports Figure 3.14

clear all;

% auxially variable z
N=101;
zmin=0;
zmax=100;
Dz=(zmax-zmin)/(N-1);
z=zmin+Dz*[0:N-1]';

% number of model parameters = number of model data
M=N;

% true model all ones
mtrue = ones(M,1);

% two different problems
% 1: sum of first K blocks
% 2: sum of pairs of blocks
G1=toeplitz( ones(N,1), [1, zeros(1,N-1)] );
G2=toeplitz( [1, 1, zeros(1, N-2)]', [1, zeros(1,N-1)] );
d1true = G1*mtrue;
d2true = G2*mtrue;
sd=0.1;

% synthetic observed data
dlobs = d1true + random('Normal',0,sd,N,1);
d2obs = d2true + random('Normal',0,sd,N,1);

% least squares solutions
mlest = (G1'*G1)\(G1'*dlobs);
m2est = (G2'*G2)\(G2'*d2obs);

% variances
C1 = (sd^2) * inv(G1'*G1);
sm1 = sqrt(diag(C1));
C2 = (sd^2) * inv(G2'*G2);
sm2 = sqrt(diag(C2));

% plot
figure(1);
clf;

% plot scale
pmmin=-3;
pmmax=3;
psmin=0;
psmax=1;

% plot solutions
subplot(2,1,1);
set(gca,'LineWidth',3);
set(gca,'FontSize',14);
hold on;
axis( [zmin, zmax, pmmin, pmmax ]' );

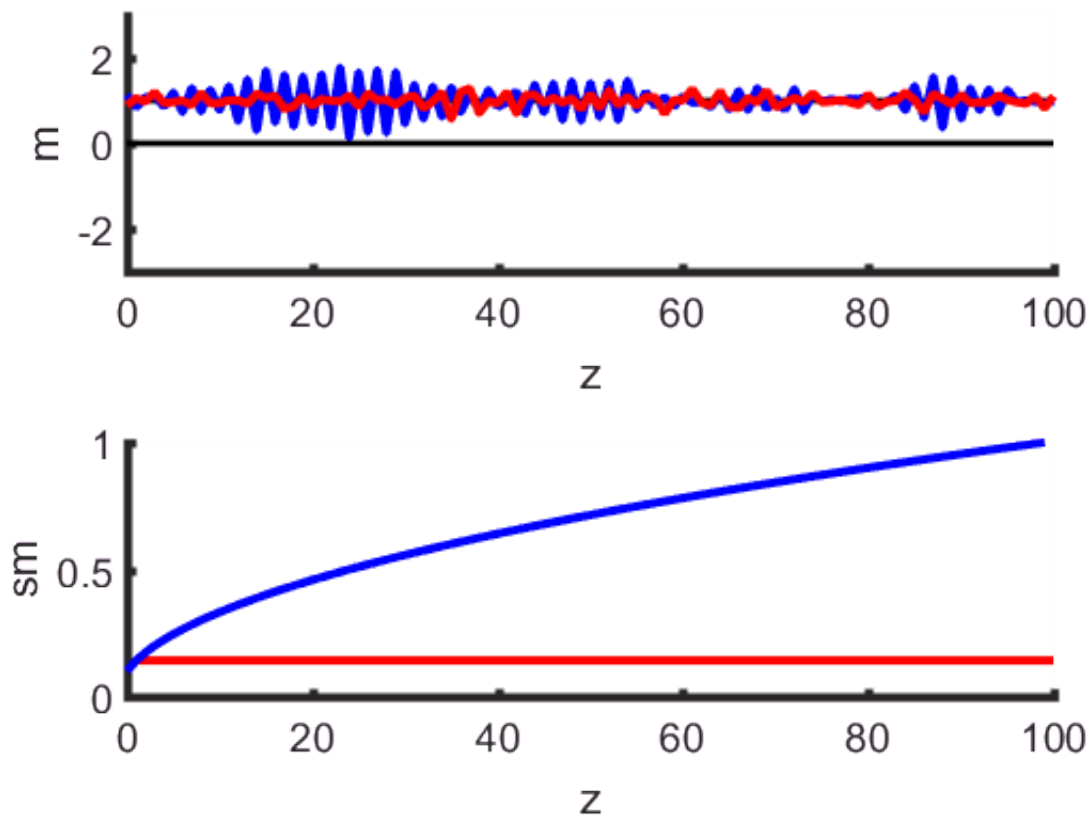
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plot( z, mtrue, 'k-', 'LineWidth', 2 );
ylabel('m');
xlabel('z');
plot( [zmin, zmax ], [0, 0]', 'k-', 'LineWidth', 2 );
plot( z, m2est, 'b-', 'LineWidth', 3 );
plot( z, m1est, 'k-', 'LineWidth', 3 );
plot( z, m1est, 'r-', 'LineWidth', 3 );

% plot sqrt(variance)
subplot(2,1,2);
set(gca, 'LineWidth', 3);
set(gca, 'FontSize', 14);
hold on;
axis( [zmin, zmax, psmin, psmax ]' );
plot( z, sm1, 'r-', 'LineWidth', 3 );
plot( z, sm2, 'b-', 'LineWidth', 3 );
ylabel('sm');
xlabel('z');

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% Figure 3.14 Two hypothetical experiments to measure the weight m_i of each of 100 bricks. In
 % 1 (red), the bricks are accumulated on a scale so that observation d_i is the sum of the weight
 % first i bricks. In experiment 2 (blue), the first brick is weighed, and then subsequently, p
 % bricks (the first and the second, the second and the third, and so forth). (A) Least squares
 % for weights m_i . (B) Corresponding error σm_i . Note that the first experiment has the lower error