**HW2**

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**Code**

% Generate trainning points for 2nd order surrogate model

P = [1200 2000 2800]';

E = [24000 30000 36000]';

trpt = zeros(243,5);

trpt(:,1) = repelem(P,3^4);

for i=5:-1:2

trpt(:,i)=repmat(repelem(E,3^(5-i)),3^(i-1),1);

end

% Build the surrogate model

g = @(P,E1,E2,E3,E4) P.\*(1./E1+1./E2+1./E3+1./E4);

Y = g(trpt(:,1),trpt(:,2),trpt(:,3),trpt(:,4),trpt(:,5));

X = [ones(243,1) trpt trpt(:,1).^2 trpt(:,2).^2 trpt(:,3).^2 trpt(:,4).^2 ...

trpt(:,5).^2 trpt(:,1).\*trpt(:,2) trpt(:,1).\*trpt(:,3) trpt(:,1).\*trpt(:,4)...

trpt(:,1).\*trpt(:,5) trpt(:,2).\*trpt(:,3) trpt(:,2).\*trpt(:,4) trpt(:,2).\*trpt(:,5)...

trpt(:,3).\*trpt(:,4) trpt(:,3).\*trpt(:,5) trpt(:,4).\*trpt(:,5)];

b = (X'\*X)\(X'\*Y);

s = @(P,E1,E2,E3,E4) b(1)+b(2).\*P+b(3).\*E1+b(4).\*E2+b(5).\*E3+b(6).\*E4+...

b(7)\*P.^2+b(8)\*E1.^2+b(9)\*E2.^2+b(10)\*E3.^2+b(11)\*E4.^2+b(12)\*P.\*E1...

+b(13)\*P.\*E2+b(14)\*P.\*E3+b(15)\*P.\*E4+b(16)\*E1.\*E2+b(17)\*E1.\*E3+...

b(18)\*E1.\*E4+b(19)\*E2.\*E3+b(20)\*E2.\*E4+b(21)\*E3.\*E4;

% Monte Carlo simulation

N = 1000;

for i=1:N

E\_MC = KLexpansion(30000,3000);

P\_MC = randn(1)\*400+2000;

Ori(i) = g(P\_MC, E\_MC(1),E\_MC(2),E\_MC(3),E\_MC(4));

PCE(i) = s(P\_MC, E\_MC(1),E\_MC(2),E\_MC(3),E\_MC(4));

end

% Plot the distribution of displacement

figure(1)

histogram(Ori,100)

figure(2)

histogram(PCE,100);

% Compare the statistic of original model and surrogate model

Ori\_Mean = mean(Ori);

PCE\_Mean = mean(PCE);

Ori\_std = std(Ori);

PCE\_std = std(PCE);

Ori\_Mean-PCE\_Mean

Ori\_std-PCE\_std

**Results:**

**Original model:**

A picture containing music

Description automatically generated

**Surrogate model:**

A picture containing music

Description automatically generated

Difference of mean value: -5.1401e-05

Difference of std: -8.0253e-04