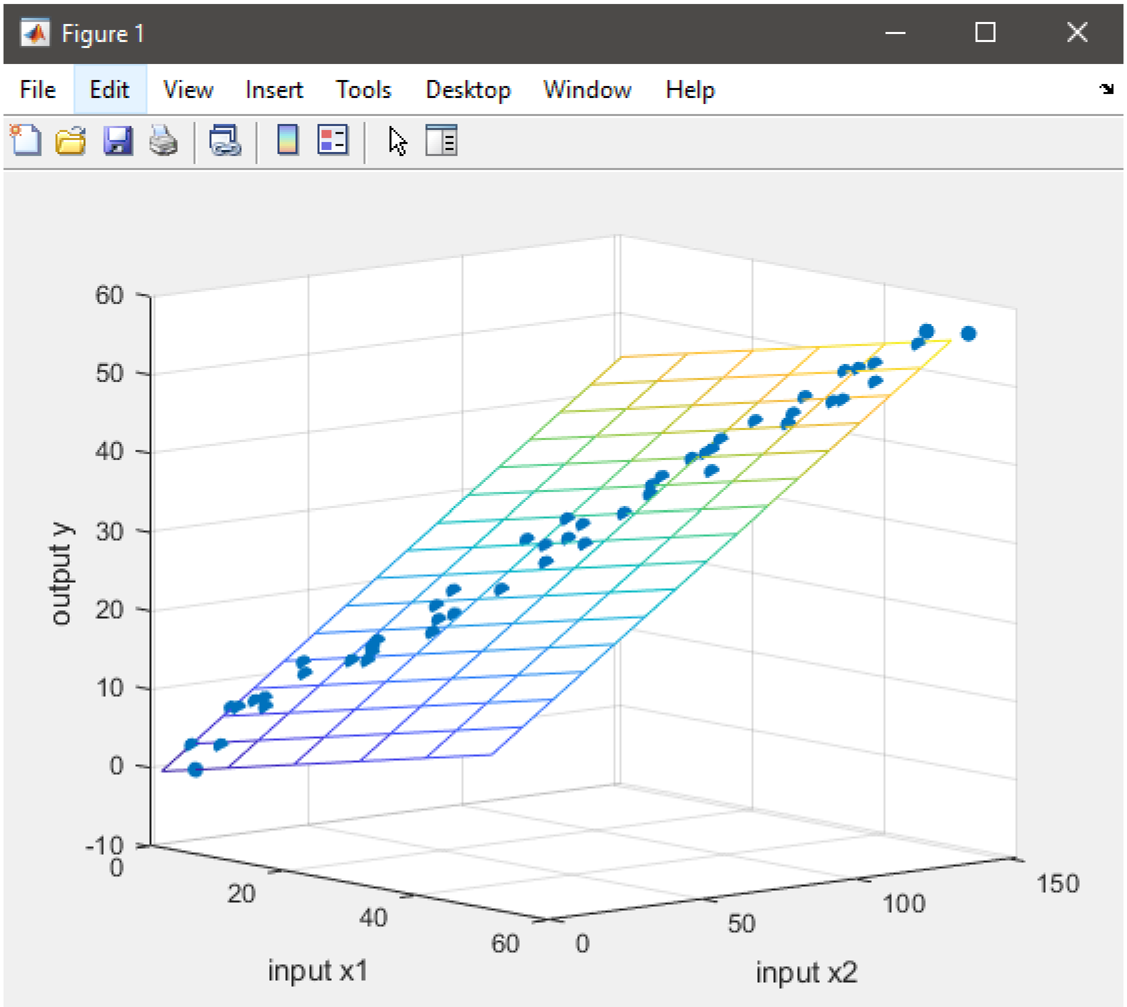
HW5

Due 4/13/2020

1. Given a set of 50 input data and output data, please find the ideal linear regression model! (40%)



Matlab Code:

```
A=xlsread('HW5-1');

%%assumes y= a+b*x1+c*x2

x1=A(:,1);

x2=A(:,2);

y=A(:,3);

X=[ones(size(x1)) x1 x2 x1.*x2];
```

```
b=regress(y,X) %% regress will calculate the coefficients
%%results: a=0, b=0.2, c= 0.3
%%y=0.2*x1+0.3*x2
%%start drawing and ploting the data%%
scatter3(x1,x2,y,'filled')
hold on
x1fit = min(x1):10:max(x1);  %设置 x1 的数据间隔
x2fit = min(x2):10:max(x2);  %设置 x2 的数据间隔
[X1FIT,X2FIT] = meshgrid(x1fit,x2fit); %生成一个二维网格平面
YFIT = b(1) + b(2)*X1FIT + b(3)*X2FIT + b(4)*X1FIT.*X2FIT;  %代入已经求得的参数，拟合函数式
mesh(X1FIT,X2FIT,YFIT) %X1FIT，X2FIT 是网格坐标矩阵，YFIT 是网格点上的高度矩阵
xlabel('input x1')
ylabel('input x2')
zlabel('output y')
view(50,10)
%改变角度观看已存在的三维图，第一个 50 表示方位角，第二个表示俯视角。
%方位角相当于球坐标中的经度，俯视角相当于球坐标中的纬度
hold off
```

ideal linear regression model: y=0.2*x1+0.3*x2

2. Given the Inertial frame and body-fixed frame on a UAV with their axes initially aligned, where their z axes are pointing upward (opposite to the direction of the gravity), please find the attitude trajectory of the UAV (i.e., ${}^{S}_{E}\hat{q}$) given the measurement of the accelerometer of SI unit stored in the excel file. The magnitude of the gravity is 9.8 m/s^2 pointing to -z axis of the inertial frame. (60%)

<u>**Solution**</u>: given a vector error function $f\left({}^{S}_{E}\hat{q},\quad {}^{E}\hat{d},\quad {}^{s}\hat{S}\right) \in \mathbb{R}^3$ defined as

$$f\left({}^{S}_{E}\hat{q},\quad {}^{E}\hat{d},\quad {}^{s}\hat{S}\right) = {}^{S}_{E}\hat{q}^{-1} \otimes {}^{E}\hat{d} \otimes {}^{S}_{E}\hat{q} - {}^{s}\hat{S},$$

$${}^{S}_{E}\boldsymbol{q}_{k+1} = {}^{S}_{E}\hat{\boldsymbol{q}}_k - \mu \frac{\nabla \boldsymbol{f}({}^{S}_{E}\hat{\boldsymbol{q}}_k, {}^{E}\hat{\boldsymbol{d}}, {}^{S}\hat{\boldsymbol{s}})}{\left\| \nabla \boldsymbol{f}({}^{S}_{E}\hat{\boldsymbol{q}}_k, {}^{E}\hat{\boldsymbol{d}}, {}^{S}\hat{\boldsymbol{s}}) \right\|}, \quad k = 0, 1, 2 \ldots n$$

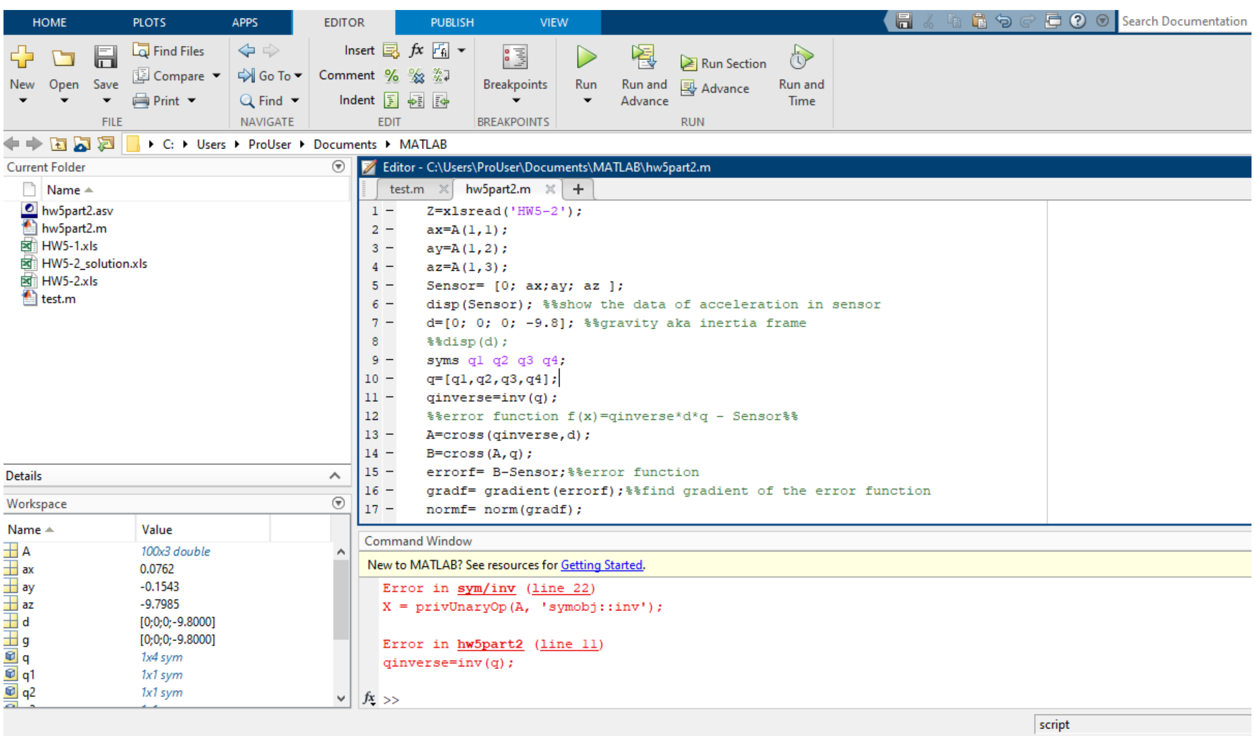
$$\nabla \boldsymbol{f}({}^{S}_{E}\hat{\boldsymbol{q}}_k, {}^{E}\hat{\boldsymbol{d}}, {}^{S}\hat{\boldsymbol{s}}) = \boldsymbol{J}^T({}^{S}_{E}\hat{\boldsymbol{q}}_k, {}^{E}\hat{\boldsymbol{d}}) \boldsymbol{f}({}^{S}_{E}\hat{\boldsymbol{q}}_k, {}^{E}\hat{\boldsymbol{d}}, {}^{S}\hat{\boldsymbol{s}})$$

$${}^{E}\hat{d} = [0 \quad 0 \quad 0 \quad -9.8]^T$$

$${}^{S}_{E}\hat{q} = [q_1 \quad q_2 \quad q_3 \quad q_4]^T$$

$${}^{s}\hat{S} = [0 \quad a_x \quad a_y \quad a_z]^T$$

$$f\left({}^{S}_{E}\hat{q},\quad {}^{E}\hat{d},\quad {}^{s}\hat{S}\right) = \begin{bmatrix} 2(q_2q_4 - q_1q_3) - a_x \\ 2(q_1q_2 + q_3q_4) - a_y \\ 2\left(\frac{1}{2} - {q_2}^2 - {q_3}^2\right) - a_z \end{bmatrix} \qquad J_g\left({}^{S}_{E}\hat{q}\right) = \begin{bmatrix} -2q_3 & 2q_4 & -2q_1 & 2q_2 \\ 2q_2 & 2q_1 & 2q_4 & 2q_3 \\ 0 & -4q_2 & -4q_3 & 0 \end{bmatrix}$$



Code: （寫到卡著了） 希望助教會上傳解答的程式碼讓我學習xD

```
Z=xlsread('HW5-2');
ax=A(1,1);
ay=A(1,2);
az=A(1,3);
Sensor= [0; ax;ay; az ];
disp(Sensor); %%show the data of acceleration in sensor
d=[0; 0; 0; -9.8]; %%gravity aka inertia frame
%%disp(d);
syms q1 q2 q3 q4;
q=[q1,q2,q3,q4];
qinverse=inv(q);
%%error function f(x)=qinverse*d*q - Sensor%%
A=cross(qinverse,d);
B=cross(A,q);
errorf= B-Sensor;%%error function
gradf= gradient(errorf);%%find gradient of the error function
normf= norm(gradf);
%%set learning rate u=0.5%%
u=0.5;
q=q-u*gradf/normf;
disp(q); %%print q result
%%write data to excel file%%
Y=xlswrite('HW5-2_solution','q','A2');
```