Max Kramer

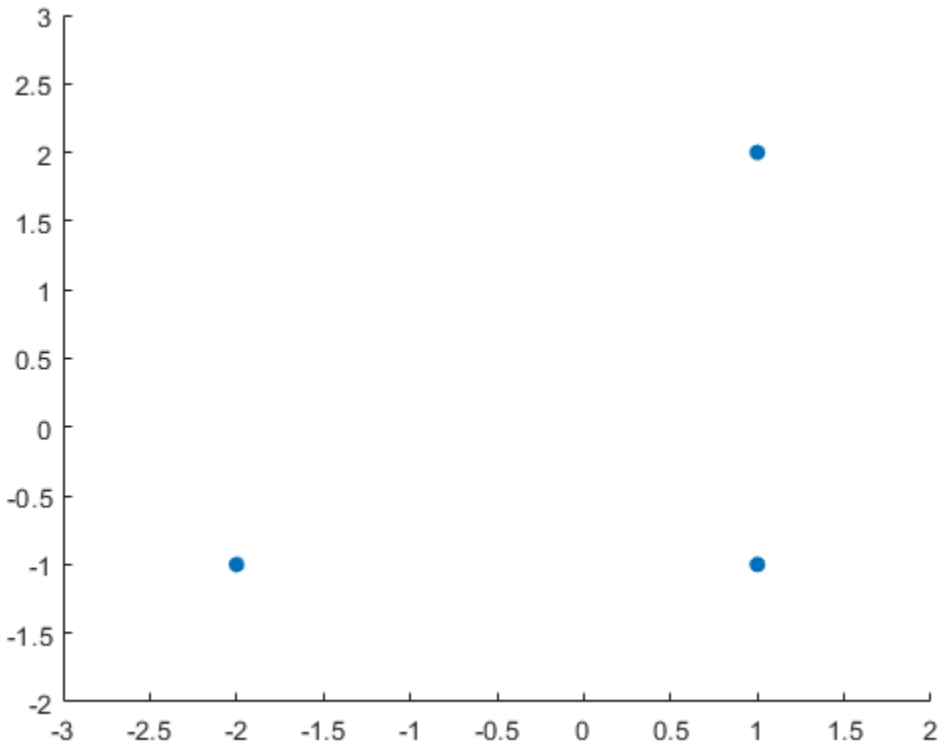
I affirm that I have adhered to the honor code on this assignment

Hello again, scientist! I'll do all my writing in italics, and problems for you will be in ***bold.*** *Comment your code, and* explain your ideas in plaintext. *As a general rule, I expect you to do at least as much writing as I do. Code should be part of your solution, but I expect variables to be clear and explanation to involve complete sentences. Cite your sources; if you work with someone in the class on a problem, that's an extremely important source. Don't work alone.*

Problem F.05: Fit the triangle.

Here's a triangle with center of mass at the origin:

```
T = [-2 -1; 1 -1; 1 2];
figure;
scatter(T(:,1),T(:,2),'filled')
axis([-3 2 -2 3])
```

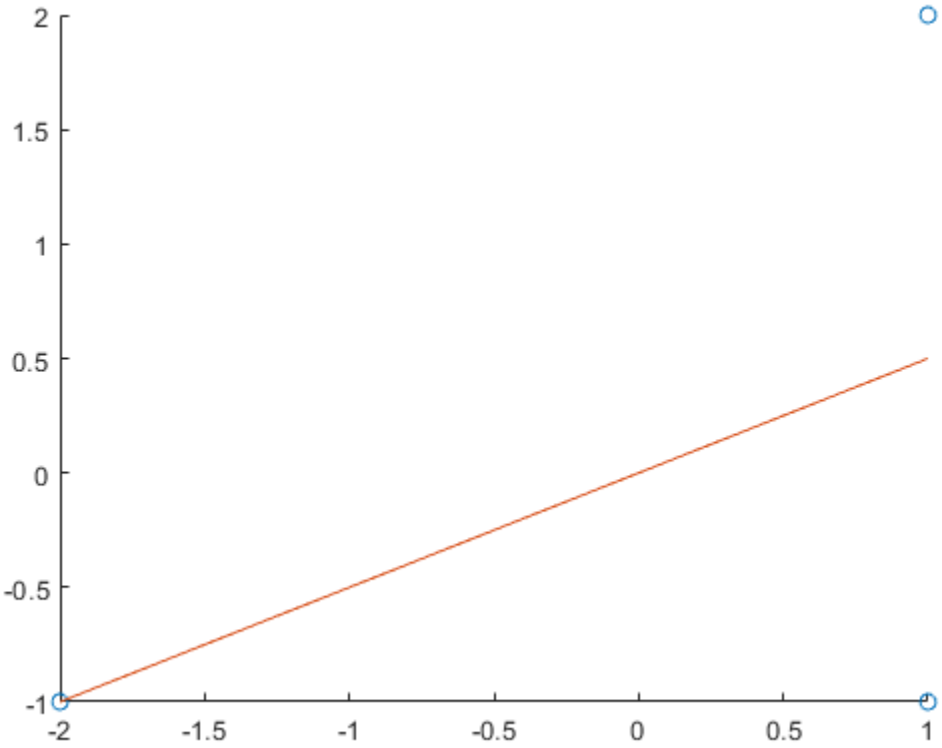


There are three fundamentally different "lines of best fit" to T.

Fit a function of the form y = ax+b to the data T. *What, exactly, does this line of best fit minimize?* ***Explain.***

```
syms x;
functionone = 1;
```

```
functionx = x;

inputs = T(:,1); outputs = T(:,2);
X = [subs(functionone,x,inputs) subs(functionx,x,inputs)];

Xtx = X' * X;
Xty = X' * outputs;

b = Xtx^(-1) * Xty;
f = [1 x]*b;

figure;
scatter(T(:,1),T(:,2))
hold on
fplot(f,[-2 1])
```



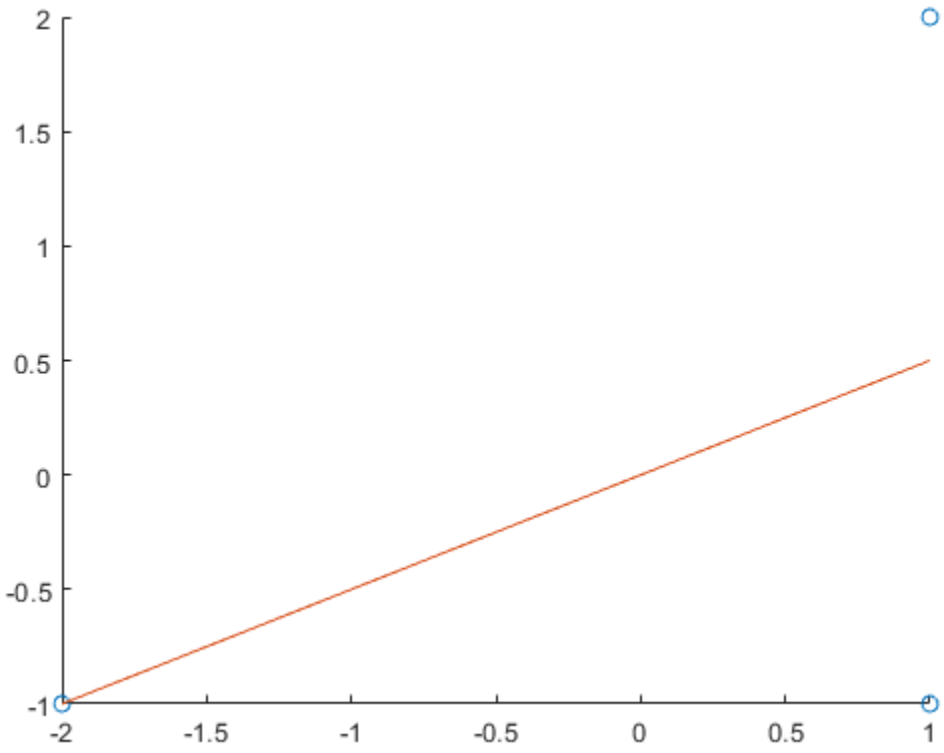
This function minimizes the squared differences between the predicted and observed values of the DEPENDENT variable.

Fit a function of the form x = ay+b to the data T. *Your answer will be different than the previous one! What, exactly, does this line of best fit minimize?* ***Explain.***

```
syms y;
functiony = y;

inputs2 = T(:,2); outputs2 = T(:,1);
Y = [subs(functionone,y,inputs2) subs(functiony,y,inputs2)]
```

```
Yty = Y' * Y;
Ytx = Y' * outputs2;

b2 = Yty^(-1) * Ytx;
f2 = [1 y]*b2;

figure;
scatter(T(:,1),T(:,2))
hold on
fplot(f2, [-2 1])
```

```
Y =

[ 1, -1]
[ 1, -1]
[ 1,  2]
```



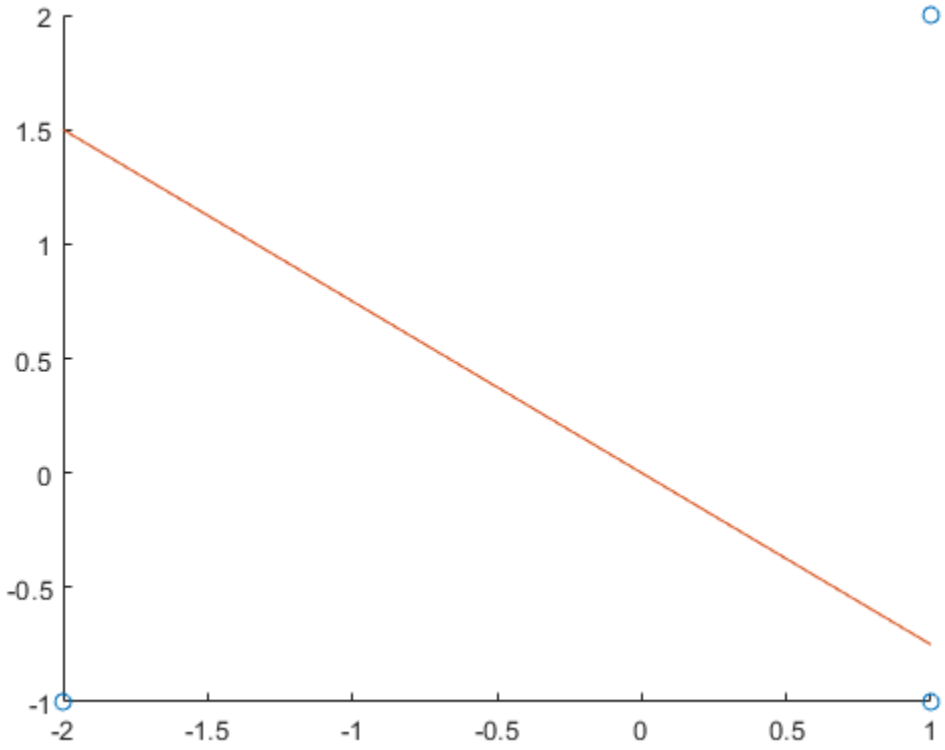
This function minimizes the squared differences between the predicted and observed values of the INDEPENDENT variable.

Use the SVD to project T onto the closest rank-1 matrix. *(That is, find the SVD, set all but the largest singular value to 0, then remultiply.) What, exactly, does this line of best fit minimize?* ***Explain.*** *(This method is called "total least squares" regression; it's also called "Deming regression" in chemistry. With*

the other two methods you're trying to predict an unknown variable in terms of a known one; total least squares is more exploratory.)

```
[U,S,V] = svd(T);
S(2,2) = 0;
T2 = U*S*V;
rank(T2)

inputs3 = T2(:,1); outputs = T2(:,2);
X3 = [subs(functionone,x,inputs) subs(functionx,x,inputs)];

Xtx3 = X3' * X3;
Xty3 = X3' * outputs;

b3 = Xtx3^(-1) * Xty3;
f3 = [1 x]*b3;

figure;
scatter(T(:,1),T(:,2))
hold on
fplot(f3,[-2 1])
```

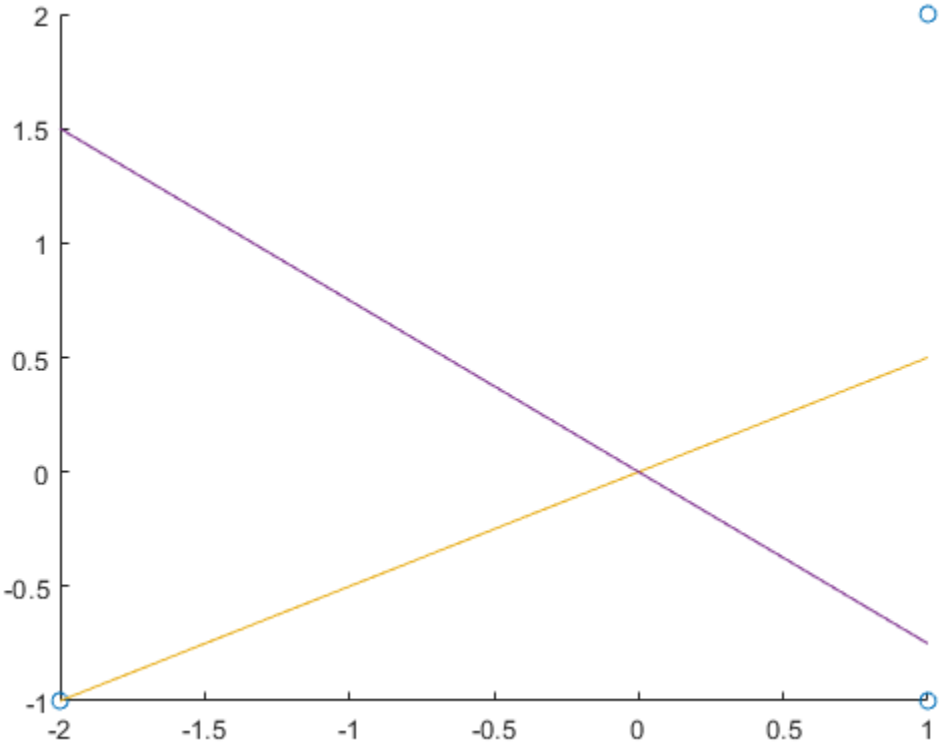
```
ans =

     1
```



This function minimizes the squared differences between the predicted and observed values of the BOTH THE INDEPENDENT AND DEPENDENT variables.

Plot T, and your three lines of best fit, on the same axes.

```
figure;
scatter(T(:,1),T(:,2))
hold on
fplot(f,[-2 1])
fplot(f2, [-2 1])
fplot(f3, [-2 1])
```



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