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4. Computing and least squares

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Recitation due Sep 13, 2021 20:30 IST Completed



Explore

You will notice that we are giving you very small data sets on which to compute least squares approximation so that you can do these computations by hand (i.e. with the aid of a simple calculator). However, you are completing this course on a computer. And computers can help with these computations!

There are three pieces involved in solving a least squares problem:

- 1. Identifying the type of fitting (linear, power law, etc.)
- 2. Performing some algebraic operations on the data to obtain the coefficients of a system of equations
- 3. Solving the system of equations

Steps 2 and 3 can both be assisted by a computer!

How to do least squares interpolation with a personal computer

Here are two methods (that work in 2021) for doing least squares interpolation with a personal computer:

1. Use a spreadsheet program (e.g. Google Sheets)

As of 2021, Google Sheets has a LINEST function. The input is two columns, the *y*-values and the *x*-values, and the output will be two numbers, the slope (*a*) and the *y*-intercept (*b*). You can see an example in the screenshots below.

B9		fx	=LINEST(C3:C6,B3:B6)	
	A	B	C	
1				
2		X	Y	
3		-2	-1	
4		2	3	
5		0	1	
6		4	2	
7				
8		a (slope)	b (intercept)	
9		=LINEST(C3:C6,B3:B6)		
10				

B10		fx		
	A	B	C	
1				
2		X	Y	
3			-2	-1
4			2	3
5			0	1
6			4	2
7				
8		a (slope)	b (intercept)	
9		0.55	0.7	
10				

If you want to transform the data, say taking *ln* of the *x*-values, then you can make a new column and use the LN function to convert the data. Then use this new column as the input to LINEST.

2. Use a programming language (e.g. Python)

There are many Python packages that implement least-squares interpolation. Perhaps the simplest is the `scipy.stats.linregress` method. The input to `scipy.stats.linregress` is two lists of equal length, the *x*-values and the *y*-values, and the output is an object containing the slope and intercept as member variables (together with some other statistics).

```
Python 3.7.3 (default, Apr 24 2020, 18:51:23)
Type 'copyright', 'credits' or 'license' for more information
IPython 7.16.1 -- An enhanced Interactive Python. Type '?' for help.

[In [1]: X = [-2,2,0,4]

[In [2]: Y = [-1,3,1,2]

[In [3]: import scipy.stats

[In [4]: BestLine = scipy.stats.linregress(X,Y)

[In [5]: BestLine.slope
Out[5]: 0.55

[In [6]: BestLine.intercept
```

Calculator

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If you want to transform the data, you can create a new list to input to `scipy.stats.linregress`.

```
Python 3.7.3 (default, Apr 24 2020, 18:51:23)
Type 'copyright', 'credits' or 'license' for more information
IPython 7.16.1 -- An enhanced Interactive Python. Type '?' for help.

[In [1]: X = [0.389,0.724,1,1.524,5.2,9.51]

[In [2]: Y = [87.77,224.7,365.25,686.95,4332.62,10759.2]

[In [3]: import math

[In [4]: logX = [math.log(x) for x in X]

[In [5]: logY = [math.log(y) for y in Y]

[In [6]: import scipy.stats

[In [7]: BestLine = scipy.stats.linregress(logX,logY)

[In [8]: BestLine.slope
Out[8]: 1.503135347778292

[In [9]: BestLine.intercept
Out[9]: 5.897898811978948
```

Try it yourself

2/2 points (graded)
Use a computer to find the least-squares line of best fit between the following set of 20 x,y pairs:

You can copy-paste each column into a Google spreadsheet. Or, you can copy and paste each column into a Python script and use something like `dataX = [float(x) for x in X.split("\n")]` to convert it to a list. You might want to look up how to span a string over multiple lines in Python.

X	Y
65.2	-48.2
21.9	53.9
-14.1	86.1
29.6	15.1
2.1	68.3
64.5	-41.7
5.5	80.8
36.7	2.6
43.0	1.8
6.2	73.0
21.6	53.0
-1.7	49.3
-12.1	77.7
22.8	27.7
41.7	9.5
68.3	-37.5
64.2	-30.5
53.0	-37.1
62.8	-28.8
-14.5	67.2

Round to 2 decimal places.

Slope: _____

-1.57

✓ Answer: -1.57

Intercept:

66.68

✓ Answer: 66.68

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You have used 1 of 5 attempts

i Answers are displayed within the problem

4. Computing and least squares

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