Statistics How To

Statistics for the rest of us!

Find a Linear Regression Equation: By Hand or in Excel

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How to Find a Linear Regression Equation: Overview

Regression analysis is used to find equations that fit data. Once we have the regression equation, we can use the model to make predictions. One type of regression analysis is linear analysis. When a **correlation coefficient** shows that data is likely to be able to predict future outcomes and a scatter plot of the data appears to form a straight line, you can use simple linear regression to find a predictive function. If you recall from elementary algebra, the equation for a line is **y = mx + b**. This article shows you how to take data, calculate linear regression, and find the equation **y' = a + bx**. **Note**: If you're taking AP statistics, you may see the equation written as $b_0 + b_1x$, which is the same thing (you're just using the variables $b_0 + b_1$ instead of a + b.

Watch the video or read the steps below to find a linear regression equation by hand. Scroll to the bottom of the page if you would prefer to use Excel:

Find an article

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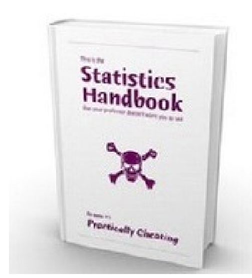


Feel like "cheating" at Statistics? Check out the grade-increasing book that's recommended reading at top universities!

The Linear Regression Equation

Linear regression is a way to model the relationship between two variables. You might also recognize the equation as the **slope formula**. The equation has the form Y=a+bX, where Y is the dependent variable (that's the variable that goes on the Y axis), X is the independent variable (i.e. it is plotted on the X axis), b is the slope of the line and a is the y-intercept.

$$a = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$b = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2}$$

The first step in finding a linear regression equation is to determine if there is a relationship between the two variables. This is often a judgment call for the researcher. You'll also need a list of your data in x-y format (i.e. two columns of data — independent and dependent variables).

Warnings:

1. Just because two variables are related, it does not mean that one *causes* the other. For example, although there is a relationship between high GRE scores and better performance in grad school, it doesn't mean that high GRE scores **cause** good grad school performance.
2. If you attempt to try and find a linear regression equation for a set of data (especially through an automated program like Excel or a TI-83), you *will* find one, but it does not necessarily mean the equation is a good fit for your data. One technique is to make a scatter plot first, to see if the data roughly fits a line *before* you try to find a linear regression equation.

How to Find a Linear Regression Equation: Steps

Step 1: *Make a chart of your data, filling in the columns in the same way as you would fill in the chart if you were finding the Pearson's Correlation Coefficient.*

SUBJECT	AGE X	GLUCOSE LEVEL Y	XY	X^2	Y^2
1	43	99	4257	1849	9801
2	21	65	1365	441	4225
3	25	79	1975	625	6241
4	42	75	3150	1764	5625
5	57	87	4959	3249	7569
6	59	81	4779	3481	6561
Σ	247	486	20485	11409	40022

From the above table, Σx = 247, Σy = 486, Σxy = 20485, Σx2 = 11409, Σy2 = 40022. n is the sample size (6, in our case).

Step 2: Use the following equations to find a and b.

$$a = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$$

$$b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

a = **65.1416**
b = **.385225**

Click here if you want easy, step-by-step instructions for solving this formula.

Find a:

> ((486 × 11,409) – ((247 × 20,485)) / 6 (11,409) – 247^2)
> 484979 / 7445
> =**65.14**

Find b:

> (6(20,485) – (247 × 486)) / (6 (11409) – 247^2)
> (122,910 – 120,042) / 68,454 – 247^2
> 2,868 / 7,445
> = **.385225**

Step 3: *Insert the values into the equation.*
y' = a + bx
y' = 65.14 + .385225x

That's how to find a linear regression equation by hand!

> *Like the explanation? Check out the Practically Cheating Statistics Handbook, which has hundreds more step-by-step solutions, just like this one!*

* **Note** that this example has a low correlation coefficient, and therefore wouldn't be too good at predicting anything.

Find a Linear Regression Equation in Excel

Watch the video or read the steps below:

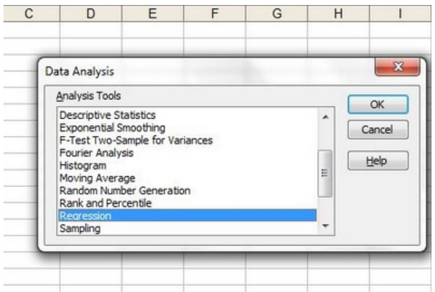
Linear Regression Equation Microsoft Excel: Steps

Step 1: **Install the Data Analysis Toolpak**, if it isn't already installed. For instructions on how to load the Data Analysis Toolpak, click here.

Step 2: **Type your data into two columns in Excel.** For example, type your "x" data into column A and your "y" data into column b. Do not leave any blank cells between your entries.

Step 3: **Click the "Data Analysis" tab** on the Excel toolbar.

Step 4: **Click "regression"** in the pop up window and then click "OK."



The Data Analysis pop up window has many options, including linear regression.

Step 5: **Select your input Y range.** You can do this two ways: either select the data in the worksheet or type the location of your data into the "Input Y Range box." For example, if your Y data is in A2 through A10 then type "A2:A10" into the Input Y Range box.

Step 6: **Select your input X range** by selecting the data in the worksheet or typing the location of your data into the "Input X Range box."

Step 7: **Select the location where you want your output range** to go by selecting a blank area in the worksheet or typing the location of where you want your data to go in the "Output Range" box.

Step 8: **Click "OK".** Excel will calculate the linear regression and populate your worksheet with the results.

Tip: The linear regression equation information is given in the last output set (the coefficients column). The first entry in the "Intercept" row is "a" (the y-intercept) and the first entry in the "X" column is "b" (the slope).

Leverage in Linear Regression

Data points that have leverage have the potential to move a linear regression line. They tend to be outliers. An outlier is a point that is either an extremely high or extremely low value.

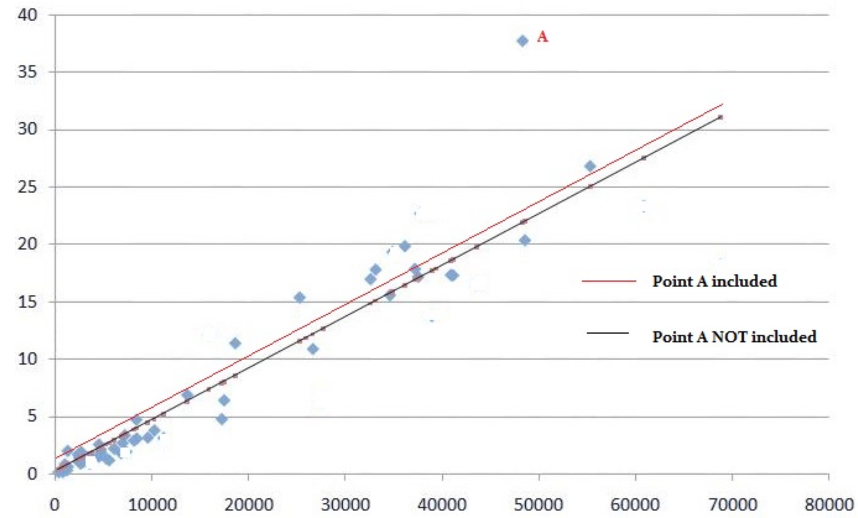
Influential Points

If the parameter estimates (sample standard deviation, variance etc.) change significantly when an outlier is removed, that data point is called an *influential observation*.

The more a data point differs from the mean of the other x-values, the more *leverage* it has. The more leverage a point is, the higher the probability that point will be *influential* (i.e. it could change the parameter estimates).

Leverage in Linear Regression: How it Affects Graphs

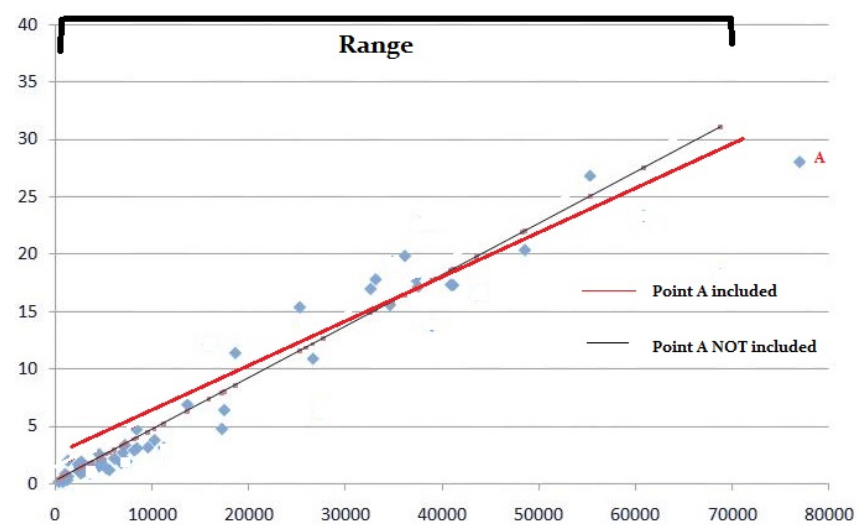
In linear regression, the influential point (outlier) will try to pull the linear regression line toward itself. The graph below shows what happens to a linear regression line when outlier A is included:



Two linear regression lines. The influential point A is included in the upper line but not in the lower line.

Outliers with **extreme X values** (values that aren't within the range of the other data points) have more leverage in linear regression than points with less extreme x values. In other words, **extreme x-value outliers will move the line more** than less extreme values.

The following graph shows a data point outside of the range of the other values. The values range from 0 to about 70,000. This one point has an x-value of about 80,000 which is outside the range. It affects the regression line a lot more than the point in the first image above, which was inside the range of the other values.

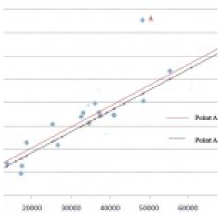


A high-leverage outlier. The point has moved the graph more because it is outside the range of the other values.

In general outliers that have values close to the mean of x will have less leverage that outliers towards the edges of the range. Outliers with values of x outside of the range will have more leverage. Values that are extreme on the y-axis (compared to the other values) will have more influence than values closer to the other y-values.

TI83 Linear Regression

Watch the video or read the steps below:



Two linear regression lines.

TI 83 Linear Regression: Overview

Linear regression is tedious and prone to errors when done by hand, but you can perform linear regression in the time it takes you to input a few variables into a list. **Linear regression** will only give you a reasonable result if your data looks like a line on a scatter plot, so before you find the equation for a **linear regression line** you may want to view the data on a scatter plot first. See this article for how to make a scatter plot on the TI 83.

TI 83 Linear Regression: Steps

Sample problem: Find a linear regression equation (of the form y = ax + b) for x-values of 1, 2, 3, 4, 5 and y-values of 3, 9, 27, 64, and 102.

Step 1: Press STAT, then press ENTER to enter the lists screen. If you already have data in L1 or L2, clear the data: move the cursor onto L1, press CLEAR and then ENTER. Repeat for L2.

Step 2: *Enter your x-variables, one at a time.* Follow each number by pressing the ENTER key. For our list, you would enter:
1 ENTER
2 ENTER
3 ENTER
4 ENTER
5 ENTER

Step 3: Use the arrow keys to scroll across to the next column, L2.

Step 4: Enter your y-variables, one at a time. Follow each number by pressing the enter key. For our list, you would enter:
3 ENTER
9 ENTER
27 ENTER

64 ENTER
102 ENTER

Step 5: Press the STAT button, then use the scroll key to highlight “CALC.”

Step 6: Press 4 to choose “LinReg(ax+b)”. Press ENTER and then ENTER again. The TI 83 will return the variables needed for the equation. Just insert the given variables (a, b) into the equation for linear regression (y=ax+b). For the above data, this is **y = 25.3x – 34.9**.

That’s how to perform TI 83 Linear Regression!

How to Find the Regression Coefficient

A regression coefficient is the same thing as the **slope of the line of the regression equation**. The equation for the regression coefficient that you’ll find on the AP Statistics test is: $B_1 = b_1 = \Sigma\ [(x_i - x)(y_i - y)] / \Sigma\ [(x_i - x)^2]$. “y” in this equation is the mean of y and “x” is the mean of x.

You could find the regression coefficient by hand (as outlined in the section at the top of this page).
However, you won’t have to calculate the regression coefficient by hand in the AP test — you’ll use your TI-83 calculator. Why? Calculating linear regression by hand is very time consuming (allow yourself about 30 minutes to do the calculations and check them) and because of the *huge* number of calculations you have to make you’re very likely to make mathematical errors. When you find a linear regression equation on the TI83, you get the regression coefficient as part of the answer.

Sample problem: Find the regression coefficient for the following set of data:
x: 1, 2, 3, 4, 5.
y: 3, 9, 27, 64, 102.

Step 1: Press STAT, then press ENTER to enter LISTS. You may need to clear data if you already have numbers in L1 or L2. To clear the data: move the cursor onto L1, press CLEAR and then ENTER. Repeat for L2 if you need to.

Step 2: *Enter your x-data into a list.* Press the ENTER key after each entry.
1 ENTER
2 ENTER
3 ENTER
4 ENTER
5 ENTER

Step 3: Scroll across to the next column, L2 using the arrow keys at the top right of the keypad.

Step 4: Enter the y-data:
3 ENTER
9 ENTER
27 ENTER
64 ENTER
102 ENTER

Step 5: Press the STAT button, then scroll to highlight “CALC.” Press ENTER

Step 6: Press 4 to choose “LinReg(ax+b)”. Press ENTER. The TI 83 will return the variables needed for the linear regression equation. The value you’re looking for — the regression coefficient — is b, which is **25.3** for this set of data.

That’s it!

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