

TI-83/83 Plus: Inference for Regression

The following pages contain some instructions on the usage of the TI-83/83 Plus graphing calculator.

The examples used below are taken out of David Moore's text titled "The Basic Practice of Statistics, 2nd Edition".

Example#11.1–11.5 on pages 530–540: Infants who cry easily may be more easily stimulated than others and this may be a sign of higher IQ. Child development researchers explored the relationship between the crying of infants four to ten days old and their later IQ test scores. A snap of a rubber band on the sole of the foot caused the infants to cry. The researchers recorded the crying and measured its intensity by the number of peaks in the most active 20 seconds. They later measured the children's IQ at age three years using the Stanford-Binet IQ test. Table 11.1 on page 530 of the text contains data on 38 infants. The same table is given below.

<u>Crying</u>	<u>IQ</u>	<u>Crying</u>	<u>IQ</u>	<u>Crying</u>	<u>IQ</u>	<u>Crying</u>	<u>IQ</u>
10	87	20	90	17	94	12	94
12	97	16	100	19	103	12	103
9	103	23	103	13	104	14	106
16	106	27	108	18	109	10	109
18	109	15	112	18	112	23	113
15	114	21	114	16	118	9	119
12	119	12	120	19	120	16	124
20	132	15	133	22	135	31	135
16	136	17	141	30	155	22	157
33	159	13	162				

Press **[STAT]**. Press **[ENTER]** to select **1:Edit** from the STAT EDIT menu. Press **[↑]** to move the cursor to the top line where the list names are located and then press **[▶]** until you reach the unnamed column. The cursor is in alpha mode as it is indicated by the highlighted capital A in the upper right hand corner of your display. Type in the name CRYIN short for Crying. Press **[ENTER]** to store the list name. Press **[↓]** to begin entering the data set. Start typing in the numbers from the Crying data set, pressing **[ENTER]** after each data point. When you have finished entering the last Crying data point, your screen should look like the screen on the left given below.

WHITE	YELLO	CRYIN 1A
		10
		23
		9
		16
		31
		22

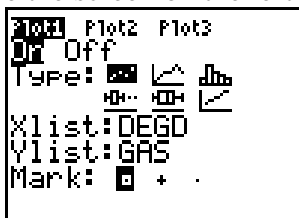
		████████
CRYIN(39) =		

YELLO	CRYIN	IQ 2D
	10	109
	23	113
	9	119
	16	124
	31	135
	22	157
	-----	████████
		████████
IQ(39) =		

To enter the numbers for the IQ data set press **[STAT]**. Press **[ENTER]** to select **1:Edit** from the STAT EDIT menu. Press **[↑]** to move the cursor to the top line where the list names are located and then press **[▶]** until you reach the unnamed column. The cursor is in alpha mode

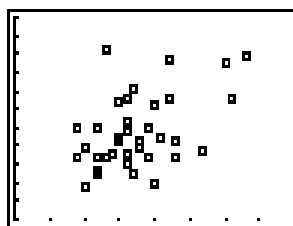
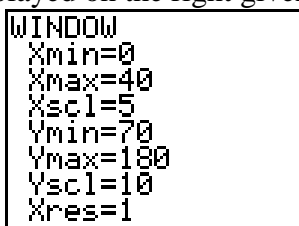
mode as it is indicated by the highlighted capital A in the upper right hand corner of your display. Type in the name IQ. Press **ENTER** to store the list name. Press **▼** to begin entering the data set. Start typing in the numbers from the IQ data set, pressing **ENTER** after each data point. When you have finished entering the last IQ score, your screen should look like the screen on the right given above.

The scatterplot is obtained by using the STAT PLOTS menu. Press **2nd** and **Y=** to access the STAT PLOTS menu. Press **ENTER** to get to the settings screen for **Plot1**. Your screen should look like the screen on the left given below.



While the cursor blinking over the **On** option press **ENTER** to turn on **Plot1**. Press **▼** to scroll down to **Type:**, while the blinking cursor over the first type (scatterplot) press **ENTER** to make the selection. Press **▼** to scroll down to **Xlist:** The list name CRYIN, which had been already stored, must be assigned to **Xlist:** Press **2nd** and **STAT** to access the LIST menu. Press **▼** till you move the cursor by the name CRYIN and press **ENTER** to paste the name by **Xlist:** Press **▼** to scroll down to **Ylist:** The list name IQ, which had been already stored, must be assigned to **Ylist:** Press **2nd** and **STAT** to access the LIST menu. Press **▼** till you move the cursor by the name IQ and press **ENTER** to paste the name by **Ylist:** Your screen should look like the screen on the right given above.

Press **WINDOW** to select the WINDOW menu. The appropriate WINDOW menu settings used for this scatterplot are displayed on the left given below. Press **GRAPH** to see the scatterplot displayed on the right given below.

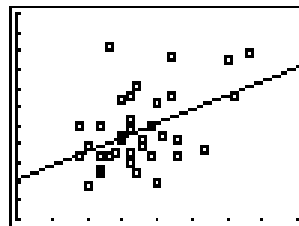


The equation of the Least-Squares Regression line can be obtained by using the STAT menu. Press **STAT** to access the STAT menu. Press **▶** to display the choices for the STAT CALC menu. Press **▼** three times to move the cursor down to **4:LinReg(ax+b)**. Press **ENTER** to select **4:LinReg(ax+b)** from the STAT CALC menu and paste it onto the Home screen. Now the list names CRYIN and IQ need to be pasted, as they are separated by a coma, where the blinking cursor is on the Home screen. To accomplish this, the LIST menu is accessed by pressing **2nd** and **STAT**. Press **▼** till you move the cursor by the name CRYIN and press **ENTER** to paste the list name CRYIN by the **LinReg(ax+b)** command on the Home screen. Press **,**. Press **2nd** and **STAT** to access the LIST menu. Press **▼** till you move the cursor by the name IQ and press **ENTER** to paste the list name IQ by the coma on your screen. Press **,**. To store the LSR equation into the function editor **Y=** as Y_1 , press **VARS**, press **▶** to move the cursor to VARS Y-VARS menu. Press

ENTER to select **1:Function**. Press **ENTER** to select **1:Y₁** from the FUNCTION menu and paste it onto the Home. At this point, your screen should look like the screen on the left below.

```
LinReg(ax+b) LCR
Y1N, LIQ, Y1
```

```
LinReg
y=ax+b
a=1.492896598
b=91.26829865
r²=.2069999897
r=.4549725153
```



Press **ENTER** to have the calculator display the equation of the LSR line along with the correlation coefficient, r , and the coefficient of determination, r^2 . Your screen should look like the screen in the middle given above.

Caution: If your calculator does not display the r and r^2 values, the **DiagnosticOn** command from the CATALOG menu must be executed first.

In order for the graph of the LSR line of this data set to be superimposed over the scatterplot, press **GRAPH**. Your screen should look like the screen on the right given above.

The equation of the LSR line, up to four decimal places, is given as follows: $\hat{y} = 1.4929x + 91.2683$. The slope of the LSR line represents the amount of change in \hat{y} when x increases by one unit. The slope 1.4929 in this example says that, on the average, IQ is about 1.5 points higher for each added crying peak. The correlation coefficient measures the strength and direction of the relationship between two quantitative variables. The correlation coefficient of 0.455 in this example shows a positive, but not a strong linear relationship between crying intensity and IQ scores. Prediction of IQ will not be very accurate. The coefficient of determination, r^2 , is the fraction of the variation in the response variable that is explained by the linear relationship with the explanatory variable. In this example $r^2 = 0.207$, which means only about 21% of the variation in IQ scores is explained by crying intensity.

Once the **LinReg(ax+b)** command is executed, the residuals for this data set is automatically computed and stored under the list name RESID. To see the 38 residuals, access the LIST menu by pressing **2nd** and **STAT**. Press **▼** till you move the cursor by the name RESID and press **ENTER** to paste the list name RESID onto the Home screen. At this point, your screen should look like the screen on the left below.

```
LinReg
y=ax+b
a=1.492896598
b=91.26829865
r²=.2069999897
r=.4549725153
LRESID
```

```
a=1.492896598
b=91.26829865
r²=.2069999897
r=.4549725153
LRESID
(-19.19726463 -...
```

Press **ENTER** to see the values of the 38 residual displayed on your Home screen. At this point, your screen should look like the screen on the right above. Scroll right by pressing **▶** to see the rest of the residual values.

To obtain a basic regression output for the crying study, press **STAT**. Press **▶** two times to scroll right to the TESTS menu option. Press **▼** several times to move the cursor down

to **E:LinRegTTest**. At this point, your screen should look like the screen on the left given below.

```

EDIT CALC TESTS
1:2-SampZInt...
0:2-SampTInt...
A:1-PropZInt...
B:2-PropZInt...
C: $\chi^2$ -Test...
D:2-SampFTest...
E:LinRegTTest...

```

```

LinRegTTest
Xlist:L1
Ylist:L2
Freq:1
 $\beta \neq 0$  &  $p \neq 0$  <0 >0
RegEQ:
Calculate

```

```

LinRegTTest
Xlist:CRYIN
Ylist:IQ
Freq:1
 $\beta \neq 0$  &  $p \neq 0$  <0 >0
RegEQ:Y1
Calculate

```

Press **ENTER** to select **E:LinRegTTest** and go into the STAT TESTS menu screen. At this point, your screen should look like the screen in the middle given above with the cursor blinking by **Xlist**: The list name CRYIN, which had been already stored, must be assigned to **Xlist**: Press **2nd** and **STAT** to access the LIST menu. Press **↓** till you move the cursor by the name CRYIN and press **ENTER** to paste the name by **Xlist**: Press **↓** to scroll down to **Ylist**: The list name IQ, which had been already stored, must be assigned to **Ylist**: Press **2nd** and **STAT** to access the LIST menu. Press **↓** till you move the cursor by the name IQ and press **ENTER** to paste the name by **Ylist**: Press **↓** to move the cursor down to **Freq:**, which is left at the default value of 1. Press **↓** to move the cursor down to **$\beta \neq 0$** : Move the cursor over to the **$\neq 0$** option and press **ENTER** to select that option. Press **↓** to move the cursor down to **RegEQ**: To store the LSR equation into the function editor **Y=** as **Y₁**, press **VARS**, press **→** to move the cursor to VARS Y-VARS menu. Press **ENTER** to select **1:Function**. Press **ENTER** to select **1:Y₁** from the FUNCTION menu and paste it by **RegEQ**: Press **↓** to move the cursor down to **Calculate** option. At this point, your screen should look like the screen on the right given above with the cursor blinking over the **Calculate** option.

Press **ENTER** to select the **Calculate** option. Your calculated result screen should look like the screen on the left given below. Press **↓** several times to see the rest of the items on the calculated result screen. Your screen should look like the screen on the right given below.

```

LinRegTTest
y=a+bx
 $\beta \neq 0$  and  $p \neq 0$ 
t=3.065489379
p=.0041053001
df=36
↓a=91.26829865

```

```

LinRegTTest
y=a+bx
 $\beta \neq 0$  and  $p \neq 0$ 
↑b=1.492896598
s=17.49872122
r2=.2069998897
r=.4549725153

```

The standard error about the line, $s=17.4987$, appears on the calculated result screen on the right given above.

The null hypothesis $H_0: \beta=0$ says that crying has no straight-line relationship with IQ. The scatterplot show that there is a relationship, so it should not come as a surprise that the above calculated result screen displays $t=3.0655$ with two-sided P-value 0.0041. There is very strong evidence that IQ is correlated with crying intensity.