



## hp calculators

HP 49G+ Trend Lines

The STAT menu

Trend Lines

Practice predicting the future using trend lines



## The STAT menu

The Statistics menu is accessed from the RED shifted function of the  $\boxed{5}$  key by pressing  $\boxed{\rightarrow}$   $\boxed{STAT}$ . When pressed, a CHOOSE box is displayed with a number of problem areas within statistics where the HP 49G+ can be applied.



Figure 1

The first choice deals with calculating many values related to the statistics of a single variable, such as the average, standard deviation and others. The second choice deals with placing data within bins or classes and is useful when dealing with frequency distributions or when there is a need to summarize data within a histogram. The third choice, Fit Data.. is what we will use to compute trend lines. The fourth choice allows for the computation of summary statistics from a data set, such as the sum of all X values, the sum of all the Y values squared, and others. The fifth choice allows for the evaluation of many different hypothesis tests and the sixth choice allows for the construction of confidence intervals around a sample mean.

To estimate a trend line, press the  $\boxed{\nabla}$  key until the third choice Fit Data.. is highlighted and press the  $\boxed{F6}$  key to register the choice of  $\boxed{\text{FIT}}$  shown above the  $\boxed{F6}$  key at the right side of the display. The  $\boxed{ENTER}$  key can also be used to make selections from a CHOOSE box and will be used below. Alternatively, since the Fit Data.. choice is the third item in the list, the  $\boxed{3}$  key can be pressed to immediately choose this function.

The screen displayed allows for the entry of the existing data for the solution of trend lines. The  $\Sigma$ DAT field at the top of the screen is where a matrix containing the statistics data is entered.



Figure 2

When the cursor is on this field, press the  $\boxed{FI}$  key at the top left of the keyboard to register the choice of  $\boxed{\text{FIT}}$ . When pressed, the MatrixWriter is started to allow for the entry of the statistical data as shown in the screen below.

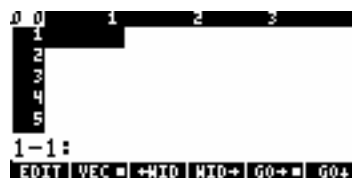


Figure 3

In many ways, this screen works like any spreadsheet. Enter numbers and they will go in the highlighted cell. The menu labels at the lower left corner of the screen,  $\boxed{\text{GOE}}$  and  $\boxed{\text{GOF}}$ , determine the direction the cursor moves after a data point has been entered, either right to the next column or down to the next row. In this example, the selection is to move right after each data point has been entered. This is indicated by the square present next to the  $\boxed{\text{GOE}}$  menu label. To change the way the cursor will move, press the menu label for the direction desired and the square in the menu label will change accordingly. If a column is too small to show the data entered, the  $\boxed{\text{WID}}$  and  $\boxed{\text{WID}}$  menu keys may be used to expand or shrink the area displayed for each column.

Enter the first X data value by keying in the numbers and pressing the  $\boxed{ENTER}$  key. The cursor will move to the right into the second column where the first Y data value should be keyed with the  $\boxed{ENTER}$  key pressed to accept this value. At this point, the cursor will be in column 3. Use the  $\boxed{\nabla}$  and  $\boxed{\leftarrow}$  keys to move back to the first column and enter the second X data value. Since the variable for  $\Sigma$ DAT will hold its contents from one calculation to the next, be alert to extra rows of data that may exist below the last row entered

for the current calculation. Any rows not needed can be deleted if the cursor is on the row to be deleted by pressing the **(NXT)** key and then pressing the **DEL** menu label above the **(F2)** key. Continue entering the pairs of numbers in columns 1 and 2 until all have been entered. Press the **(▲)** key until the cursor is in row 1 and the screen would look something like this:

```

5 2      1
1      1.00      150.00
2      2.00      165.00
3      3.00      160.00
4      4.00      175.00
5      5.00      170.00
1-1: 1.00
EDIT VEC +HID MID- GO- GO+

```

Figure 4

To accept the data as input, press the **(ENTER)** key to return to the previous menu. If an error is noticed, use the **(◀)** **(▲)** **(▼)** **(▶)** cursor keys to move to the cell with the incorrect value. Key in the correct value and press the **(ENTER)** key. Do this until all data values have been corrected and press the **(ENTER)** key again to return to the previous menu. The screen will now look something like this:

```

FIT DATA
EDAT: [[1.,150.] [2.,1...
X-Col: 1 Y-Col: 2
Model: Linear Fit

Enter statistical data
EDIT CH00S PRED CANCEL OK

```

Figure 5

To make predictions using a linear regression model, leave the model choice set to the value of Linear Fit. Other choices include Logarithmic, Exponential, Power and Best fits. To access the prediction screen, press the **(F4)** key to register the choice of **PRED**. The screen displayed will look like this:

```

PREDICT VALUES
EDAT: [[1.,150.] [2.,1...
X-Col: 1 Y-Col: 2
Model: Linear Fit
X:      Y:
Enter indep value or press PRED
EDIT      PRED

```

Figure 6

Move the cursor key down to the X: or Y: data entry locations. You may then enter an X or Y value for which you wish to predict the corresponding X or Y value. To actually predict the corresponding value, press the **PRED** key after entering the X or Y value. You may do this as often as you like by moving the cursor back and forth.

To exit from this data entry screen, press the **(ON)** key to return to the previous data entry screen. From this location, you can either press the **(ON)** key again to quit the STAT screen or press **QUIT** shown above the **(F6)** to exit the STAT screen but with the extra feature of copying to the screen information about the linear regression line that was used. Three items will be shown on the screen. The top level indicates the equation of the linear regression-determined line. The second level indicates the correlation of the line. The bottom level indicates the covariance of the line. The correlation will always be between  $-1$  and  $+1$ , where values closer to  $-1$  and  $+1$  indicating a good "fit" of the line to the data. Values nearer to zero indicate little to no "fit." Little reliance should be placed upon predictions made where the correlation is not near  $-1$  or  $+1$ . Exactly how far away from these values the correlation can be and the equation still be considered a good predictor is a matter of debate. Once these data items are viewed, pressing **(R) STAT** will return you to the STAT menu where you can reenter the Fit Data.. area if desired.

## Trend Lines

A trend line is actually an equation of a line in the form  $Y = bX + a$ , where  $b$  is the slope of the line and  $a$  is the Y-intercept. Linear regression calculates the equation for this line by minimizing the sum of the squared residuals between the actual data points and the predicted data points using the estimated line's slope and intercept. Once the slope and intercept have been calculated, it is fairly easy to substitute other values for  $X$  and predict a corresponding value for  $Y$ , or to substitute a value for  $Y$  and predict a value for  $X$ . When the  $X$  value is a measure of time (months or years, for example), the equation is specifically referred to as a trend line. These are often used to predict future sales growth given past sales data. Be aware, however, that it is rarely a good idea to use such an

equation to predict too far into the future from the actual data used, since circumstances can change rather quickly. Also be aware that these predictions are linear in nature and make no adjustment for any seasonality that may exist.

### Practice predicting the future using trend lines

**Example 1:** John's store has had sales for the last 5 months of \$150, \$165, \$160, \$175, and \$170. Use a trend line to predict sales for months 6 and 7 and also predict when estimated sales would reach \$200. What is the correlation for the regression line?

**Solution:** The X values will be the months of 1 through 5. The Y values will be the existing sales numbers.

$\rightarrow$  STAT  $\nabla$   $\nabla$  ENTER  $\frac{\square}{\square}$  1 ENTER 1 5 0 ENTER  $\nabla$   $\leftarrow$   $\leftarrow$  2 ENTER 1 6 5 ENTER  
 3 ENTER 1 6 0 ENTER 4 ENTER 1 7 5 ENTER 5 ENTER 1 7 0 ENTER

```

5 2 1 2 3
2 2. 165.
3 3. 160.
4 4. 175.
5 5. 170.
6
6-1:

```

EDIT VEC +MIO MIO+ GO+ GO+

Figure 7

ENTER  $\frac{\square}{\square}$   $\nabla$   $\nabla$   $\nabla$  6 ENTER  $\frac{\square}{\square}$

```

PREDICT VALUES
EDAT: [[1.,150.] [2.,1...
X-Col: 1 Y-Col: 2
Model: Linear Fit
X: 6 Y: 179
Enter dep value or press PRED

```

EDIT PRED

Figure 8

$\leftarrow$  7 ENTER  $\frac{\square}{\square}$

```

PREDICT VALUES
EDAT: [[1.,150.] [2.,1...
X-Col: 1 Y-Col: 2
Model: Linear Fit
X: 7 Y: 184
Enter dep value or press PRED

```

EDIT PRED

Figure 9

2 0 0 ENTER  $\nabla$   $\nabla$   $\nabla$   $\frac{\square}{\square}$

```

PREDICT VALUES
EDAT: [[1.,150.] [2.,1...
X-Col: 1 Y-Col: 2
Model: Linear Fit
X: 10.2 Y: 200
Enter indep value or press PRED

```

EDIT PRED

Figure 10

ON  $\frac{\square}{\square}$

```

RAD XYZ HEX R= 'X' ALG
{HOME}

: 149.+5.*
Correlation: .82199493
Covariance: 12.5

```

EDIT VIEW STACK RCL PURGE CLEAR

Figure 11

**Answer:** Sales in month 6 are predicted to be \$179 and in month 7 \$184. Sales are predicted to reach \$200 between months 10 and 11. The correlation is 0.82, which indicates a fairly strong relationship and predictive ability.

**Example 2:** A store's quarterly sales for the last 2 years have been \$30,000, \$31,200, \$30,500, \$32,400, \$32,200, \$33,100, \$32,600 and \$33,250. Use a trend line to predict sales for the next year and also predict when estimated sales would reach \$38,000. What is the correlation of the linear regression line?

**Solution:** The X values will be the quarters of 1 through 8. The Y values will be the existing sales numbers. Predictions will be made for quarters 9, 10, 11, and 12.

(→) STAT (▼) (▼) ENTER (1) ENTER (3) 0 0 0 0 ENTER (▼) (←) (←) (1) (1) (1) (1) (2) ENTER  
 (3) (1) (2) (0) (0) ENTER (3) ENTER (3) 0 5 0 0 ENTER (4) ENTER (3) (2) (4) (0) (0) ENTER  
 (5) ENTER (3) (2) (2) (0) (0) ENTER (6) ENTER (3) (3) (1) (0) (0) ENTER (7) ENTER  
 (3) (2) (6) (0) (0) ENTER (8) ENTER (3) (3) (2) (5) (0) ENTER



Figure 12

ENTER (1) (1) (1) (1) (2) ENTER (9) ENTER (1) (1) (1) (1) (2)

PREDICT VALUES  
 EDAT: [[1.,30000.] [2. ...  
 X-Col: 1 Y-Col: 2  
 Model: Linear Fit  
 X: 9 Y: 33907.1...  
 Enter dep value or press PRED  
 EDIT PRED

Figure 13

(←) (1) (0) ENTER (1) (1) (1) (1) (2)

PREDICT VALUES  
 EDAT: [[1.,30000.] [2. ...  
 X-Col: 1 Y-Col: 2  
 Model: Linear Fit  
 X: 10 Y: 34351.7...  
 Enter dep value or press PRED  
 EDIT PRED

Figure 14

(←) (1) (1) ENTER (1) (1) (1) (1) (2)

PREDICT VALUES  
 EDAT: [[1.,30000.] [2. ...  
 X-Col: 1 Y-Col: 2  
 Model: Linear Fit  
 X: 11 Y: 34796.4...  
 Enter dep value or press PRED  
 EDIT PRED

Figure 15

(←) (1) (2) ENTER (1) (1) (1) (1) (2)

PREDICT VALUES  
 EDAT: [[1.,30000.] [2. ...  
 X-Col: 1 Y-Col: 2  
 Model: Linear Fit  
 X: 12 Y: 35241.0...  
 Enter dep value or press PRED  
 EDIT PRED

Figure 16

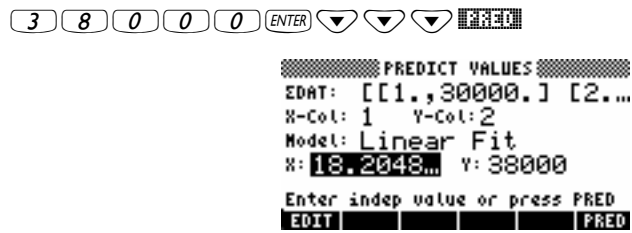


Figure 17

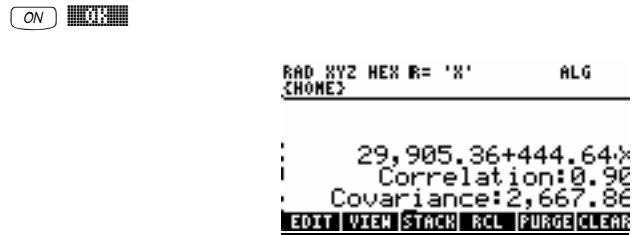


Figure 18

Answer: Sales for quarters 9 through 12 are predicted to be \$33,907, \$34,351, \$34,796 and \$35,241. Sales are predicted to reach \$38,000 between months 18 and 19. The correlation is 0.90, which indicates a fairly strong relationship and predictive ability.