

**Tektronix
4050D05**

**PLOT 50 Statistics:
Nonlinear Estimation**



**Product
Support
Bulletin**

Overview

PLOT 50 Statistics: Nonlinear Estimation is the fourth of a new generation of statistical software products.



Figure 1. The product

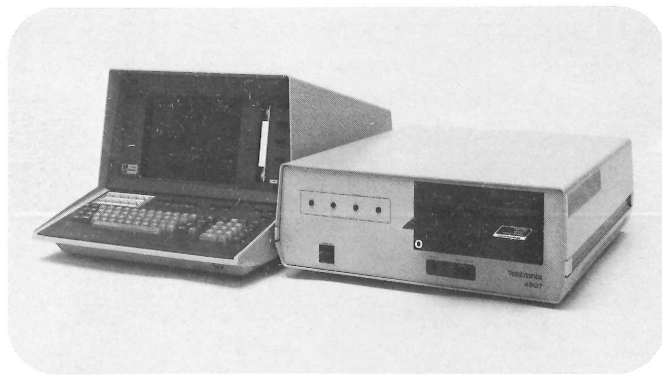


Figure 2. Required equipment

Insert the autoloader tape in any 4050 Series desktop computer tape drive and press the autoloader key. Place the overlay over the system's user-definable keys. Mount the disk in a 4907 File Manager, and you are ready to start.

After the disk is mounted, **PLOT 50 Statistics: Nonlinear Estimation** automatically displays a main menu containing 14 statistical and data handling programs (see Figure 3).

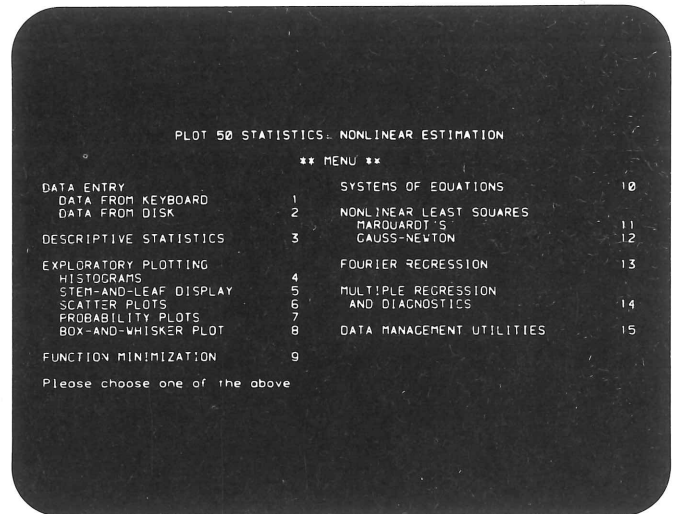


Figure 3. The statistics menu

The Nonlinear Estimation software creates an interactive environment in which a user responds to a system prompts in a specified way. Prompts may require a yes or no answer, allow a user to select an item from a submenu, or may require a word entry.

Most of the PLOT 50 Statistics: Nonlinear Estimation programs start by requesting whatever information they need to do their computations. Some begin by displaying a submenu of routines for you to choose from. Many programs also have options giving you additional statistical routines.

These options are accessed by pressing the **Options** key, which is one of the 18 special function keys featured by the product. The function keys give you greater flexibility over the program execution. The function key names are printed on the overlay (See Figure 4) and described in Section 4 of the users manual.

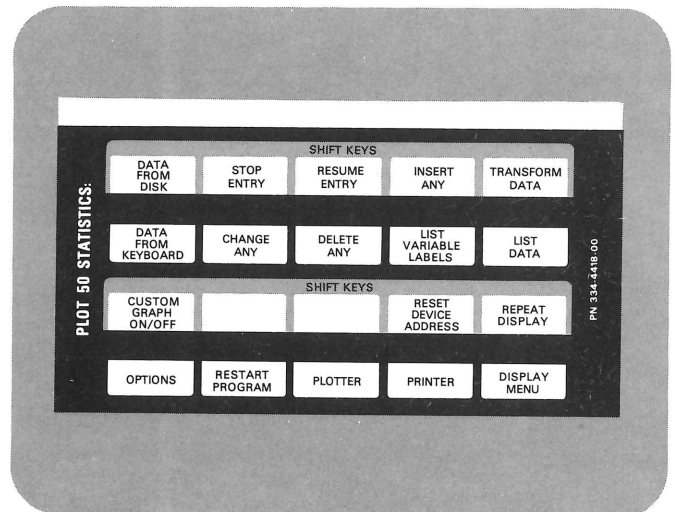


Figure 4. The function key overlay

In addition to statistical routines, Nonlinear Estimation software provides 13 utility programs that allow you to manipulate data files. **Data Management Utilities** (Program 15) lists the Utility menu (See Figure 5) and brings the Utility operating system into memory.

PLOT 50 STATISTICS: NONLINEAR ESTIMATION
DATA MANAGEMENT UTILITIES

1. GET FILE
2. PUT FILE
3. DIRECTORY
4. DUPLICATE DISK
5. DELETE FILE
6. APPEND FILE
7. LIST FILE
8. CHANGE TITLE, CHANGE LABELS
9. COMBINE FILES
10. SORT FILE
11. RENAME FILE
12. TRANSFORM DATA
13. CHANGE DEVICE ADDRESSES AND DISK DRIVE NUMBERS
14. STATISTICS: NONLINEAR ESTIMATION

Please choose one of the above:

Figure 5. The utilities menu

The Statistics Programs

Before doing a Nonlinear Estimation analysis, you must bring a data file into the system's memory by entering data through the keyboard or retrieving a file from the disk.

To enter a file through the keyboard, run **Data From Keyboard** (Program 1). This program begins by asking you questions about how the file is to be labeled. After you specify such things as a file name, title, observation labels, and variable labels, the program allows you to enter data.

Once entered, the data is automatically stored on the disk as a PLOT 50 Standard File. PLOT 50 Standard Files are used to communicate data between various PLOT 50 Standard File compatible products such as PLOT 50 Statistics: Tests and Distributions, Analysis of Variance, Multiple Linear Regression or Presentation Aids I, Business Planning and Analysis Volume 2 and others. This means that you may use PLOT 50 Statistics: Nonlinear Estimation to analyze data generated by another PLOT 50 product or transfer your data to another PLOT 50 product.

To retrieve an existing data file from the disk, run **Data From Disk** (Program 2). Once a file has been identified, you may select a program from the Statistics menu to analyze data and produce statistical tables and graphs.

Run **Descriptive Statistics** to list 11 statistics including central tendency and dispersion statistics. (See Figure 6)

STUDY OF CHLORINE IN PRODUCT A

DESCRIPTIVE STATISTICS

Filename: SMITHDUBEY

Variable 2: CHLORIN - Available Chlorine

TOTAL NUMBER OF OBSERVATIONS	44
NUMBER OF OBSERVATIONS WITH MISSING VALUES	0
NUMBER OF OBSERVATIONS WITH VALID VALUES	44
MEAN	0.425
VARIANCE	9.19E-004
STANDARD DEVIATION	0.030
STANDARD ERROR OF THE MEAN	0.005
COEFFICIENT OF VARIATION	7.131
SKEWNESS	0.659
KURTOSIS	2.363
MINIMUM VALUE	0.380
MAXIMUM VALUE	0.490
RANGE	0.110
MEDIAN	0.415

Figure 6. Descriptive statistics

Run **Histograms** to display frequency and relative frequency histograms (See Figures 7-9). You may specify the number of cells and the cell interval size by pressing the **Custom Graph** function key.

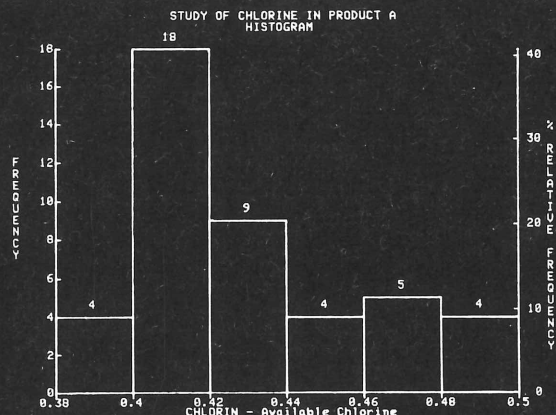


Figure 7. Regular histogram

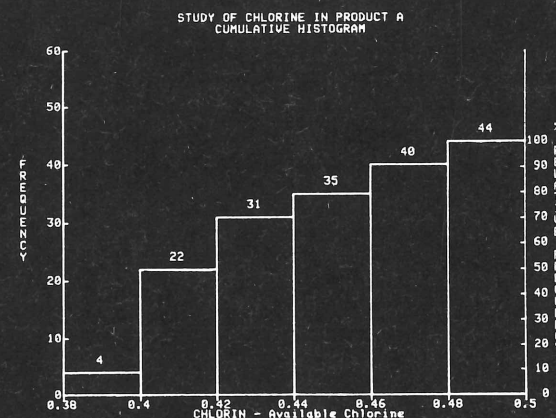


Figure 8. Cumulative histogram

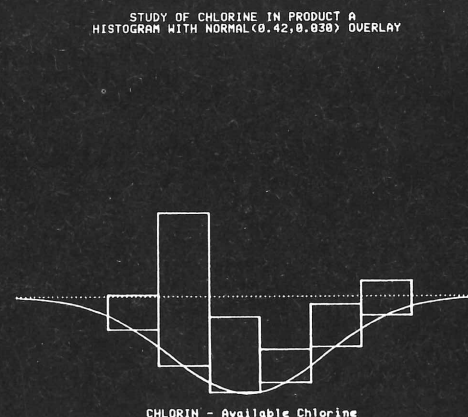


Figure 9. Suspended histogram

In Figure 9, the distance of the cells from the zero line indicates the deviation of the sample distribution from a normal distribution.

Run **Probability Plot** to compare the theoretical distribution (normal or log-normal) to the empirical distribution of the data (See Figure 10).

Run **Stem-and-Leaf** to display the frequency distribution of data and to determine if any values are extremely high or low (See Figure 11). Each data value is split into a stem (its initial digits) and a leaf (the trailing digits).

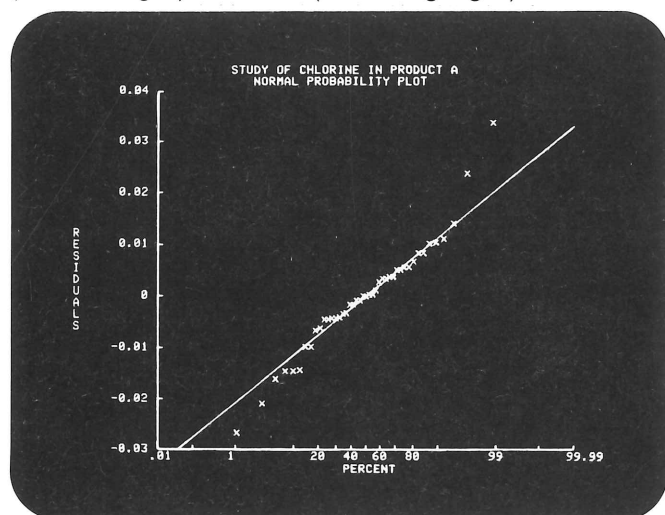


Figure 10. Probability plot

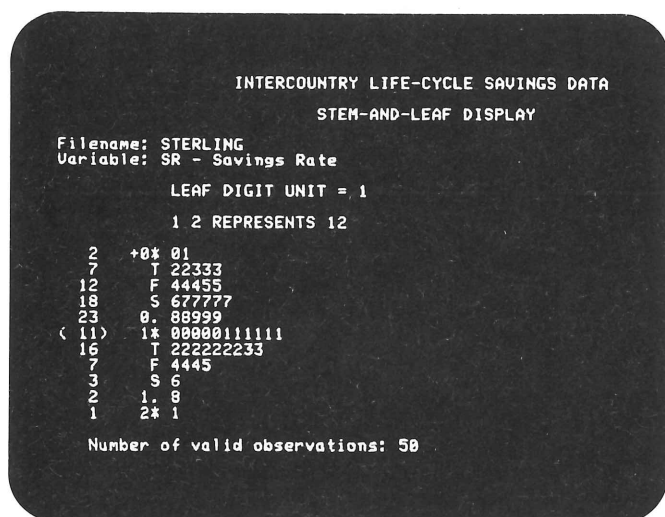


Figure 11. Stem-and-leaf display

Run **Box-and-Whisker Plots** to display boxplots which show how data is distributed and identifies "outliers" (See Figure 12). You may display notched or unnotched boxplots. Notched boxplots are especially useful in comparing two groups because two groups whose notched intervals do not overlap are significantly different at roughly the 5% level.

Run **Scatter Plot** to examine the relationship between two variables (See Figure 13).

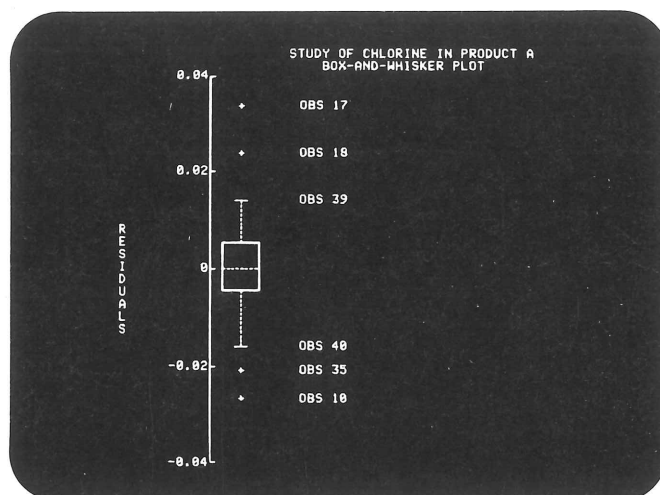


Figure 12. Box-and-whisker plot

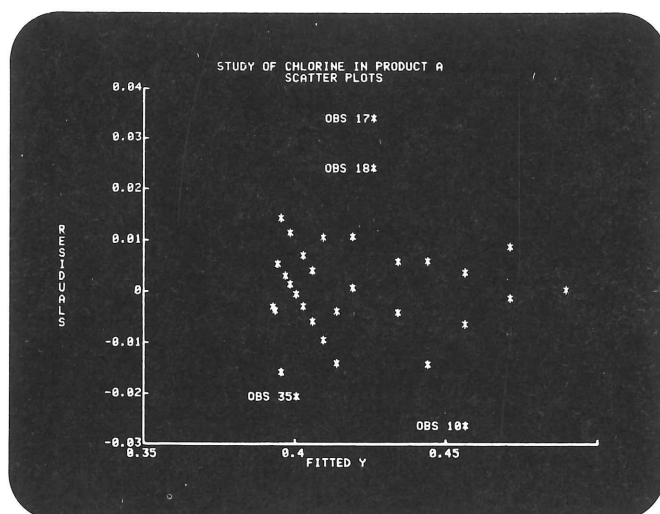


Figure 13. Scatter plot

You may label some or all of the observations in your scatter plot. This allows you to flag critical data points.

The next step in using PLOT 50 Statistics: Nonlinear Estimation is selecting and running one of the six Nonlinear Estimation procedures.

The **Function Minimization** program finds parameter values to minimize a nonlinear function. Many types of problems can be solved using this procedure by formulating the problem as a function to be minimized.

The **Systems of Equations** program solves a system of nonlinear equations.

The **Marquardt's Nonlinear Least Squares** program fits a nonlinear function to the data.

The **Gauss-Newton Nonlinear Least Squares** program also fits a nonlinear function to data. Some of the parameters in the function can be held constant if desired. You must specify the partial derivatives as well as the function.

The **Fourier Regression** program performs a least squares fit or a discrete Fourier series frequency decomposition on data for a Fourier series model or linear trigonometric model (See Figures 14 and 15).

The **Multiple Regression and Diagnostics** program performs a QR decomposition to compute the parameters for a multiple regression model. Residual analysis and extensive regression diagnostics are also available.

All of the regression procedures (Gauss-Newton Non-linear Least Squares, Marquardt's Nonlinear Least Squares, Fourier Regression and Multiple Regression) store the residuals and fitted values in the current file. You may analyze the residuals and fitted values with any of the exploratory plotting programs (See Figure 16, 17, 18, and 19).

The **Data Management Utilities** deletes the Statistics operating system and displays a menu of 13 utilities. The utility programs include the following:

1. **Get**—Copies a PLOT 50 Standard File or group of files from another disk or from a data tape.
2. **Put**—Copies a PLOT 50 Standard File or group of files to another disk or to a data tape.
3. **Directory**—Lists the file directory for a disk or magnetic tape.
4. **Duplicate Disk**—Copies the entire contents of a system disk or data disk for archival purposes.

MONTHLY PRICE OF BUTTER - Oct 77 to 1980
FOURIER REGRESSION
SUMMARY TABLE

Filename: FOURIER
Y Variable: Y(t) - PRICE
X variable: t - TIME

$$Y = A0t^2 + A1\cos(0.1795(X-X_{min})) + B1\sin(0.1795(X-X_{min})) + A4\cos(0.7181(X-X_{min})) + B4\sin(0.7181(X-X_{min}))$$

R-square: 0.9788 Rbar-square: 0.9735
Root of Residual MS: 0.3591

PARAMETER	ESTIMATE	STANDARD ERROR	AMPLITUDE	PHASE (rad)
A0#2	9.9643	0.1200	9.9643	0.00E+000
A1 <COS>	-0.1765	0.0339	0.1777	3.0254
B1 <SIN>	-0.0206	0.0339	0.3400	-2.7072
A2 <COS>	-0.3084	0.0339	2.9706	-0.7479
B2 <SIN>	0.1431	0.0339	0.1509	0.7506
A3 <COS>	2.1773	0.0339		
B3 <SIN>	2.0204	0.0339		
A4 <COS>	0.1104	0.0339		
B4 <SIN>	-0.1029	0.0339		

Mean of Y variable: 5.0322
Standard deviation of Y variable: 2.1638

Figure 14. Fourier regression

INTERCOUNTRY LIFE-CYCLE SAVINGS DATA
MULTIPLE REGRESSION AND DIAGNOSTICS
REGRESSION DIAGNOSTICS

Filename: STERLING
Observation deleted: 49
Libya

Hat element:	0.5315	Residual:	-2.0235
COVRATIO:	-2.0906	DFITS:	-1.1801
Est. Y(49):	-2.0493	Est. Y:	11.7195
RSTUDENT:	-1.0893	FUARRATIO:	2.1255

COEFFICIENTS	ORIGINAL ESTIMATES	NEW ESTIMATES	DBETAS
b(0)	20.5663	24.5243	0.5507
b(1)	-0.4612	-0.3914	-0.4832
b(2)	-1.6914	-1.2008	-0.3798
b(3)	-0.0003	-0.0003	-0.0193
b(4)	0.4097	0.6103	-1.0245

Figure 16. Anova and regression

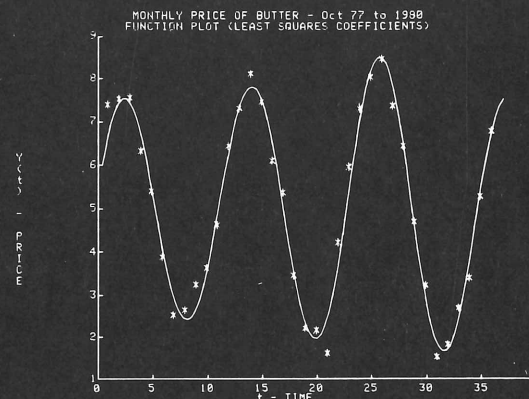


Figure 17. Partial regression plot

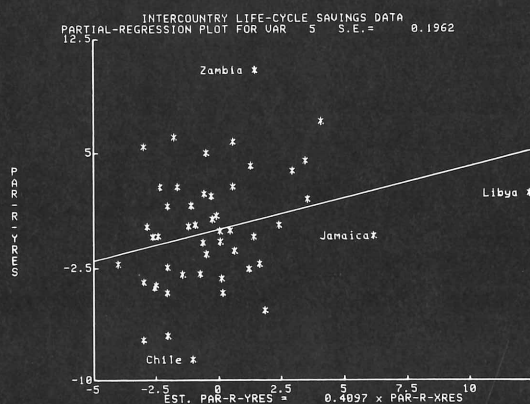


Figure 15. Fourier function plot

STUDY OF CHLORINE IN PRODUCT A
MARQUARDT'S NONLINEAR LEAST SQUARES
SUMMARY TABLE

Filename: SMITHDUBEY

Independent Variable: 1 WEEKS - Weeks Since Produced
Dependent Variable: 2 CHLORIN - Available Chlorine

Residual Sum Of Squares: 0.0050
Residual Root Mean Square: 0.0109 Degrees Of Freedom: 42

Change Relative to Parameter Variability: 0.0558

Parameter	Estimate	Error
C(1)	0.390144	0.0050
C(2)	0.101641	0.0134

Figure 18. Marquardt's nonlinear least squares

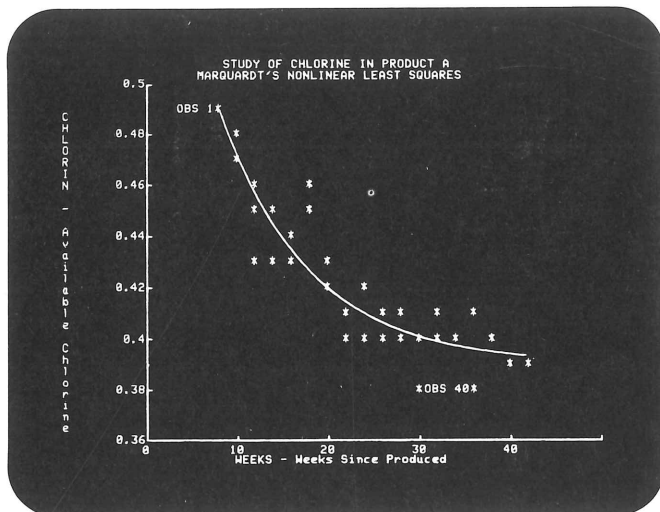


Figure 19. Marquardt's nonlinear function plot

5. **Delete**—Deletes a data file from the disk.
6. **Append**—Appends data contained in one file to the bottom of another file.
7. **List**—Lists all or part of a data file.
8. **Change Title, Change Labels**—Changes the file labeling information in a data file.
9. **Combine Files**—Creates a new file by combining variables from two other files.
10. **Sort**—Creates a new file by sorting an existing file into ascending or descending order.
11. **Rename**—Changes the name of a data file.
12. **Transform Data**—Creates a new file by doing one or a combination of the following: 1) Selecting specific variables from another file; 2) Selecting specific observations from another file; and 3) Performing mathematical transformations on data from another file. This utility offers 24 mathematical transformations, two of which you can define yourself.
13. **Change Configuration Parameters**—Changes one or more device addresses.
14. **Statistics: Nonlinear Estimation**—Brings the Statistics operating system into memory and displays the Statistics menu.

General Information

Memory Requirements

32 K bytes

Equipment Requirements

4050 Series Desktop Computer

4907 File Manager

4907 File Manager ROM Pack

Optional Equipment

4611 or 4631 Hard Copy Unit

4662 or 4663 Interactive Digital Plotter

4642 Matrix Printer

4050 Series Option 10 RS-232 Interface ROM Pack

Ordering Information

4050D05 PLOT 50 Statistics: Nonlinear Estimation

Standard Accessories

PLOT 50 Statistics: Nonlinear Estimation comes complete with a tape cartridge for initializing the system, a disk for program and data storage, an overlay for the function keys and a user's manual.

Service Policy

PLOT 50 Statistics: Nonlinear Estimation is Support Category B software and subject to services stipulated on the Tektronix Software Support Categories Addendum.

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