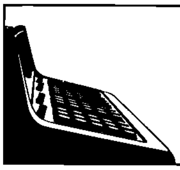
MODEL

30

HEWLETT PACKARD CALCULATOR

ONE-SAMPLE ANALYSIS PAC

HEWLETT PACKARD



CALCULATOR PRODUCTS DIVISION
P.O. Box 301, Loveland, Colorado 80537, Tel (303) 667-5000
Post Office Box 85, CH-1217 Meyrin 2, Geneva, Switzerland
Japan: YHP, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151

MODEL 30

Manual Update

June 4, 1974

ONE SAMPLE ANALYSIS PAC

Part Number 09830-70875

The following changes are to be made.

INCORPORATED
10/7/74

File #36

DELETE LINE 70

File #38

ADD LINE 22

```
22 SCALE  -2/15*X0, 13/15*X0, -0.15*Y0, 0.85*Y0
```

The software configuration is now:

Complete pac	09830-70876	Rev. A
Manual	09830-70875	Rev. A
Program cassette	09839-70875	Rev. A
Template	7120-4059	Rev. A

Table of Contents

Introduction

The following collection of programs are the result of several years of experience in providing statistical support for Hewlett-Packard programmable calculators. They are designed to facilitate analysis of one sample of observations. The approach taken was to provide much of the basic statistical information, but yet provide the ability to perform some of the more advanced data analysis techniques if desired. Recognizing that data analysis is generally characterized by an iterative approach, a "massaging" of the data, so to speak, to derive as much information as possible, the package of programs has been designed to make maximum use of the special function keys, thus providing a great deal of interaction and program control.

Irene Bever
Statistics Applications
Hewlett-Packard Company
Loveland, Colorado

Please take a moment to fill out the program registration card. It will give us an opportunity to inform you of any further additions to the HP 9830 statistics library, as well as any future modifications that could make this series of programs of even greater use.

Please use the comments section to suggest what other statistical packages could be of use to you from Hewlett-Packard.

Commentary

The One Sample Analysis package which you are about to use is designed to perform a number of statistical procedures on a collection of data which has been gathered under one experimental set of conditions. Many procedures are available for you to use. It is unlikely, however, that you will have occasion to use all the procedures on the same set of data. The following features of the program and write-up should be noted.

1. A brief DISCUSSION section is included in this writeup. The purpose of this section is to broadly describe the five general phases of operation of this program as well as to give the user a "quickie" refresher course in the terminology and procedures of one sample analysis.
2. Several EXAMPLES are included in this writeup. The first example is intended as a sample problem for checking out the program tape, etc. The other two examples are described in more detail and illustrate the use of other specialized keys (statistical procedures).
3. As with most programs for the 9830, this program is designed to operate in an INTERACTIVE mode. That is, the program will ask the user to respond to a number of questions asked either on the Display or the Printer. As you develop a little experience with this program, we are confident you will find less and less dependence on this writeup to carry out your analyses.
4. Again, it is NOT NECESSARY TO USE ALL OF THE KEYS during one analysis. Although the keys operate independently of one another, you may find that certain keys will not operate directly after another key has been pressed. For example, if you wish to do a SERIAL PLOT of the data, having already pressed the ORDER STATISTICS key, you will be reprimanded by the program. If you are determined to do a serial plot, why not try RELOADING the data and pressing the SERIAL PLOT

key again.

5. Most of the program files have been marked bigger than needed in order to allow the user to MODIFY THE PROGRAMS for himself. BASIC is an easy language to work with and requires only a little practice.

The One Sample Analysis program covers many of the needed "basic" statistical techniques. We hope you will find this package as helpful in your data analysis as we have in ours.

Thomas J Boardman

Thomas J. Boardman, Ph.D.
Director, Biometrics Unit
Statistical Laboratory
Colorado State University
Fort Collins, Colorado 80521

ONE-SAMPLE ANALYSIS

DESCRIPTION:

This program is for the user with a small sample (two through 150 data points), who wants a large amount of statistical information about the sample.

There are a total of 20 functional keys, eight of which are best described as data manipulation keys. These eight keys are the START, CORRECT, INSERT, DELETE, STORE DATA, OUTPUT DATA, RELOAD DATA, and TRANSFORM DATA keys.

The START key allows for input of the data by three modes: keyboard, magnetic tape, or card reader.

The CORRECT, INSERT DATA, DELETE DATA, and OUTPUT DATA keys allow the user to do as their names imply.

The STORE DATA key enables the user to store the sample data (that has been entered in the machine under the START key) on magnetic tape.

The RELOAD DATA key is a labor saving key as described under Special Function keys.

The TRANSFORM DATA key allows one to transform the data in any of at least 13 ways as described under Special Function keys.

SYSTEM SPECIFICATIONS:

HP9830A Calculator, 2K; **HP9861A Typewriter or HP9866A** Line printer; Plotter HP9862A - optional; Cassette Tape Reader - optional; Card Reader - optional.

The remaining twelve keys provide some basic one-sample statistics [10]: sample size, standard error of the mean, mean, coefficient of variation, variance, standard deviation, skewness, and kurtosis; some order statistics: minimum and maximum values, range, median, .25 and .75 quantiles, mid-range, and trimean; a one or two-tailed t-test; a histogram plot of the data on either the printer [6] or plotter [8]; a serial plot of the data on either the printer [6] or plotter [8]; the Shapiro - Wilk Normality test [9]; and Goodness-of-fit tests for a normal, exponential, or uniform distribution using the Pearson statistic, χ^2 [5], or the Kolmogorov-Smirnov statistic [4].

INPUT AND OUTPUT:

This program accepts any size number that the calculator will handle (see OPERATING MANUAL).

In general, the output is in F 12.4 format (that is, of the form ± XXXXXX.XXXX).

The specific input and output is covered in Special Function Keys for each key.

LIMITATIONS:

This program accepts samples with a minimum size of two and a maximum size of 150 which allows it to be run on a 2K machine. If a larger core machine is available, the maximum sample size may be increased up to 255 by changing the value of the variable B (see Variable List) in file 1 to the new sample size, and by changing the dimension of the A - array (see Variable List) in each COM statement to the dimension of the B - array (see operating manual for the procedure).

Also, not all the keys will operate properly for samples with a zero mean. One may adjust the mean by using the <u>TRANSFORM DATA</u> key and adding a constant to each data point.

METHODS, NOTATION,
AND/OR FORMULAS:

In general, whenever a population parameter is estimated, it is estimated by the maximum likelihood estimator [11].

Let N denote the sample size, X_i denote the ith sample value,(i = 1, 2, ..., N).

The sample mean, $\overline{X} = \sum_{i=1}^{N} X_i/N$.

The sample variance, $S^2 = (\sum_{i=1}^{N} X_i^2 - N \cdot \overline{X}^2)/(N-1)$.

The sample standard, $S = \sqrt{S^2}$.

Serial Correlation with log k

$$= [\sum_{i=1}^{N-k} (X_i - \overline{X})(X_{i+k} - \overline{X})]/[\sum_{i=1}^{N} X_i^2 - N \cdot \overline{X}^2].$$

Standard error of the mean = $S / \sqrt{N}$.

Coefficient of variation = $(S/\overline{X}) \cdot 100$.

$$\text{Skewness} = [\sum_{i=1}^{N} X_i^3/N - 3\overline{X} \cdot \sum_{i=1}^{N} X_i^2/N + 2\overline{X}^3] / S^3 .$$

$$\text{Kurtosis} = [\sum_{i=1}^{N} X_i^4/N - 4\overline{X} \cdot \sum_{i=1}^{N} X_i^3/N + 6\overline{X}^2 \cdot \sum_{i=1}^{N} X_i^2/ N - 3\overline{X}^4] / S^4 .$$

A $(1 - \alpha) \cdot 100\%$ confidence interval on the mean

$$= [\overline{X} - t_{N-1,\alpha/2} \cdot S/\sqrt{N} ; \overline{X} + t_{N-1,\alpha/2} \cdot S/\sqrt{N}] \text{ where}$$

$t_{N-1,\alpha/2}$ is the value of the student's t-distribution with N - 1 degrees of freedom such that

$P [T > t_{N-1,\alpha/2}] = \alpha/2$. $t_{n-1,\alpha/2}$ is approximated by an asymptotic expansion [1].

A $(1-\alpha) \cdot 100\%$ confidence interval on the variance.

$$= [(N - 1)S^2/\chi^2_{N-1,\ \alpha/2},\ (N - 1)S^2/\chi^2_{N-1,\ 1-\alpha/2}].$$

where $\chi^2_{N-1,(\cdot)}$ is the value of the chi-square distribution with N-1 degrees of freedom such that

$$P[X > \chi^2_{N-1,\alpha/2}] = \alpha/2 \quad \text{and}$$

$$P[X > \chi^2_{N-1,1-\alpha/2}] = 1 - \alpha/2 \ .$$

$\chi^2_{N-1,\alpha/2}$ and $\chi^2_{N-1,1-\alpha/2}$ are approximated to at least 3 decimal digits accuracy by a routine written by Robert W. Kopitzke [7].

In the χ^2 - G.O.F. and K.-S. G.O.F. keys, the cumulative normal probabilities are computed by Simpson's Rule [2]. The exponential and uniform cumulative probabilities are computed using their cumulative density function.

SPECIAL CONSIDERATIONS:

It is very important to answer each question in the display when the START key is depressed, until the word "DONE" appears in the display. If one fails to do this, not all variables used in the program will be properly initialized and incorrect answers may result, if the program runs at all. This is also the case for the TRANSFORM DATA, CORRECT, DELETE, and INSERT keys. But, in general, another key may be pressed if the first question appearing in the display is not answered.

Also, there is an optimal (time saving) order in which to press the keys: in numerical order, first the unshifted key then the shifted key, such as f_o, shift f_o, f_1, shift f_1, ..., etc.

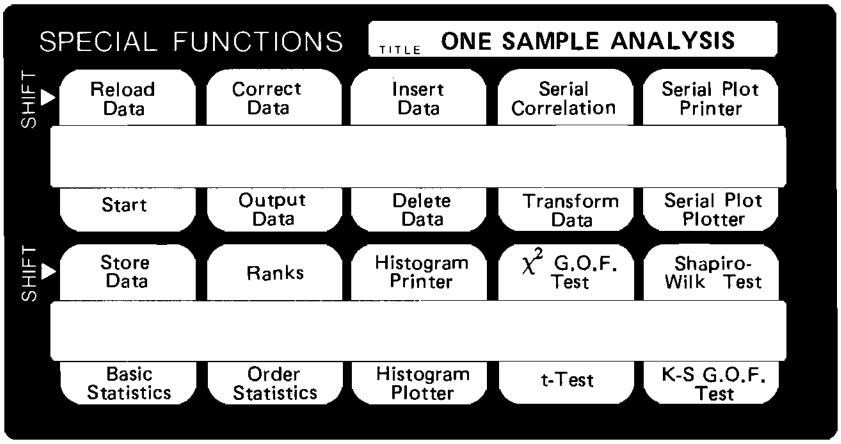
ACKNOWLEDGEMENT:

Programmer: Harris D. Murphy, C.S.U.
Consulting Programmer: Robert W. Kopitzke, C.S.U.

REFERENCES:

1. Abramowitz, Milton and Stegun, Irene A. (1970) Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables. U.S. Government Printing Office, Washington D.C., pp. 949.
2. Ibid., pp. 944, 945
3. Conte, S.D. (1965). Elementary Numerical Analysis. McGraw-Hill Book Company, New York, pp. 135.
4. Dickinson Gibbons, Jean (1971). Nonparametric Statistical Inference. McGraw-Hill Book Company, New York, pp. 75-83.
5. Ibid., pp. 69-73
6. Kopitzke, Robert W. (1973). "Basic Statistic, Histogram", Hewlett-Packard Model 30 Math Pac; 1 pp. 67-75.
7. Kopitzke, Robert W., Unpublished notes, 1973.
8. Nairn, John H. (1973) "Histogram Plot", Hewlett-Packard Model 30 Demo Plotter Pac.
9. Shapiro, S.S. and Wilk, M.B. (1965). "An Analysis of Variance Test for Normality". Biometrika; 52, 3 and 4, p. 591.
10. Snedecor, George W. and Cochran, William G. (1967). Statistical Methods. The Iowa State University Press, Ames, Iowa.
11. Mood, Graybill, Boes (1974) Introduction to the Theory of Statistics 3rd Edition, McGraw-Hill Book Company, New York. Chapter 7.
12. Box, G.E.P. and Cox, D.R. (1964). "An Analysis of Transformations". Journal of the Royal Statistical Society 26:2 pp. 211 - 252.

13. Schlesselman, J.J. (1973). "Data Transformation in Two-Way Analysis of Variance". JASA 68:342 pp. 369-378.



STARTING OPERATION:

In the starting operation, the keys are loaded, variables are initialized and the data is entered. The data may be entered in one of three modes: keyboard, cassette tape reader, or card reader.

If the data is entered through the keyboard, it may be of any form the calculator will accept. If it is entered via cassette tape, it must be full precision (4 c. p. words per data point). If the data is entered by using the card reader, there must be the same number of observations on each card (e.g. one, two, or three, ..., etc. observations per card), and one must know the number of cards.

Running Operation:

1. Type SCRATCH A, EXECUTE
2. Type LOADKEY (0), EXECUTE
3. Press START (f_0) (See RELOAD DATA key)

SPECIAL FUNCTION KEYS:

START (f_0)

START key operation:

1. Press START (f_0)
2. Print "** ONE SAMPLE STATISTICS **"
3. Print "DATA ENTRY CODES: 1 = KEYBOARD, 2 = CASSETTE; 3 = CARD READER."
4. Display "SEE ABOVE: DATA ENTRY CODE = ?"

5. Type appropriate number, EXECUTE.

6. Display "MAX SIZE = 150: SAMPLE SIZE = ?"

7. Type sample size, EXECUTE.

8. Print "SAMPLE SIZE = 'sample size'"

9. Display "TO PRINT DATA ENT 1?"

10. Type 1, EXECUTE; if the data is to be printed. Otherwise, type 0 (or any number but 1), EXECUTE. For data entry code = 1, go to Step 11; code = 2, go to Step 11a; code = 3, go to Step 11b.

11. Print, "I X(I) X(I+1) X(I+2) X(I+3) X(I+4)". 'I' indicates the observation number of the first sample point of each row.

12. Display "X(i) = ?"

13. Type observation #'i', EXECUTE. If data was to be printed, five observations are output on a line after every fifth observation is entered. Steps 12 and 13 are repeated until i = sample size.

14. Display "IF CORRECTIONS ENT 1?"

15. If any observation is in error, type 1, EXECUTE. Otherwise, type any other number (usually 0), EXECUTE. If a 1 was entered in Step 15 above, see special function key CORRECT (1). If any other number was entered in Step 15, the program calculates the sample moments and stores the data and the moments on the program tape. DO NOT press any key until the display reads "DONE"

NOTE: DATA WILL NOT STORE IN A PROTECTED CASSETTE. THUS ERROR 58 IS PRESENTED FOR LINE 55 OF FILE 13" STORE DATA IN 14"

16. Display "DONE"

Now, any key may be pressed.

This set of instructions is used if data is coming from magnetic tape.

11a. Print "(CASSETTE SELECT CODES: 5 = 9865A, 10 = 9830A)"

12a. Display "SEE ABOVE: SELECT CODE = ?"

13a. Type a 5 or a 10, EXECUTE.

14a. Print "SELECT CODE = 5 or 10"

15a. Display "YOUR FILE NUMBER = ?"

16a. Type your file number, say 'f', EXECUTE.

17a. Display "INSERT YOUR TAPE THEN ENT 1?"

18a. Insert your tape, type 1 (or any number), EXECUTE.

19a. Print "LOADING YOUR FILE FROM FILE # 'f'". The data is loaded and the cassette is rewound.

20a. If select code = 10, the display reads "INSTALL PGM TAPE; ENT 1?" If select code = 5, go to Step 22a.

21a. Reinsert program tape, type 1, EXECUTE.

22a. If the data is to be printed (a 1 was entered in Step 10 above) it is now printed; go to Step 14 above. If the data is not to be printed continue below.

DO NOT press any key until the display reads "DONE".

23a. Display "DONE".

Now, any key may be pressed.

This set of instructions is used if data is coming from card reader.

11b. Display "NUMBER OF CARDS = ?"

12b. Type # of cards, EXECUTE

13b. Display "NO. OF OBS. PER CARD = ?".

14b. Type # of observations per card, EXECUTE. If the # of observations per card times the # of cards does not equal the sample size, a message so stating is printed and step 11b is repeated.

15b. Print "ENTER YOUR FORMAT AT LINE # 100; DEFAULT FORMAT: 100 FORMAT 6 F12.4, THEN PRESS 'CONT 85, EXECUTE'".

16b. Display "SEE ABOVE: PRESS 'CONT 85, EXEC.'".

17b. Change the format at line # 100 if the default format won't suffice (if needed, see Operating Manual).

18b. Type CONT 85, EXECUTE
If an error occurs, correct it and repeat Step 18b.
Go to Step 22a, above.

RELOAD DATA
(Shift f_0)

This key is designed to restart the program if somehow the program stopped working properly. For instance, if the machine is inadvertently turned off, or there is a power failure while running the program, go through the start sequence, except press RELOAD DATA key instead of the START key.

THIS WILL WORK ONLY IF CASSETTE IS NOT PROTECTED

Also, if one must leave the calculator for some time and keeps the program tape in his possession, go through the start sequence as stated in the above paragraph.

RELOAD DATA key operation:

1. Press RELOAD DATA (Shift f_0)
2. Print "RELOAD DATA"
3. Print "DATA RELOADED; PRESS ANY KEY."
4. Display "DONE"

   Now, any key may be pressed.

OUTPUT
DATA
(f_1)

This key outputs the sample in the order that it appears in the machine, five data points per line.

OUTPUT DATA key operation

1. Press OUTPUT DATA (f_1)

   The data is printed, five data points per line, under a heading.
2. Display "DONE"

CORRECT
DATA
(Shift f_1)

This key allows one to correct any data point within the input string after all the data has been entered.

CORRECT DATA key operation

1. Press CORRECT DATA (Shift f_1)
2. Display "N = (sample size) CORRECT X(I), WHERE I = ?"
3. Type the appropriate number, say i, EXECUTE. If i is less than one, Step 8 occurs next (this is a way not to correct any data point if so desired). If i is greater than the sample size, Step 2 is repeated.
4. Display "X(i) = 'ith data point'". There is a pause before Step 5 occurs.
5. Display "NEW X(i) = ?".
6. Type correct value, say x, EXECUTE.
7. Print "** CORRECT X(i) = 'x'".

8. Display "THRU CORRECTING ENT 1?".
9. Type 1, EXECUTE if you finished correcting; go to Step 10. Otherwise, type 0 (or any number but 1), EXECUTE; go to Step 2.
10. Display "IF YOU WISH TO DELETE ENT 1?".
11. Type 1, EXECUTE if you wish to delete any sample point; see DELETE DATA key. Otherwise, type 0 (or any number but 1), EXECUTE.
12. Display "IF YOU WISH TO INSERT ENT 1?"
13. Type 1, EXECUTE if you wish to insert a value at the beginning, middle, or end of the sample; see INSERT key. Otherwise, type 0 (or any number but 1), EXECUTE.

    New moments are now calculated and stored. DO NOT press any key until the display reads "DONE".
14. Display "DONE"

    Now, any key may be pressed.

DELETE DATA (f_2)

This key allows one to delete any data point after all the data has been entered.

DELETE DATA key operation:

1. Press DELETE DATA (f_2)
2. Display "N = 'sample size': DELETE X(I), WHERE I = ?".
3. Type the appropriate number, say i, EXECUTE. If i is less than 1, go to Step 6 (this is a way not to delete any data point if so desired). If i is greater than the sample size, Step 2 is repeated.
4. Display "**DELETE X(i) = 'ith sample point'"
5. If i is less than the sample size,

   print "** DELETE X(i) = 'ith sample point'
   ** NEW X(i) = 'i + 1st sample point'
   ** N NOW = 'sample size less one'".

   If i is equal to the sample size "** NEW X(i) = (i + 1st sample point)" is excluded from the above output.
6. Display "THRU DELETING ENT 1?"
7. Type 1, EXECUTE if you finished deleting; go to Step 8.

7. (cont.) Otherwise, type 0 (or any number but 1), EXECUTE; go to Step 2
8. Display "IF YOU WISH TO CORRECT ENT 1?"
9. Type 1, EXECUTE if you wish to correct any data point; see CORRECT DATA key. Otherwise, type 0 (or any number but 1), EXECUTE.
10. Display "IF YOU WISH TO INSERT ENT 1?"
11. Type 1, EXECUTE if you wish to insert a value at the beginning, middle, or end of the sample; see INSERT key. Otherwise, type 0 (or any number but 1), EXECUTE.

    New moments are now calculated and stored. DO NOT press any key until the display reads "DONE".
12. Display "DONE".
    Now, press any key.

INSERT DATA
(Shift f_2)

The insert key allows one to insert a data point at the beginning, middle, or end of the sample once the sample has been entered.

INSERT DATA key operation

1. Press INSERT DATA (Shift f_2)
2. Display "N = 'sample size'; INSERT X(I), WHERE I = ?"
3. Type i, EXECUTE; where i = position number where you want to insert a data point. If the sample size equals the maximum allowable sample size (see Limitations you can't insert any more data points and an error message so stating is printed; go to Step 13.
   If i is less than 1, go to Step 7 (this is a way not to insert any data point if so desired).
   If i is greater than the sample size, you are in effect, adding onto the end of the sample since i is set equal to the sample size plus one.
4. Display "INSERT X(i) = ?"
5. Type the data point to be inserted, say x, EXECUTE.
6. Print "** INSERT X(i) = 'x'
   ** N NOW = 'sample size plus one'".

7. Display "THRU INSERTING ENT 1?"
8. Type 1, EXECUTE if you are finished inserting data points. Otherwise, type 0 (or any number but 1), EXECUTE; go to Step 2.
9. Display "IF YOU WISH TO DELETE ENT 1?"
10. Type 1, EXECUTE if you wish to delete any data point; see DELETE DATA key. Otherwise, type 0 (or any number but 1), EXECUTE.
11. Display "IF YOU WISH TO CORRECT ENT 1?"
12. Type 1, EXECUTE if you wish to correct any sample point; see CORRECT DATA key. Otherwise, type 0 (or any number but 1), EXECUTE.

    Now, new moments are calculated and stored. DO NOT press any key until "DONE" appears in the display.
13. Display "DONE".

TRANSFORM DATA
(f_3)

This key allows the user to transform the data by 14 preassigned transformations and one user defined transform. The required input is of the form 'Transformation code, constant'. Let TCODE denote the transformation code and C denote the constant. Also, let N denote the sample size, A(i) denote the ith sample point, and C(i) the ith constant, i = 1, 2, ..., N.
The transformation code and corresponding transformation are as follows:

TCODE, C	TRANSFORMATION
0, 0	No transformation
1, C	A(i) = A(i) + C
2, C	A(i) = A(i) * C
3, C	A(i) = A(i) / C
4, C	A(i) = C ↑ A(i)
5, C	A(i) = A(i) ↑ C
6, 0	A(i) = LOG_e (A(i))
7, 0	A(i) = A(i) + C(i)
8, 0	A(i) = A(i) - C(i)
9, 0	A(i) = A(i) * C(i)
10, 0	A(i) = A(i) / C(i)
11, 0	A(i) = A(i) ↑ C(i)
12, 0	A(i) = EXP (A(i))

T CODE, C	TRANSFORMATION
13, 0	$A(i) = LOG_{10} (A(i))$
14, 0	A(i) = User defined transform

The user defined transformation is defined during key operation.
IMPORTANT: If one wishes to save the sample prior to transforming it, use STORE DATA key to store your data on a separate tape.

TRANSFORM DATA key operation:

1. Press TRANSFORM DATA (f_3)
2. Print "TRANSFORM DATA"
3. Display "T CODE, C = ?"
4. Type T CODE, C, EXECUTE (see above)
5. The appropriate transformation title is printed.
   T CODE = 14: go to Step 7
   T CODE = 1, 2, 3, 4, 5, 6, 12, or 13: go to Step 12 belo
   T CODE = 7, 8, 9, 10, or 11:
6. Display "C (i) = ?"
   Type the ith constant, EXECUTE. Repeat Step 6 until i = sample size; go to Step 12 below.

T CODE = 14:

7. Print "ENTER YOUR SUBROUTINE BEGINNING AT LINE 70, THEN PRESS CONT EXECUTE", "NOTE: THE VARIABLE A(I) REPRESENTS THE DATA.
   Display "ENTER SUBROUTINE; BEGIN AT 70"
8. Press PRT ALL,
9. Type AUTO 70, EXECUTE. Enter your transformation, redefining A(I) as you wish. Do not exceed line # 9997.
10. Press PRT ALL, CONT, EXECUTE.
11. The transformed data is printed.
12. Display "IF CORRECTIONS ENT 1?"
13. Type 1, EXECUTE if you desire to correct a data point; see CORRECT DATA key. Otherwise, type any other number, EXECUTE.

DO NOT press any key until the display reads "DONE".

14. Display "DONE"

SERIAL CORRELATION
(Shift f_3)

This key allows one to check for randomness of the sample by computing the serial correlation with lag = 1, 2, 3, ..., or one-half the sample size.

SERIAL CORRELATION key operation:

1. Press SERIAL CORRELATION (Shift f_3)
2. Print "SERIAL CORRELATION"
3. Display " CORRELATION LAG = ?"
4. Type the correlation lag desired, say i, EXECUTE. If the correlation lag is not in the set {0, 1, 2, ..., one-half the sample size}, an error message is printed; go to Step 3.
5. Print "SERIAL CORRELATION WITH LAG = 'i' = 'computed value'"
6. Display "FOR ANOTHER LAG ENT 1?"
7. Type 1, EXECUTE to have Step 3 repeated. Otherwise, type 0 (or any number but 1), EXECUTE.
8. Display "DONE"

SERIAL PLOT PLOTTER
(f_4)

This key produces a serial plot of the data (plots the observations against the observation number) on the plotter (HP model 9862A), only if none of the following keys have been pressed, since these keys order the data:

ORDER STAT
RANKS
S.-W. TEST
K.-S. G.O.F. TESTS

SERIAL PLOT PLOTTER key operation:

1. Press SERIAL PLOT PLOTTER (f_4)
2. Print "SERIAL PLOT, PLOTTER:"
3. If the data has been ordered by one of the above keys, a message so stating is printed; go to Step 12.

4. Display, "SET UP THE PLOTTER; ENT 1?"
5. Set up the plotter: position the pen about 1/4" from each end of the paper and the top; about 1" from the bottom, type 1 (or any number); EXECUTE.
6. A serial plot of the data is drawn on the plotter.
7. Display, "TO LABEL PLOT ENT 1?"
8. Type 1, EXECUTE, if you desire to label the plot (See LETTER instruction in the Plotter Control ROM Operating Manual). Otherwise, type 0 (or any number but 1), EXECUTE; go to Step 12.
9. Display "REM: PRESS STOP WHEN FINISHED" There is a pause before Step 9 occurs.
10. Display "?"
11. Type your label; remember to press STOP when you are finished.
12. Display, "DONE"

    Now, press any key.

SERIAL PLOT PRINTER
(Shift f_4)

This key produces a serial plot of the data (plots the observations against the observation number) on the typewriter or line printer (HP Model 9866A), only if none of the following keys have been pressed, since those keys order the data:

ORDER STAT
RANKS
S.-W. TEST
K.-S. G.O.F. TESTS

SERIAL PLOT PRINTER key operation:

1. Press SERIAL PLOT PRINTER (Shift f_4)
2. Print "SERIAL PLOT-PRINTER:"
3. If the data has been ordered by one of the above keys, a message so stating is printed; go to Step 6.
4. The serial plot is printed.
5. Display, "DONE"

    Now, any key may be pressed.

NOTE: One may connect the asterisks with a ruler to give a better impression of a serial plot.

BASIC STATISTICS (f_5)

This key gives the user the following 'basic statistics':

a) sample size
b) standard error of the mean
c) mean
d) coefficient of variation
e) variance
f) standard deviation
g) skewness
h) kurtosis
i) confidence intervals for:
    (1) mean
    (2) variance

The confidence intervals may be deleted by pressing **STOP, CLEAR,** then any other key at any time after a through h(above) have been printed. It may be desirable to delete the confidence interval on the variance since it takes about three and one-half minutes for it to be calculated.

BASIC STATISTICS key operation:

1. Press BASIC STATISTICS (f_5)
2. a through h (see above) are printed.
3. Display "CONF. COEFF. FOR C.I. ON MN = ?"
4. Type confidence coefficient, say c, **EXECUTE** where c is between .7 and .995. If c is not between .7 and .995 a message is printed so stating and Step 3 is repeated.
5. Print "'c*100'% C.I. FOR MEAN: (t_1, t_2)" where t_1 and t_2 are the computed left and right endpoints of the confidence interval.
6. Print "ONE-TAIL T ('degrees of freedom', 'probability of a greater value') = 'calculated t-value'"
7. Display "C.I. ON VAR TAKES (PAUSE)ABOUT 3.5 MIN."

8. Display "CONF. COEFF. FOR C.I. ON VAR = ?"
9. Type confidence coefficient, say c, EXECUTE, where c is between .7 and .995. If c is not between .7 and .995 a message is printed so stating and Step 7 is repeated.

The program now takes about three and one-half minutes to calculate the chi-square values needed for the confidence interval [6].

10. Print"'100*c' C.I. FOR VAR (t_1, t_2)" where t_1 and t_2 are the left and right endpoints of the confidence interval.
11. Print "CHI-SQUARE ('degrees of freedom', 'probability of a greater value') = 'computed value' for the two chi-square values which have equal tail probabilities"
12. Display, "DONE".

STORE DATA
(Shift f_5)

This key allows the user to store the sample on a cassette tape for permanent storage. The advantage of doing this is that the data can easily be reread by using the cassette data entry code during the START key operation.

Note that a file of at least 600 words in length is required by this key.

The sample is stored linearly, in full precision (four words per sample point-see Operating Manual).

If one wishes to store the data exactly as it was initially entered, do so before pressing the TRANSFORM DATA key or any of the keys listed below.

If the TRANSFORM DATA key has been pressed, press it again and perform the inverse transformation, if possible, before pressing the STORE DATA key.

If one of the keys below has been pressed and the TRANSFORM DATA key has not been pressed, press the RELOAD DATA key before pressing the STORE DATA key.

Once the TRANSFORM DATA key and one of the keys below have been pressed, there is no possible way to get the data in its original form.

If one wishes to store ordered data, press any one of the following keys before pressing the STORE DATA key:

ORDER STAT
RANKS
K.-S. G.O.F. TESTS
S.-W. TEST

NOTE: To check which form the data is in before storing it, press the OUTPUT DATA key before pressing the STORE DATA key.

STORE DATA key operation:

1. Press STORE DATA (Shift f_5)
2. Print, "STORE DATA"
3. Print, "(CASSETTE SELECT CODES: 5 = 9865A; 10 = 9830A)".
4. Display, "SEE ABOVE: SELECT CODE = ?".
5. Type desired select code, say i, EXECUTE.
6. Print, "SELECT CODE = 'i'".
7. Display "INSERT YOUR TAPE; ENT 1?".
8. Make sure your tape is in the proper machine, type 1 (or any number), EXECUTE.
9. Display, "REM: NEED FILE > 600 WORDS".

There is a pause before Step 10 occurs.

10. Display, "YOUR FILE NUMBER = ?"
11. Type your file number, say j, EXECUTE.
12. Print "YOUR DATA IS STORED IN AN ARRAY A(150) ON YOUR FILE NUMBER 'j'".

After the data is stored, your tape is rewound. If the select code = 5, go to Step 15.

13. Display "INSERT PGM TAPE; ENT 1?"
14. Replace the program tape in the HP Model 9830A, type 1 (or any number), EXECUTE.

15. Display, "DONE".

ORDER STATISTICS
(f_6)

This key orders the data if it hasn't been ordered by some other key. The ordered data may be printed at the user's option. The following statistics are printed:

- a) sample size
- b) minimum sample value
- c) maximum sample value
- d) range
- e) median
- f) Tukey's hinges:
  - (1) .25 quantile
  - (2) .75 quantile
- g) mid-range = .75 quantile - .25 quantile
- h) trimean = (.25 quantile + .75 quantile)/4 + median/2.

ORDER STATISTICS key operation:

1. Press ORDER STATISTICS (f_6)
2. Print "ORDER STATISTICS"
   If the data has not been ordered, it will be now.
3. Display, "TO PRINT ORDERED DATA ENT 1?"
4. Type 1, EXECUTE if the ordered data is desired to be printed. Otherwise, type any other number, EXECUTE, go to Step 6.
5. The ordered data is printed.
6. The statistics a through h (see above) are printed.
7. Display "DONE"

RANKS
(Shift f_6)

This program orders the data if it hasn't been ordered by some other key. Then corresponding ranks are assigned and printed along with the distinct data points, three pairs to a line. Ties are assigned their average ranks.

RANKS key operation:

1. Press RANKS (Shift f_6)
2. A heading and the ranks are printed.
3. Display "DONE".

HISTOGRAM PLOTTER (f_7)

This key gives the user a histogram plot of the sample on the plotter (Model 9862A), with or without a normal curve overlay.

HISTOGRAM PLOTTER key operation:

1. Press HISTOGRAM PLOTTER (f_7)
2. Print "HISTOGRAM; PLOTTER:"
3. Display "FOR NORMAL CURVE OVERLAY ENT 1?".
4. Type 1, EXECUTE if a normal curve overlay is desired. Otherwise, type any other number, EXECUTE.
5. If 1 was entered in Step 4, Print "WITH NORMAL CURVE OVERLAY". Otherwise, go to Step 6.
6. Display "OFFSET = '?'".
   If the offset is greater than the maximum sample value, a message so stating is printed and Step 6 is repeated.
7. Type the lower limit of the first cell, say 0, EXECUTE.
8. Print "OFFSET = ' (lower limit)'".
9. Display "# OF CELLS = ?".
10. Type number of cells desired, say n, EXECUTE. n must be between 1 and 50, otherwise a message so stating is printed and Step 9 is repeated.
11. Print "# OF CELLS = 'n'".
12. Print "OPTIMUM CELL WIDTH = '[(maximum sample value - offset)/# of cells] • 1.00001'".
13. Display "CELL WIDTH = 'optimum cell width' OR = ?".
14. Type the cell width desired, say c, EXECUTE.
15. Print "YOUR CELL WIDTH = 'c'".
16. If there are observations too large or too small for the specified offset, # of cells, and cell width, messages so stating are printed. Otherwise, go to Step 19.
17. Display "OFFSET AND CELL WIDTH OK; ENT 1?".

18. Type 1, <u>EXECUTE</u> if this is the desired test. Otherwise type any other number, <u>EXECUTE</u>, go to Step 6.

19. Display "SET UP THE PLOTTER THEN ENT 1?"

20. Make sure the plotter is completely set up then type 1, <u>EXECUTE</u>.

21. A histogram is now drawn on the plotter along with a normal curve if a 1 was entered in Step 4.

22. Display "TO LABEL PLOT ENT 1?".

23. Type 1, <u>EXECUTE</u> if you desire to print a title or some other message on the plot; See LETTER instruction in Plotter Control ROM Operating Manual. Otherwise, type any other number, <u>EXECUTE</u>, go to Step 29.

24. Display "CHARACTER HEIGHT (%) = ?"

25. Type the number desired indicating the % of the height of the plot you wish the letters, such as 1, 2, 3, or 4, <u>EXECUTE</u>. 2.5% or 3% is a recommended height.

26. Display "REM: PRESS STOP WHEN FINISHED" This is a reminder to press the <u>STOP</u> key when you have finished labeling the histogram.

27. Display '?'.

28. Type in your label after positioning the pen and remember to press the <u>STOP</u> key when finished.

29. Display "FOR CELL STAT ENT 1?"

30. Type 1, <u>EXECUTE</u> if the cell statistics are desired. Otherwise, type any other number, <u>EXECUTE</u>; go to Step 34.

31. Print "CELL STATISTICS:"

32. Print "CELL # LOWER NUMBER % RELATIVE "

"CELL #	LOWER LIMIT	NUMBER OF OBS.	% RELATIVE " FREQUENCY

33. The cell #, lower limit, number of observations, and % relative frequency are printed for each cell of the histogram under the above headings.

34. Display "DONE".

HISTOGRAM PRINTER
(Shift f_7)

This key gives the user a histogram plot of the data on the printer, with or without a normal curve overlay.

HISTOGRAM PRINTER key operation:

1. Press HISTOGRAM PRINTER (Shift f_7)
2. Print "HISTOGRAM-PRINTER:"
   See Steps 3 through 18 of HISTOGRAM PLOTTER key.

18. A histogram is now printed along with a normal curve overlay if a 1 was entered in Step 4.
    See Steps 29 through 34 of HISTOGRAM PLOTTER key.

t - TEST
(f_8)

This key computes a one or two tailed students t-test of the hypothesis:

$$H_O: \mu = \text{user specified mean}$$

The computed t-value and corresponding one or two tailed probability is printed. The probability is computed by using [2].

t-TEST key operation:

1. Press **t-TEST** (f_8)
2. Print "ONE-SAMPLE T-TEST:"
3. Display "1 OR 2 TAILED TEST?"
4. Type 1 (or 2), **EXECUTE**
5. Print "'1 (or 2)' TAILED TEST"
6. Display "H0: MU = 'sample mean' or = ?"
7. Type hypothesized mean, say m, **EXECUTE.**
8. Print "HO: MU = 'm'

```
                    N = 'sample size'
                 MEAN = 'sample mean'
    STD ERROR OF MEAN = 'sample standard error of the mean'
                    T = 'computed t-value'
                   DF = 'degrees of freedom'
```

9. If a one tailed test, Print "P(T > '|computed t-value|') = 'computed probability'".
   If a two tailed test, Print "1-P('-|computed t-value|' < T < '|computed t-value|') = 'computed probability'".
10. Display "DONE"

χ^2 G.O.F. TEST (Shift f_8)

This key computes a chi-square goodness-of-fit test for distribution for the normal, exponential, or uniform distribution.

χ^2 G.O.F. TEST key operation:

1. Press χ^2 **G.O.F.** TEST (Shift f_8)
2. Print "CHI-SQUARE GOODNESS-OF-FIT TEST:"
3. Print "GOODNESS-OF-FIT (GOF) CODES:
   1 = NORMAL; 2 = EXPONENTIAL; 3 = UNIFORM"
4. Display "SEE ABOVE: GOF CODE = ?"
5. Type 1, 2, or 3; EXECUTE.
6. Print "GOODNESS-OF-FIT CODE = 1, 2, or 3"

   If the GOF code = 1, go to Step 11. If the GOF code = 2, go to Step 10. If the GOF code = 3, continue with Step 7.
7. Display "LOWER & UPPER LIMIT ON UNIF. = ?".
8. Type lower and upper limits, say l_1 and l_2, EXECUTE.
9. Print "TEST ON UNIFORM ('l_1', 'l_2')". Go to Step 11.
10. If the sample mean is negative or zero, a message stating so is printed and Step 4 is repeated since the mean of an exponential distribution must be greater than zero.
11. Display "OFFSET = ?"
12. Type the lower limit on first cell, say 0, EXECUTE. The offset must not be less than zero for GOF code = 2 and must not be less than the lower limit of the uniform distribution (for GOF code = 3), otherwise a message so stating is printed and Step 11 is repeated.

13. Print "OFFSET = '0'"
14. If the offset is greater than the maximum sample value a message stating so is printed and Step 11 is repeated.
15. Display "# OF CELLS = ?"
16. Type number of cells desired, say n, EXECUTE. n must be between 1 and 50, otherwise a message so stating is printed and Step 14 is repeated.
17. Print "# OF CELLS = 'n'".
18. Print "OPTIMUM CELL WIDTH = '[(maximum sample value - offset)/# of cells] • 1.00001'."
19. Display "CELL WIDTH = 'optimum cell width' OR = ?"
20. Type cell width desired, say c, EXECUTE.
21. Print "YOUR CELL WIDTH = 'c'".
22. If there are observations too large or too small for the specified offset, # of cells, and cell width, messages so stating are printed. Otherwise, go to Step 23.
23. Display "OFFSET AND CELL WIDTH OK; ENT 1?"
24. Type 1, EXECUTE if this is the desired test. Otherwise type any other number, EXECUTE; go to Step 11.
25. Print "CELL # LOWER OBSERVED EXPECTED"
    LIMIT # OF OBS. # OF OBS.
26. The cell #, lower limit, observed number of observations and calculated expected number of observations are printed under the title in Step 25.
27. Print "CHI-SQUARE GOODNESS-OF-FIT FOR 'appropriate distribution'".
28. Print 'CHI-SQUARE VALUE = 'computed value'; DEGREES OF FREEDOM = "number of non-empty cells less: one plus # of parameters estimated'".
29. Display "FOR ANOTHER GOF CODE ENT 1?"
30. Type 1, EXECUTE if another GOF test is desired: go to Step 4. Otherwise, type any other number, EXECUTE.
31. Display "DONE".

K-S G.O.F. TEST
(f_9)

This key orders the data if it hasn't been ordered by some other key. Then a Kolmogorov-Smirnov goodness-of-fit test is performed for distribution for a normal, exponential, or uniform distribution. The test takes a maximum of about 5 minutes.

K-S G.O.F. TEST key operation

1. Press K-S G.O.F. TEST (f_9)
2. Print "KOLMOGOROV-SMIRNOV GOODNESS-OF-FIT TEST"
3. Print "GOODNESS-OF-FIT (GOF) CODE:
   1 = NORMAL; 2 = EXPONENTIAL; 3 = UNIFORM"
4. Display "SEE ABOVE: GOF CODE = ?"
5. Type 1, 2, or 3; EXECUTE.
6. Print "GOODNESS-OF-FIT CODE = 1, 2, or 3"

   If GOF code = 1, go to Step 13. If GOF code = 2, go to Step 10. If GOF code = 3, continue with Step 7.

7. Display "LOWER & UPPER LIMIT ON UNIFORM = ?,?"
8. Type lower and upper limits, say l_1 and l_2, EXECUTE.
9. Print "TEST ON UNIFORM ('l_1', 'l_2')" Go to Step 18.
10. Display "MEAN = 'sample mean' OR = ?"
11. Type hypothesized mean, say m, EXECUTE. The hypothesized mean must not be greater than zero for GOF code = 2. If m is not greater than zero, a message so stating is printed and Step 10 is repeated.
12. Print "MEAN = 'm'". Go to Step 18.
13. Display "MEAN = 'sample mean' OR = ?"
14. Type hypothesized mean, say m, EXECUTE.
15. Display "VARIANCE = 'sample variance' OR = ?"
16. Type hypothesized variance, say v, EXECUTE.
17. Print "MEAN = 'm' VARIANCE = 'v'"
18. Print "N = 'sample size', KOLMOGOROV-SMIRNOV STATISTICS: DN = 'computed value' SQR(N)*DN = KN = 'computed value'".
19. Display "FOR ANOTHER GOF CODE ENT 1?"
20. Type 1, EXECUTE if you wish another test; go to Step 4. Otherwise, type any other number, EXECUTE.

21. Display "DONE".

SHAPIRO - WILK TEST (Shift f_9)

This key orders the data if it hasn't been ordered by some other key. Then a Shapiro-Wilk test for normality is performed for a sample of size 3 to 50, inclusive.

SHAPIRO-WILK TEST key operation:

1. Press SHAPIRO-WILK TEST (Shift f_9)
2. Print "SHAPIRO-WILK NORMALITY TEST:"

   If the sample size is less than three or greater than 50, a message is printed stating that this program won't work and to try a chi-square goodness of fit test for N > 50; go to Step 6.
3. Print "W STATISTIC FOR NORMALITY (N = 'sample size') = 'computed value'"
4. Print "% POINTS FOR W (SMALL VALUE SIGNIFICANT) .01, .02, .05, .1, .5"
5. Display "DONE".

DISCUSSION

In the beginning of elementary statistics classes, the instructor generally describes a number of techniques for analysis of one sample data ... that is, data gathered under one set of experimental treatment conditions. Some of the reasons for this analysis are: 1) to obtain the basic statistics that represent the data, i.e., mean, standard deviation, largest value, smallest value, etc.; 2) to study the assumption that the data comes from a normal population; 3) to see if there is any time order sequencing to the data, i.e., is there any association or correlation between successive data points; and 4) to check for possible "outliers", "wild shots", or "mavericks" in the data. This program package allows the user a great deal of flexibility in studying a set of data for any one of the reasons listed above or for other reasons.

In order to describe the general functions of the twenty keys defined for this program, let us look at the keys in five general phases of operation.

1. INPUT-OUTPUT PHASE

During this phase of operation of the program initialization of the registers and variables is performed, the data is **input to the machine** by any one of three modes of entry (keyboard, magnetic tape, or card reader), the data may be corrected (if required), and the data may be stored on a separate cassette for future analyses.

Although this phase of operations on any program is very important, it is mainly "housekeeping" in that little if any real statistical information is generated. For further description of the seven keys which may be used in this phase, see the SPECIAL FUNCTION KEYS: section under: START; RELOAD DATA; OUTPUT DATA; CORRECT; DELETE; INSERT; TRANSFORM DATA.

2. SERIAL (TIME)-ORDER SEQUENCES

Oftentimes, the order of the data as it is entered may represent the time sequence in which the data was obtained. It may be instructive to study a plot of each value (on Y axis) versus the time sequence

(X axis; 1, 2, 3, ..., n). If a trend is observed in the plot it may indicate lack of independence between the observations. Also, if a cyclical pattern is observed, lack of independence may be a possibility. If the **9866A Printer is used, it may be helpful to connect the points with** a ruler in order to "see" the time order effects. This is done automatically if the **9862A Plotter is used.**

Another way to study the interrelationship between successive data points is to obtain the serial correlation for various lags. The serial correlation with lag k is the correlation between every kth observation. For example, suppose k = 1 and we have observations X_1, X_2, X_3, ... X_{10}. We would conceptually form the pairs, (X_1,X_2), (X_2,X_3), (X_3,X_4), ... (X_9,X_{10}) and calculate the correlation coefficient. The serial correlation coefficient ranges between (-1, +1) with strong positive values indicating increasing trends and strong negative values indicating decreasing trends when k = 1.

For further information on the three keys which may be used in this phase, see the SPECIAL FUNCTION KEYS: SERIAL CORRELATION; SERIAL PLOT-PRINTER; and SERIAL PLOT-PLOTTER.

3. TRANSFORM PHASE

Sometimes in order to achieve a more meaningful response or a more homogeneous subgroup, transformations on the original data are performed. Thirteen of the most commonly used transformations are performed automatically if required by the user. Additional transformation may be accomplished by using the user defined option during which the user writes a small BASIC routine to perform the required transformation. For further discussion on the use of transformation, see reference 10 (sections 11.10 - 11.18), and references 12 and 13 above. See SPECIAL FUNCTION KEYS: **TRANSFORM** DATA.

4. GENERAL STATISTICS PHASE

This phase of operation obtains the standard statistical measures used to characterize a set of data such as the measures of central tendency (means, medians) and measures of dispersion (variance, standard deviation, range, maximum value, and minimum value). In addition, certain "Tukeyisms" are included which further help to characterize the data. (John Tukey, Princeton University and Bell Laboratory, is one of the world's most prominent statisticians.) The order statistics, the arrangement of the data from smallest to largest, are quite often useful to determine outliers, etc. In addition, the order statistics are needed for several of the keys in the next section. Histograms of the data may be generated on either the printer or the plotter. Histograms are a "picture" of the grouping of data points. The user selects a "window" or cell width and the number of cells and then a representation of the frequency of occurrence of the observations within a cell or window is plotted. See SPECIAL FUNCTION KEYS: BASIC STAT; ORDER STAT; RANKS; HISTOGRAM PLOTTER; HISTOGRAM PRINTER for further information.

5. TESTS OF SIGNIFICANCE

A statistical test of significance is a procedure based on concepts of probability which allows the user to reject or accept some standard or null hypothesis with a predetermined small chance of making a type one error. The type one error is rejecting the null hypothesis (H_o:) when we should, if we knew the "true" state of the population, accept H_o:. The four keys used to perform the statistical tests are:

a. t TEST - This test is used to study hypotheses about the population average (mean) value designated by the Greek letter μ. The null hypothesis and the three possible alternative hypotheses (H_1:) are:

1	2	3
$H_o: \mu = \mu_o$	$H_o: \mu = \mu_o$	$H_o: \mu = \mu_o$
$H_1: \mu \neq \mu_o$	$H_1: \mu > \mu_o$	$H_1: \mu < \mu_o$

Where μ_o is specified by the user usually from past information. μ_o may represent a "benchmark" or standard mean value used for comparative purposes. The alternative hypothesis specifies what should be "true" if the null hypothesis is not ... that is if we reject H_o:. Hypotheses set (1) is called a two sided alternative test while sets (2) and (3) are called one sided alternative hypotheses.

b. χ^2 - GOF (Chi-square - Goodness of Fit) TEST -

c. KS - GOF (Kolmogorov-Smirnov Goodness of Fit) TESTS -

These two keys test the hypothesis (H_o:) that the data is normally, exponentially, or uniformly distributed versus, for each distribution separately, that it is not. Figure 1 shows a graph of typical normal, exponential, and uniform probability (density) destributions.

H_o: Population [Normal, Exponential, or Uniform]

H_1: Population [Not Normal, Exponential, or Uniform]

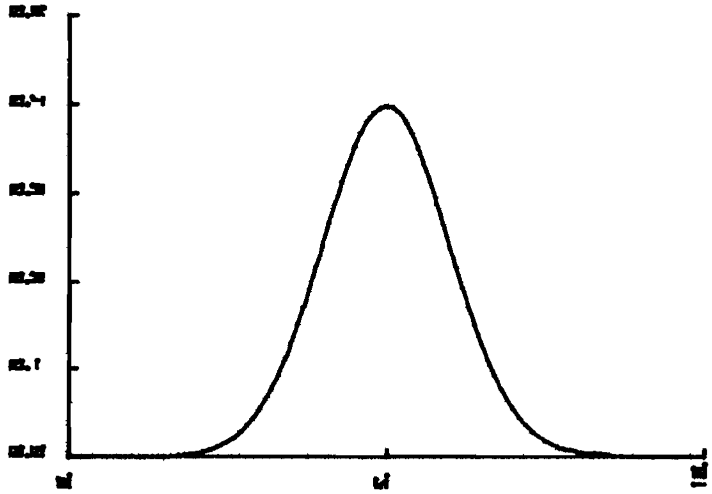
d. SW TESTS (Shapiro-Wilk Test for Normality) -

The Shapiro-Wilk test for normality is an extremely powerful test of normality for the population. It is recommended for samples size $n \leq 50$, that this test be used for checking the assumption of normality.

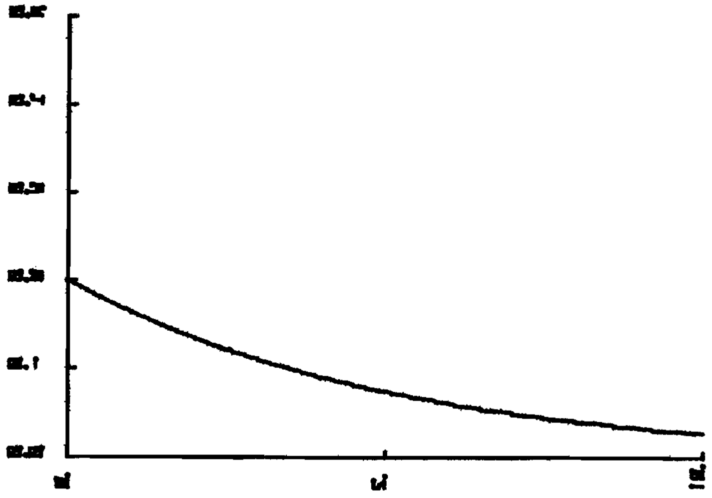
For further information about any of the four tests described very briefly above see the references sited above. For specific key operation, see SPECIAL FUNCTION KEYS: **t TEST**; **χ^2 G.O.F.**; **K-S G.O.F.**; or SHAPIRO-WILK TEST.

The discussion section which you have just read is intended only to refresh your memory about the various statistical concepts used in this program package. Further information about these procedures and other one sample statistics can be found in references 10 and 11 above.

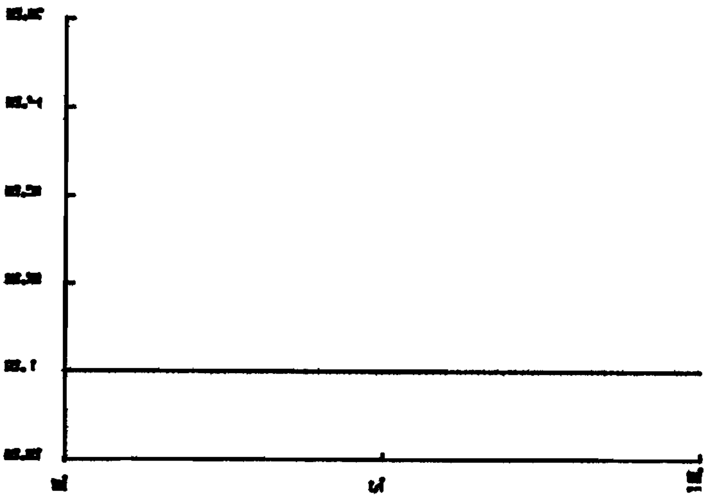
FIGURE 1: Typical Probability Density Function for Normal, Exponential, and Uniform



NORMAL.



EXPONENTIAL



UNIFORM

EXAMPLE

EXAMPLE #1

```
**ONE SAMPLE STATISTICS**
/////////////////////////////

DATA ENTRY CODES:  1=KEYBOARD; 2=CASSETTE; 3=CARD READER.



RELOAD DATA
***********


DATA RELOADED; PRESS ANY KEY.


**DATA**
   I            X(I)          X(I+1)          X(I+2)          X(I+3)          X(I+4)
   1          60.0000        49.0000        45.0000        40.0000        40.0000
   6          40.0000        35.0000        39.0000        35.0000        36.0000
  11          33.0000        33.0000        35.0000        31.0000        33.0000
  16          34.0000        33.0000        30.0000        36.0000        32.0000
  21          34.0000        33.5000        37.0000        34.0000        33.0000
  26          30.0000        37.0000        33.0000        35.0000        31.5000
  31          30.0000        35.0000        36.0000        32.0000        37.0000
  36          35.0000        30.0000        33.0000        31.0000        31.0000
  41          29.0000        29.0000        25.0000        31.5000        30.0000
  46          31.0000        30.0000        30.0000        29.0000        27.5000

**CORRECT X( 36    )= 37

**DELETE X( 29    )= 35    **NEW X( 29    )= 31.5    **N NOW = 49

**INSERT X( 7     )= 32    **N NOW = 50


**DATA**
   I            X(I)          X(I+1)          X(I+2)          X(I+3)          X(I+4)
   1          60.0000        49.0000        45.0000        40.0000        40.0000
   6          40.0000        32.0000        35.0000        39.0000        35.0000
  11          36.0000        33.0000        33.0000        35.0000        31.0000
  16          33.0000        34.0000        33.0000        30.0000        36.0000
  21          32.0000        34.0000        33.5000        37.0000        34.0000
  26          33.0000        30.0000        37.0000        33.0000        31.5000
  31          30.0000        35.0000        36.0000        32.0000        37.0000
  36          37.0000        30.0000        33.0000        31.0000        31.0000
  41          29.0000        29.0000        25.0000        31.5000        30.0000
  46          31.0000        30.0000        30.0000        29.0000        27.5000
```

EXAMPLE

```
SERIAL PLOT: PRINTER:
*********************
             25       32.00     39.00     46.00     53.00     60.00
              +---------+---------+---------+---------+---------+
             .
      1.0000 .                                                  *
      2.0000 .                                  *
      3.0000 .                            *
      4.0000 .                     *
      5.0000 .                     *
      6.0000 .                     *
      7.0000 .          *
      8.0000 .              *
      9.0000 .                    *
     10.0000 .              *
     11.0000 .                  *
     12.0000 .           *
     13.0000 .           *
     14.0000 .              *
     15.0000 .        *
     16.0000 .           *
     17.0000 .            *
     18.0000 .           *
     19.0000 .       *
     20.0000 .               *
     21.0000 .          *
     22.0000 .            *
     23.0000 .            *
     24.0000 .                 *
     25.0000 .            *
     26.0000 .           *
     27.0000 .       *
     28.0000 .                 *
     29.0000 .           *
     30.0000 .         *
     31.0000 .       *
     32.0000 .              *
     33.0000 .               *
     34.0000 .          *
     35.0000 .                 *
     36.0000 .                 *
     37.0000 .       *
     38.0000 .           *
     39.0000 .        *
     40.0000 .        *
     41.0000 .     *
     42.0000 .     *
     43.0000 .*
     44.0000 .         *
     45.0000 .       *
     46.0000 .        *
     47.0000 .       *
     48.0000 .       *
     49.0000 .     *
     50.0000 .   *
              +---------+---------+---------+---------+---------+
```

EXAMPLE

```
BASIC STATISTICS:
*****************

        N=             50             STD ERROR OF MEAN=      0.8069
     MEAN=        34.2000             COEF OF VARIATION=     16.68 %
 VARIANCE=        32.5510            STANDARD DEVIATION=      5.7054
 SKEWNESS=         2.1853                      KURTOSIS=      9.8762



   99.00% C.I. FOR MEAN:  (       32.0373 ,       36.3627)

ONE-TAIL  T( 49    , 5.00000E-03    )= 2.680402628



 95.00% C.I. FOR VAR:  (       22.7135 ,       50.5468)

CHI-SQUARE(   49,  0.9750)=      31.5549
CHI-SQUARE(   49,  0.0250)=      70.2226

ORDER STATISTICS:
*****************

ORDERED DATA:

    I           X(I)         X(I+1)        X(I+2)        X(I+3)        X(I+4)
    1         25.0000       27.5000       29.0000       29.0000       29.0000
    6         30.0000       30.0000       30.0000       30.0000       30.0000
   11         30.0000       30.0000       31.0000       31.0000       31.0000
   16         31.0000       31.5000       31.5000       32.0000       32.0000
   21         32.0000       33.0000       33.0000       33.0000       33.0000
   26         33.0000       33.0000       33.0000       33.5000       34.0000
   31         34.0000       34.0000       35.0000       35.0000       35.0000
   36         35.0000       36.0000       36.0000       37.0000       37.0000
   41         37.0000       27.0000       38.0000       39.0000       40.0000
   46         40.0000       40.0000       45.0000       49.0000       60.0000

      N= 50
   XMIN=        25.0000
   XMAX=        60.0000
  RANGE=        35.0000
 MEDIAN=        33.0000

TUKEY'S HINGES:
.25 QUANTILE=      31.0000
.75 QUANTILE=      36.0000

MID-RANGE=       5.0000
   TRIMEAN=      33.2500
```

EXAMPLE

```
RANKED DATA:
************
                 DISTINCT                          DISTINCT                          DISTINCT
(   RANK      DATA POINT)    (   RANK      DATA POINT)    (   RANK      DATA POINT)

(    1.00        25.0000)    (    2.00        27.5000)    (    4.00        29.0000)
(    9.00        30.0000)    (   14.50        31.0000)    (   17.50        31.5000)
(   20.00        32.0000)    (   25.00        33.0000)    (   29.00        33.5000)
(   31.00        34.0000)    (   34.50        35.0000)    (   37.50        36.0000)
(   40.50        37.0000)    (   43.00        38.0000)    (   44.00        39.0000)
(   46.00        40.0000)    (   48.00        45.0000)    (   49.00        49.0000)
(   50.00        60.0000)



HISTOGRAM; PRINTER:
*******************

OFFSET = 20
# OF CELLS = 10
OPTIMUM CELL WIDTH = 4.00004

YOUR CELL WIDTH = 4


THERE ARE 1     OBS TOO LARGE FOR 10    CELLS; NEED LARGER CELL WIDTH
OR MORE CELLS.



EACH X = 0.90 %


     20.0000 .
             .
     24.0000 .
             .XXXX
     28.0000 .
             .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
     32.0000 .
             .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
     36.0000 .
             .XXXXXXXXXXXXXXXXX
     40.0000 .
             .XXXXXX
     44.0000 .
             .XX
     48.0000 .
             .XX
     52.0000 .
```

```
CELL STATISTICS:

  CELL#          LOWER          NUMBER            %RELATIVE
                 LIMIT          OF OBS.           FREQUENCY

    2           24.0000            2                4.00
    3           28.0000           16               32.00
    4           32.0000           18               36.00
    5           36.0000            8               16.00
    6           40.0000            3                6.00
    7           44.0000            1                2.00
    8           48.0000            1                2.00




KOLMOGOROV-SMIRNOV GOODNESS-OF-FIT TEST
***************************************


GOODNESS-OF-FIT (GOF) CODES:
1=NORMAL; 2=EXPONENTIAL; 3=UNIFORM.


GOODNESS-OF-FIT CODE= 2

MEAN= 34

N=  50,  KOLMOGOROV-SMIRNOV STATISTICS:  DN =  0.53462
                              SQR(N)*DN = KN =  3.78032
```

EXAMPLE 2 ONE HUNDRED FAILURE - TIME DATA

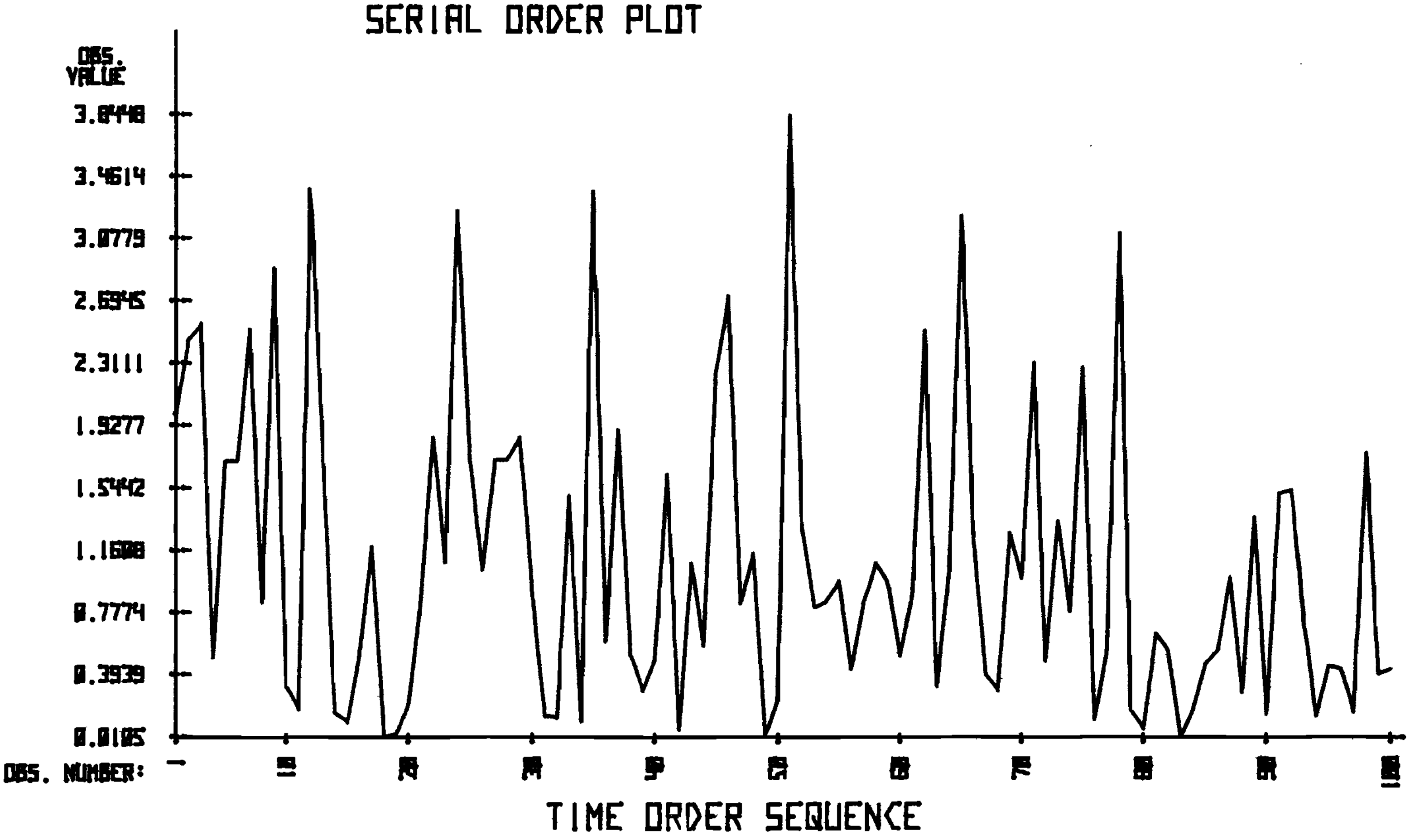
One hundred observations of the time until failure of an electronic circuit were obtained from a life testing experiment. The coded data are shown below. The third data point was corrected from a value of 3.5576 to 2.5576. The serial correlations with lag 1 and lag 2 were quite small indicating apparent "independence" of the observation. Also a serial plot of the data on the printer shows no particular patterns.

This type of data is assumed to come from an exponential random variable with parameter m mean = 1.0. The histogram of the data indicates that this assumption might be valid. Furthermore, the normal curve overlay does not fit the data very well. If the data really is exponential with parameter $\lambda = 1$, then the sample mean and variance also should be about 1. From the basic statistics output we see that $\overline{x} = 1.0856$ and $s^2 = .8651$ which do not differ from one by a great deal.

Both the Chi-square Goodness of Fit Test and the Kolmogorov-Smirnov Goodness of Fit Test indicate that we can not reject the hypothesis that the data came from an exponentially distributed population with parameter $\lambda = 1$. The χ^2 test yields a test statistic of 9.248 with 8 degrees of freedom which is not significant even at the $\alpha = .10$ level. The K-S test statistic DN = .09907 which is not significant at $\alpha = .20$ level. (See attached χ^2 and K-S tables in Appendix). However, both tests (χ^2 and K-S) indicate that the data is not normally distributed.

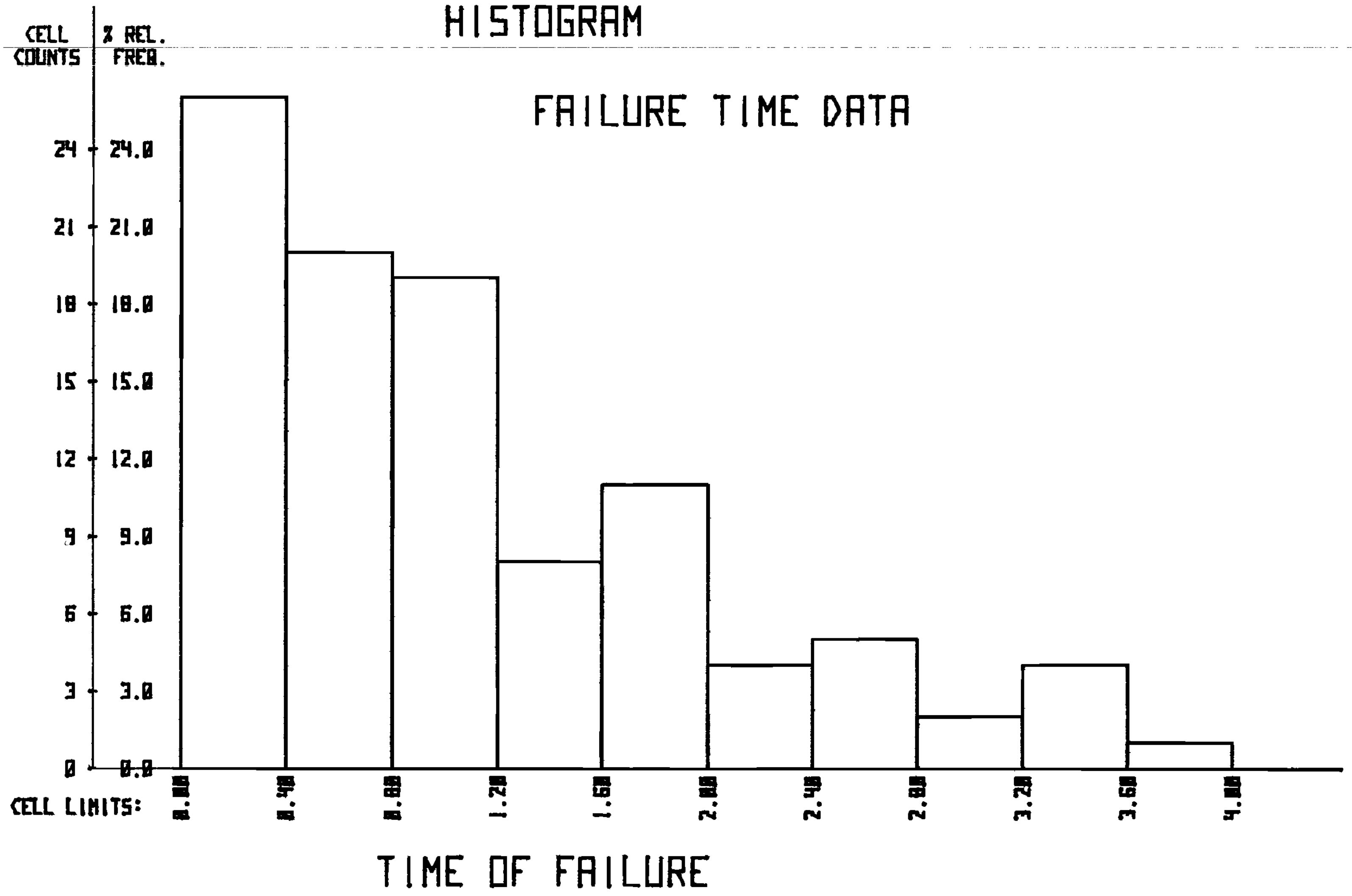
EXAMPLE

```
**ONE SAMPLE STATISTICS**
//////////////////////////////

DATA ENTRY CODES:  1=KEYBOARD; 2=CASSETTE; 3=CARD READER.
DATA ENTRY CODE= 2

SAMPLE SIZE = 100

(CASSETTE SELECT CODES:  5= 9865A; 10= 9830A)

CASSETTE SELECT CODE= 5

LOADING DATA FROM FILE # 2

**DATA**
   I          X(I)          X(I+1)          X(I+2)          X(I+3)        X(I+4)
   1        2.0079          2.4545          3.5576          0.5025        1.7143
   6        1.7143          2.5248          0.8439          2.8990        0.3222
  11        0.1818          3.3878          1.7149          0.1602        0.1036
  16        0.5353          1.1887          0.0148          0.0351        0.2158
  21        0.8477          1.8577          1.0850          3.2537        1.7357
  26        1.0388          1.7230          1.7233          1.8558        0.8984
  31        0.1422          0.1279          1.4995          0.1101        3.3735
  36        0.6019          1.9080          0.5214          0.2958        0.4973
  41        1.6301          0.0574          1.0836          0.5765        2.2521
  46        2.7278          0.8340          1.1464          0.0207        0.2390
  51        3.8448          1.2953          0.8129          0.8502        0.9739
  56        0.4328          0.8397          1.0849          0.9598        0.5117
  61        0.8953          2.5107          0.3238          1.0627        3.2196
  66        1.2055          0.3940          0.2973          1.2711        0.9867
  71        2.3150          0.4806          1.3441          0.7867        2.2879
  76        0.1219          0.5402          3.1125          0.1748        0.0632
  81        0.6531          0.5445          0.0105          0.1805        0.4643
  86        0.5534          0.9949          0.2895          1.3660        0.1509
  91        1.5127          1.5390          0.7745          0.1430        0.4490
  96        0.4334          0.1654          1.7606          0.4010        0.4323
**CORRECT X( 3     )= 2.5576


SERIAL CORRELATION
*******************

SERIAL CORRELATION WITH LAG = 1      = 0.016057726


SERIAL CORRELATION WITH LAG = 2      =-0.012354872



SERIAL PLOT; PLOTTER:
**********************
```


SERIAL ORDER PLOT
OBS. VALUE
3.8448
3.4614
3.0779
2.6945
2.3111
1.9277
1.5442
1.1608
0.7774
0.3939
0.0105
OBS. NUMBER:
1
TIME ORDER SEQUENCE

EXAMPLE

```
HISTOGRAM; PLOTTER:
*******************

WITH NORMAL CURVE OVERLAY


OFFSET = 0
# OF CELLS = 10
OPTIMUM CELL WIDTH = 0.384483845

YOUR CELL WIDTH = 0.4

CELL STATISTICS:

  CELL#          LOWER         NUMBER            %RELATIVE
                 LIMIT         OF OBS.           FREQUENCY

     1           0.0000          26                26.00
     2           0.4000          20                20.00
     3           0.8000          19                19.00
     4           1.2000           8                 8.00
     5           1.6000          11                11.00
     6           2.0000           4                 4.00
     7           2.4000           5                 5.00
     8           2.8000           2                 2.00
     9           3.2000           4                 4.00
    10           3.6000           1                 1.00


BASIC STATISTICS:
*****************

       N=           100         STD ERROR OF MEAN=       0.0930
    MEAN=        1.0856         COEF OF VARIATION=      85.68 %
VARIANCE=        0.8651        STANDARD DEVIATION=       0.9301
SKEWNESS=        1.0156                  KURTOSIS=       3.2646


   95.00% C.I. FOR MEAN:  (        0.9010 ,        1.2702)

ONE-TAIL  T( 99    , 0.025    )= 1.984661757


  95.00% C.I. FOR VAR:  (        0.6669 ,        1.1675)

CHI-SQUARE(    99,   0.9750)=      73.3611
CHI-SQUARE(    99,   0.0250)=     128.4219
```


HISTOGRAM
FAILURE TIME DATA
CELL COUNTS
% REL. FREQ.
24
21
18
15
12
9
6
3
0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0
CELL LIMITS:
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
TIME OF FAILURE

EXAMPLE

```
CHI-SQUARE GOODNESS-OF-FIT TEST
*******************************

GOODNESS-OF-FIT (GOF) CODES:
1=NORMAL; 2=EXPONENTIAL; 3=UNIFORM.


GOODNESS-OF-FIT CODE= 2

OFFSET= 0
# OF CELLS= 10
OPTIMUM CELL WIDTH= 0.384483845

YOUR CELL WIDTH= 0.4


 CELL #        LOWER      OBSERVED          EXPECTED
               LIMIT      # OF OBS.         # OF OBS.
    1         0.0000         26              30.82
    2         0.4000         20              21.32
    3         0.8000         19              14.75
    4         1.2000          8              10.20
    5         1.6000         11               7.06
    6         2.0000          4               4.88
    7         2.4000          5               3.38
    8         2.8000          2               2.34
    9         3.2000          4               1.62
   10         3.6000          1               1.12

CHI-SQUARE GOODNESS-OF-FIT FOR EXPONENTIAL DISTRIBUTION

CHI-SQUARE VALUE =      9.248;  DEGREES OF FREEDOM =   8



KOLMOGOROV-SMIRNOV GOODNESS-OF-FIT TEST
***************************************


GOODNESS-OF-FIT (GOF) CODES:
1=NORMAL; 2=EXPONENTIAL; 3=UNIFORM.


GOODNESS-OF-FIT CODE= 2

MEAN= 1

N= 100,  KOLMOGOROV-SMIRNOV STATISTICS:  DN =  0.09907
                             SQR(N)*DN = KN =  0.99066
```

EXAMPLE

```
RDER STATISTICS:
****************


RDERED DATA:

   I          X(I)           X(I+1)           X(I+2)          X(I+3)          X(I+4)
   1         0.0105          0.0148           0.0207          0.0351          0.0574
   6         0.0632          0.1036           0.1101          0.1219          0.1279
  11         0.1422          0.1430           0.1509          0.1602          0.1654
  16         0.1748          0.1805           0.1818          0.2158          0.2390
  21         0.2895          0.2958           0.2973          0.3222          0.3238
  26         0.3940          0.4010           0.4323          0.4328          0.4334
  31         0.4490          0.4643           0.4806          0.4973          0.5025
  36         0.5117          0.5214           0.5353          0.5402          0.5445
  41         0.5534          0.5765           0.6019          0.6531          0.7745
  46         0.7867          0.8129           0.8340          0.8397          0.8439
  51         0.8477          0.8502           0.8953          0.8984          0.9598
  56         0.9739          0.9867           0.9949          1.0388          1.0627
  61         1.0836          1.0849           1.0850          1.1464          1.1887
  66         1.2055          1.2711           1.2953          1.3441          1.3660
  71         1.4995          1.5127           1.5390          1.6301          1.7143
  76         1.7143          1.7149           1.7230          1.7233          1.7357
  81         1.7606          1.8558           1.8577          1.9080          2.0079
  86         2.2521          2.2879           2.3150          2.4545          2.5107
  91         2.5248          2.5576           2.7278          2.8990          3.1125
  96         3.2196          3.2537           3.3735          3.3878          3.8448


     N= 100
  XMIN=          0.0105
  XMAX=          3.8448
 RANGE=          3.8343
EDIAN=           0.8458

UKEY'S HINGES:
25 QUANTILE=           0.3589
75 QUANTILE=           1.7143

ID-RANGE=          1.3554
  TRIMEAN=         0.9412
```

EXAMPLE 3 BLACK-BELLIED TREE DUCKS

An experiment was conducted subjecting black-bellied tree ducks to Blough's psychophysical tracking procedure. The experimental conditions described below represent only a portion of the total experiment with these ducks. A duck was exposed to 25 ft-c of white light for sixty minutes as a regular pre-exposure treatment. The duck was then placed in a Skinner box in a dark room. The duck had been previously trained to respond to a light patch inside the box by pecking one of two stimulus keys - one to reduce the intensity (or actually the milliamperes) and one to increase the intensity of the light patch. The light patch in the box was set at time zero at 60 milliamperes. The ducks had been trained to reduce this intensity by pecking the proper key. They had been trained also to keep some light in the box using a variable ratio reward system which was programmed into the pecking procedure. As the ducks became dark adapted, they are able to see a weaker intensity of light behind the stimulus patch. In comparison with other diurnal (active during the daytime) birds, the black-bellied tree duck's visual sensitivity is greater in weak light intensities.

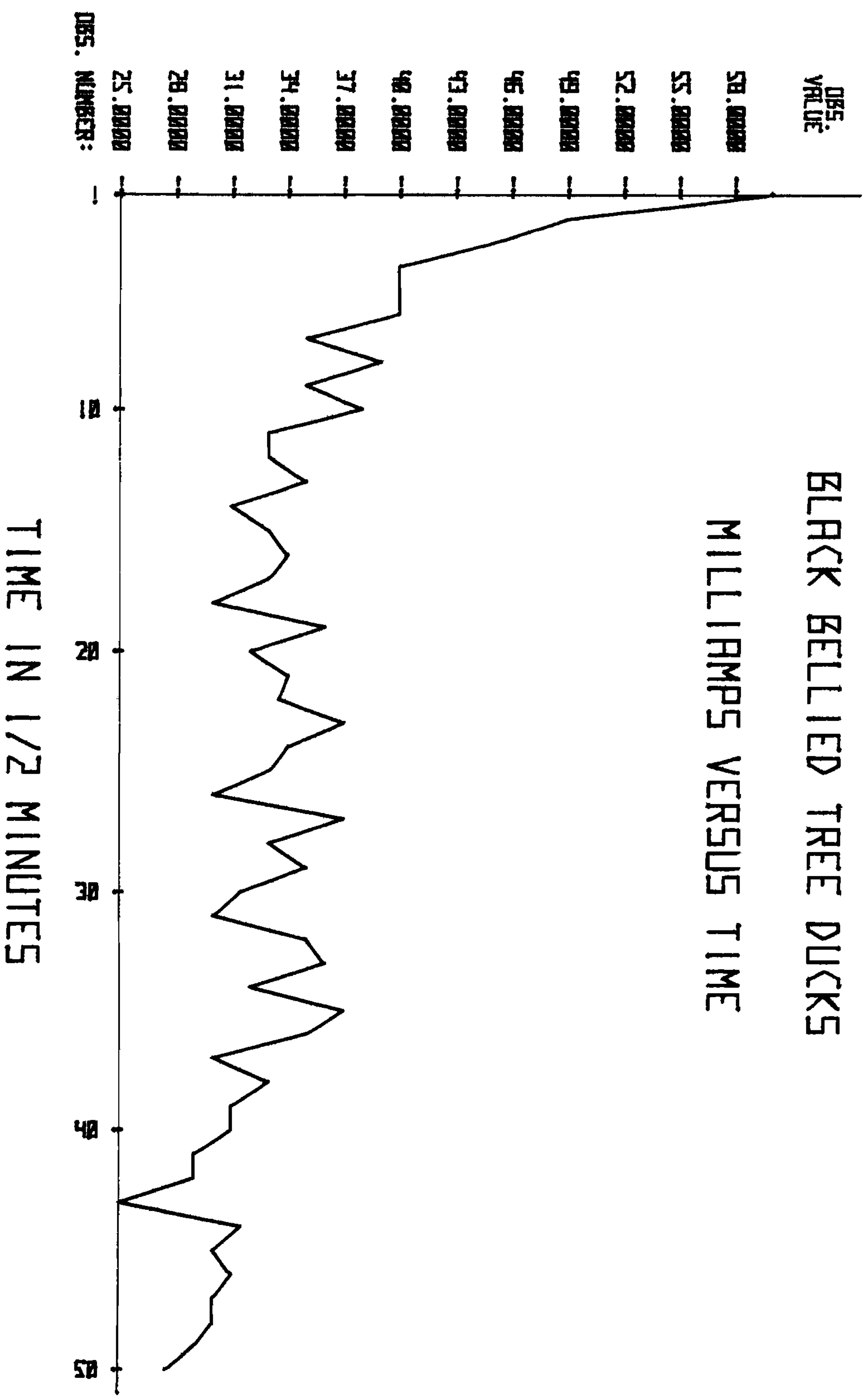
The data as recorded were the "milliamperes of intensity" as measured approximately every one-half minute for one duck. Only the first fifty observations will be used here. Notice that one would expect autocorrelation between successive data points since they are not independent.

The basic statistics for this set of data show a mean value of 34.22 with a standard deviation of 5.6849 and a coefficient of variation of 16.61%. The basic statistics however, do not tell us very much about the "order" sequencing of the data-time sequencing. The serial correlation with lag 1 is 0.57 and 0.47 with lag 2 indicating that the data may not be independent. Finally, the serial plot of the data on the 9862A Plotter shows most of the "story". The duck is indeed driving down the "intensity" of the light patch. Part of the purpose of this study was to determine the threshold level, that is the level at which the duck can just barely see.

By fitting (using another program) a curve of the form Y = A + B * EXP(C*X) where X = time, one might be able to determine the threshold value A.

EXAMPLE

```
**ONE SAMPLE STATISTICS**          EXAMPLE  3  - BLACK BELLIED TREE DUCKS
//////////////////////////////

DATA ENTRY CODES:  1=KEYBOARD; 2=CASSETTE; 3=CARD READER.


DATA ENTRY CODE= 1

SAMPLE SIZE = 50


   I            X(I)         X(I+1)         X(I+2)         X(I+3)         X(1+4)
   1         60.0000        49.0000        45.0000        40.0000        40.0000
   6         40.0000        35.0000        39.0000        35.0000        38.0000
  11         33.0000        33.0000        35.0000        31.0000        33.0000
  16         34.0000        33.0000        30.0000        36.0000        32.0000
  21         34.0000        33.5000        37.0000        34.0000        33.0000
  26         30.0000        37.0000        33.0000        35.0000        31.5000
  31         30.0000        35.0000        36.0000        32.0000        37.0000
  36         35.0000        30.0000        33.0000        31.0000        31.0000
  41         29.0000        29.0000        25.0000        31.5000        30.0000
  46         31.0000        30.0000        30.0000        29.0000        27.5000


BASIC STATISTICS:
*****************

        N=             50         STD ERROR OF MEAN=         0.8040
     MEAN=        34.2200         COEF OF VARIATION=        16.61 %
 VARIANCE=        32.3180        STANDARD DEVIATION=         5.6849
 SKEWNESS=         2.1976                  KURTOSIS=         9.9865


SERIAL CORRELATION
*******************

SERIAL CORRELATION WITH LAG = 1    = 0.574534662


SERIAL CORRELATION WITH LAG = 2    = 0.467910178


SERIAL CORRELATION WITH LAG = 3    = 0.344766163


SERIAL PLOT; PLOTTER:
*********************
```


BLACK BELLIED TREE DUCKS
MILLIAMPS VERSUS TIME
OBS. VALUE:
58.0000
55.0000
52.0000
49.0000
46.0000
43.0000
40.0000
37.0000
34.0000
31.0000
28.0000
25.0000
OBS. NUMBER:
1
10
20
30
40
50
TIME IN 1/2 MINUTES

VARIABLES LIST

Name	Used in Files	Description
		VARIABLES USED IN COMMON
A[150]	C = Common	Variable array used to hold the sample data
B	C	Used as the maximum sample size
FI[1]	C: 37 and files 38, 39, 40, 41, 43, 44, 45, 46, 47, 48, 49	Used as cell counts
F9	C: 33, 34	Used as computed t-value
	35	Used as computed t-value
N	C	Used as the number of observations
S1	C	Used as a flag; equals zero if the data hasn't been ordered by any key; equals one if the data has been ordered by some key.
S2	C: 1, 2, 3, 4	Used as a flag; equals zero if the data is not to be printed during the start operation; equals one if the data is to be printed during the start operation.
	13, 21	Used as $\sum_{i=1}^{N} X_i^2$, the sum of observations squared.
S3	C: 1, 2	Used as a flag; equals zero to print (equals 6 to not print) the data during the start operation under keyboard data entry.
	C: 4	Used as the number of cards to be read.
	21	Used as $\sum_{i=1}^{N} X_i^3$, the sum of the observations cubed.
S5	C	Used in all files but 1-4. Used as the sample mean.
S6	C	Used in all files but 1-4. Used as the sample standard deviation.

VARIABLES LIST

Name	Used in Files	Description
T	C: 3	Used as the select code in all but line 120, where it is used as a flag (see note below).
	C: 4	Used as the number of observations per card in all but line 120 where it is used as a flag (see note below).
	C: 5	Used as a flag (see note below).
	C: 28, 30, 31	Used as a line indicator.
	C: 38	Used as the number of cells.
	9, 10, 11, 12	Used as the transformation code in all but line 25 of files 11 and 12, where it is used as a flag (see note below). NOTE: When T is used as a flag, it is used in conjunction with file 5. T equals one if the data is to be stored on the program tape after it is printed; equals zero otherwise.
	13	Used as $\sum_{i=1}^{N} X_i$, the sum of observations
	23	Used as the t-value of the students t-distribution with N-1 degrees of freedom such that P[X > t] = P where P equals (1 - confidence coefficient)/2
	24	Used as a temporary variable
	39, 40, 42, 43, 47 48	See C: 38
	41	Used as the number of spaces before typing a "*".
T1	C: 33, 34	Used as a flag; equals one for a one-tailed t-test; equals two for a two-tailed t-test.
	36	See C: 33, 34, above.

VARIABLES LIST

Name	Used in Files	Description
	12	Used as a flag; equals one for 'C' a constant; equals two for 'C' a variable.
	17	Used as the minimum sample value
	23	Used as $t_{N-1,\ \alpha/2} \cdot S/\ N$ (see confidence interval for mean under Method, Notation and/or Formulas).
	27	Used as the lower confidence limit on the confidence interval for variance.
	30, 51, 57	Used as a temporary variable
X[8]	C: 30, 51, 57	Array used in the sorting routine 'QSORT' obtained from Colorado State University Computer Center applications library. The dimension '8' allows the sort routine to sort $2^8 = 256$ data points.
Y[8]	C: 30, 51, 57	See X[8], above.
		VARIABLES DEFINED WITHIN FILES
A	44, 45, 48, 49	Used as the number of the left-most non-empty cell.
B[2, 2]	28	Variable array used as temporary storage of computed rank and corresponding distinct data point.
B1	40, 41, 44, 45, 48, 49, 50	Used as the number of the right-most non-empty cell.
C	58, 59, 182	Used as the numerator of the W-statistic
	9, 12	Used as a constant
	38, 39, 40, 41, 42, 43, 45, 47, 48, 49	Used as the cell width
C1	15	Used as the value of $\sum_{i=1}^{N-k} (X_i-\overline{X})(X_{i+k}-\overline{X})$.
CS[12]	58	Array used for the Shapiro-Wilk coefficients.

VARIABLES LIST

Name	Used in Files	Description
D	48. 49, 50	Used as the degrees of freedom
	53, 54, 55, 56	Used as the Kolmogorov-Smirnov statistic
D1	54, 55	Used as the value of the empirical c.d.f. at K-1st observation for K = 1, 2, ..., N (i.e., D1 = (K-1)/N).
D2	54, 55	Used as the value of the empirical c.d.f. at Kth observation for K = 1, 2, ..., N (i.e., D2 = K/N).
D3	54, 55	Used as Max (D1, D2).
DS[4]	58	Array used for Shapiro-Wilk percentage points
E	49, 54	Used as the value of the integral, for each cell.
E1	49	Used as the lower limit of integration for the exponential distribution.
E2	49	Used as the upper limit of integration for the exponential distribution.
F	16	Used as the select code.
H	49, 54	Used as the step size for integration.
K	15	Used as the correlation lag.
	40, 43	Used as a constant for the exponential curve overlay on the plotter.
L1	46, 47, 49, 53, 55	Lower limit on the uniform or exponential distribution.
L2	46, 49, 53, 55	Upper limit on the uniform distribution.
M	53, 54, 55	Used as the hypothesized mean.
M1	53, 54, 55	Used as the lower limit of integration.
N1		Used as the number of steps for integration.
N9	40, 42	Used as the maximum cell count.
O	38, 39, 41, 42, 43, 45, 47, 48, 49	Used as the offset, the lower limit of the left-most cell.
P	17	Used as a flag; equals zero for the

VARIABLES LIST

Name	Used in Files	Description
		printer; equals one for the plotter.
	22, 23, 24, 27, 36	Used as probabilities.
	37, 41, 43	Used as a flag; equals one for a normal curve overlay; equals zero for no normal curve overlay.
	46, 47, 49, 50, 52, 53, 55	Used as the goodness-of-fit code
P1	37, 39, 40	See P, 17.
P2	27	Used as a probability.
R	18, 21	Used as the number of X's to print.
S	2	Used as a counter to determine when to print a line of data.
	53, 54	Used as the hypothesized variance.
S4	1	Used as the data entry code.
	21	Used as $\sum_{i=1}^{N} X_i^4$, the sum of observations quadrupled.
T2	17, 18, 19, 37, 38, 46, 47	Used as the maximum sample value
	27	Used as the upper confidence limit on the confidence interval for variance.
T4	39, 48	Used as the number of observations that are less than the offset.
T5	39, 48	Used as the number of observations that are too large for the upper limit of the right-most cell.
T9	36	Used as the P-quantile point of the t-distribution.
U	40, 41	Used as a constant for the exponential curve overlay on the printer.
V	58, 59, 182	Used as the file indicator for the Shapiro-Wilk coefficients or percentage points.

VARIABLES LIST

Name	Used in Files	Description
W	17, 18, 40, 41	Used as the value of each character position.
	59, 82	Used as the value of the W-statistic.
X	48, 49, 50	Used as the chi-square value.
X0	19, 20, 40, 42, 43	Used as the X-axis scale factor.
X1	49	Used as the lower limit of integration.
X2	48, 49	Used as the upper limit of integration.
Y	39, 48	Used as the cell index into which an observation falls.
	41	Used as the lower cell limit.
Y0	19, 20, 40, 42, 43	Used as the Y-axis scale factor.
Z	53, 54, 55	Used as the cumulative c.d.f.

FILE DESCRIPTION

File No.	File Size	File Usage	Other Files Called	Description
0	190	182	1,5,6,7 8,9,13, 15,16, 17,21, 28,31, 33,37, 46,52, or 58	Contains key instructions which will load appropriate file when pressed.
1	385	333	2,3,or 4	Start file; initialization
2	385	330	6 or 13	Start file; keyboard input
3	275	225	5 or 13	Start file; cassette tape input
4	365	315	5 or 13	Start file; card reader input
5	410	364	6 or 13	Output data file
6	260	213	7,8 or 13	Correct file
7	290	244	6,8 or 13	Delete file
8	340	289	6,7 or 13	Insert file
9	385	339	10 or 12	Transform data file; initialization and label
10	295	244	11 or 12	Transform data file; label
11	185	137	5	Transform data file; user defined transformations
12	330	270	5	Transform data file; defined transformations
13	200	148	14	Calculate mean and standard deviation and store data (lines 10 to 65). Reload data (lines 70 to 120).
14	1050	0	--	Data file for sample points, sample size, maximum sample size, S1, sample mean, and the sample standard deviation (for maximum sample size of 255)
15	300	249	--	Serial correlation file.
16	295	246	17 or 18	Serial plot file; initialization
17	220	171	--	Serial plot file; printer
18	395	344	19	Serial plot file; plotter: labeled axis
19	190	137	--	Serial plot file; plotter: plot and label

FILE DESCRIPTION

File No.	File Size	File Usage	Other Files Called	Description
20	375	325	21	Basic statistics file; basic statistics
21	210	159	22	Basic statistics file; confidence coefficient for confidence interval on mean.
22	280	229	23	Basic statistics file; confidence interval on mean.
23	375	324	25	Basic statistics file; confidence coefficient for confidence interval on variance.
24	310	256	23, 25 or 26	Basic statistics file; chi-square value calculation.
25	420	371	26	Basic statistics file; subroutine called by file 24.
26	210	158	--	Basic statistics file; confidence interval on variance.
27	310	259	--	Store data file.
28	410	356	29 or 30	Order statistics file.
29	365	315	28	Output of order statistics
30	420	375	28 or 31	'Qsort' sorting routine
31	200	151	30, 32	Ranks file; label
32	410	356	--	Ranks file; computes and outputs ranks.
33	230	179	34	Histogram file; initialization, #1.
34	275	222	35	Histogram file; initialization, #2.
35	325	274	34 or 36	Histogram file; initialization, #3.
36	235	184	37	Histogram file; initialization, #4.
37	370	317	40	Histogram file; histogram on printer.
38	320	270	39	Histogram file; labeled axis on plotter.
39	290	236	40	Histogram file; histogram on plotter, normal curve overlay, and label.
40	200	151	41	Histogram file; cell statistics label.
41	125	76	--	Histogram file; cell statistics output.
42	245	193	43	t-test file; initialization.
43	325	276	44	t-test file; calculate t-probability, #1.
44	200	140	45	t-test file; calculate t-probability, #2.
45	400	346	--	t-test file; calculate t-probability, #3.
46	340	292	47	Chi-square goodness-of-fit file; initialization, #1.
47	345	296	48	Chi-square goodness-of-fit file; initialization, #2.

FILE DESCRIPTION

File No.	File Size	File Usage	Other Files Called	Description
48	400	348	47 or 49	Chi-square goodness-of-fit file; initialization, #3.
49	420	371	50	Chi-square goodness-of-fit file; cell statistics and calculation of chi-square value.
50	240	189	46	Chi-square goodness-of-fit file; output of chi-square value.
51	420	375	52	'Qsort" sorting routine.
52	240	190	51, 53	Kolmogorov-Smirnov goodness-of-fit file; initialization #1.
53	320	268	54 or 55	Kolmogorov-Smirnov goodness-of-fit file; initialization #2.
54	325	273	56	Kolmogorov-Smirnov goodness-of-fit file; calculation of goodness-of-fit for normal distribution.
55	235	185	56	Kolmogorov-Smirnov goodness-of-fit file; calculation of goodness-of-fit for exponential or uniform distribution.
56	180	130	52	Kolmogorov-Smirnov goodness-of-fit file; output of statistic.
57	420	375	58	'Qsort' sorting routine
58	325	278	57,59 or 182 and some files between 60 and 181(see files 60-181)	Shapiro-Wilk normality test file; calculate numerator (loads data (coefficients) from files 60, 61, or 62, 63, or ..., or 178, 179, 180, 181).
59 & 182	225	175		Shapiro-Wilk normality test file; outputs statistic and percentage points.
60, 62, ... 180	24	24		Coefficients (twelve per file) and percentage points for the Shapiro-Wilk normality test.
61, 63, ... 181	10	10		Algorithm to find the file number(s) containing the coefficients and percentage points for a sample size n, $3 \leq n \leq 50$: Let t = [(n-3)/24] where [X] = largest integer less than or equal to X.

FILE DESCRIPTION

File No.	File Size	File Usage	Other Files Called	Description
				Then the file number, $f = (t+1)\cdot(n-2-12t) + n + 56.$ If $1 \leq [n/2] \leq 12$ all the coefficients are on file f and the percentage points are on file $f + 1$. If $12 < [n/2] \leq 24$ the first twelve coefficients are on file f; the remaining $[n/2] - 12$ coefficients are on file $f + 1$ with the percentage points on file $f + 2$. If $n = 50$, the first twelve coefficients are on file f, the second twelve coefficients are on file $f + 1$, and the last of the 25 coefficients is on file $f + 2$. The percentage points are on file $f + 3$.

LISTING

FILE 0

```
OAD1,5,10*

OAD13,5,70*

OAD 5,5,60*

OAD 6,5,10*

OAD7,5,10*

OAD8,5,10*

OAD9,5,10*

OAD15,5,10*

OAD16,5,30*

OAD16,5,10*

OAD20,5,10*

OAD27,5,10*

OAD 28,5,15*

OAD31,5,10*

OAD33,5,30*

OAD33,5,10*

OAD42,5,10*

OAD46,5,10*

OAD 52,5,10*

OAD58,5,10*
```

LISTING

```
FILE # 1
*********

5 COM N,B,A[150],S1,S2,S3
10 PRINT
15 PRINT "**ONE SAMPLE STATISTICS**"
20 PRINT "/////////////////////////"
25 PRINT
30 PRINT "DATA ENTRY CODES:  1=KEYBOARD; 2=CASSETTE; 3=CARD READER."
35 PRINT
40 PRINT
45 DISP "SEE ABOVE: DATA ENTRY CODE =";
50 INPUT S4
55 IF S4#2 AND S4#1 AND S4#3 THEN 45
60 PRINT "DATA ENTRY CODE="S4
65 PRINT
70 B=150
71 S1=0
75 DISP "MAX SIZE="B;": SAMPLE SIZE =";
80 INPUT N
85 IF N<2 OR N>B THEN 75
90 PRINT "SAMPLE SIZE ="N
95 PRINT
100 DISP "TO PRINT DATA ENT 1";
105 INPUT S2
110 IF S2#1 OR S4#1 THEN 140
115 S3=0
120 PRINT
125 WRITE (15,130)
130 FORMAT 3X,"I",10X,"X(I)",8X,"X(I+1)",8X,"X(I+2)",8X,"X(I+3)",8X,"X(I
135 GOTO 150
140 GOTO S4 OF 145,155,160
145 S3=6
150 LOAD 2,5,60
155 LOAD 3,5,10
160 LOAD 4,5,10

FILE # 2
*********

5 COM N,B,A[150],S1,S2,S3
10 GOTO S OF 45,35,25,15
15 WRITE (15,55)N-3,A[N-3],A[N-2],A[N-1],A[N]
20 RETURN
25 WRITE (15,55)N-2,A[N-2],A[N-1],A[N]
30 RETURN
35 WRITE (15,55)N-1,A[N-1],A[N]
40 RETURN
45 WRITE (15,55)N,A[N]
50 RETURN
55 FORMAT F4.0,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4
```

LISTING

```
0 S=S3
5 FOR I=1 TO N
0 DISP "X("I;") =";
5 INPUT A[I]
0 S=S+1
5 GOTO S OF 110,110,110,110,100
0 NEXT I
5 GOTO 115
00 S=S3
05 WRITE (15,55)I-4,A[I-4],A[I-3],A[I-2],A[I-1],A[I]
10 NEXT I
15 IF S2#1 THEN 135
20 S=N-INT(N/5)*5
25 IF S=0 THEN 135
30 GOSUB 10
35 PRINT
40 PRINT
45 DISP "IF CORRECTIONS ENT1";
50 INPUT I
55 IF I=1 THEN 165
60 LOAD 13,5,10
65 LOAD 6,5,10

ILE # 3
********
 COM N,B,A[150],S1,S2,S3,T
0 PRINT "(CASSETTE SELECT CODES:  5= 9865A; 10= 9830A)"
5 PRINT
0 PRINT
5 DISP "SEE ABOVE: SELECT CODE=";
0 INPUT T
5 IF T#5 AND T#10 THEN 25
0 PRINT "CASSETTE SELECT CODE="T
5 PRINT
0 PRINT
5 DISP "YOUR FILE NUMBER =";
0 INPUT I
5 DISP "INSERT YOUR TAPE THEN ENT 1";
0 INPUT J
5 PRINT "LOADING DATA FROM FILE #"I
0 PRINT
5 PRINT
0 LOAD  DATA #T,I,A
5 REWIND #T
00 IF T=5 THEN 115
05 DISP "INSTALL PGM TAPE; ENT 1";
10 INPUT I
15 IF S2#1 THEN 130
20 T=1
25 LOAD 5,5,65
30 LOAD 13,5,10
```

LISTING

```
FILE # 4
*********

5 COM N,B,A[150],S1,S2,S3,T
10 DISP "NUMBER OF CARDS=";
15 INPUT S3
20 DISP "NO. OF OBS. PER CARD=";
25 INPUT T
30 IF S3*T=N THEN 45
35 PRINT "(NO. OF CARDS)X(NO. OF OBS. PER CARD)#"N;" THE SAMPLE SIZE."
40 GOTO 10
45 PRINT"ENTER YOUR FORMAT AT LINE #100;DEFAULT FORMAT:100 FORMAT 6F12.4"
50 PRINT "THEN  PRESS 'CONT 85, EXECUTE'"
55 PRINT
60 PRINT "IF ERROR OCCURS, CORRECT IT THEN PRESS 'CONT 85, EXECUTE'"
65 PRINT
70 PRINT
75 DISP "SEE ABOVE: PRESS 'CONT85, EXEC.'";
80 STOP
85 WRITE (1,*)"C"
90 FOR J=1 TO S3
95 ENTER (1,100)(FORI=1TOT,A[T*(J-1)+I])
100 FORMAT 6F12.4
105 NEXT J
110 WRITE (1,*)"B"
115 WRITE (1,*)"S"
120 T=1
125 IF S2#1 THEN 135
130 LOAD 5,5,65
135 LOAD 13,5,10

FILE # 5
*********

5 COM N,B,A[150],S1,S5,S6,T
10 GOTO J OF 45,35,25,15
15 WRITE (15,55)N-3,A[N-3],A[N-2],A[N-1],A[N]
20 RETURN
25 WRITE (15,55)N-2,A[N-2],A[N-1],A[N]
30 RETURN
35 WRITE (15,55)N-1,A[N-1],A[N]
40 RETURN
45 WRITE (15,55)N,A[N]
50 RETURN
55 FORMAT F4.0,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4
60 T=0
65 PRINT "**DATA**"
70 WRITE (15,75)
75 FORMAT 3X,"I",10X,"X(I)",8X,"X(I+1)",8X,"X(I+2)",8X,"X(I+3)",8X,"X(I+4)"
80 J=INT(N/5)*5
85 FOR I=5 TO J STEP 5
```

```
0 WRITE (15,55)I-4,A[I-4];A[I-3],A[I-2];A[I-1],A[I]
5 NEXT I
00 J=N-J
05 IF J=0 THEN 115
10 GOSUB 10
15 PRINT
20 PRINT
25 DISP "IF CORRECTIONS ENT 1";
30 INPUT I
35 IF I=1 THEN 150
40 IF T=0 THEN 155
45 LOAD 13,5,10
50 LOAD 6,5,10
55 DISP "DONE"
60 END

ILE # 6
********

 COM N,B,A[150],S1,S5,S6
0 DISP "N="N;" CORRECT X(I), WHERE I=";
5 INPUT I
0 IF I<1 THEN 55
5 IF I>N THEN 10
0 DISP "X("I;")="A[I]
5 WAIT 3000
0 DISP "NEW X("I;")=";
5 INPUT A[I]
0 PRINT "**CORRECT X("I;")="A[I]
5 DISP "THRU CORRECTING ENT 1";
0 INPUT I
5 IF I#1 THEN 10
0 PRINT
5 PRINT
0 DISP "IF YOU WISH TO DELETE ENT 1";
5 INPUT I
0 IF I=1 THEN 115
5 DISP "IF YOU WISH TO INSERT ENT 1";
00 INPUT I
05 IF I#1 THEN 120
10 LOAD 8,5,10
15 LOAD 7,5,10
20 LOAD 13,5,10

ILE # 7
********

 COM N,B,A[150],S1,S5,S6
0 DISP "N="N;": DELETE X(I), WHERE I=";
5 INPUT I
0 IF I<1 THEN 80
5 IF I>N THEN 10
```

```
30 PRINT "**DELETE X("I;")="A[I];
35 WAIT 2000
40 IF I=N THEN 70
45 PRINT "**NEW X("I;")="A[I+1];
55 FOR J=I+1 TO N
60 A[J-1]=A[J]
65 NEXT J
70 N=N-1
75 PRINT "**N NOW ="N
80 DISP "THRU DELETING ENT 1";
85 INPUT I
90 IF I#1 THEN 10
95 PRINT
100 PRINT
105 DISP "IF YOU WISH TO INSERT ENT 1";
110 INPUT I
115 IF I#1 THEN 125
120 LOAD 8,5,10
125 DISP "IF YOU WISH TO CORRECT ENT 1";
130 INPUT I
135 IF I#1 THEN 145
140 LOAD 6,5,10
145 LOAD 13,5,10

FILE # 8
*********

5 COM N,B,A[150],S1,S5,S6
10 DISP "N="N;"INSERT X(I), WHERE I =";
15 INPUT I
20 IF N<B THEN 35
25 PRINT"MAX SAMPLE SIZE OF"B;"IS IN THE MACHINE.YOU CAN'T ADD MORE DATA."
30 GOTO 155
35 IF I<1 THEN 90
40 N=N+1
45 IF I<N THEN 60
50 I=N
55 GOTO 75
60 FOR J=N TO I+1 STEP -1
65 A[J]=A[J-1]
70 NEXT J
75 DISP "INSERT X("I;")=";
80 INPUT A[I]
85 PRINT "**INSERT X("I;")="A[I];"**N NOW ="N
90 DISP "THRU INSERTING ENT 1";
95 INPUT I
100 IF I#1 THEN 10
105 PRINT
110 PRINT
115 DISP "IF YOU WISH TO DELETE ENT 1";
```

```
20 INPUT I
25 IF I#1 THEN 135
30 LOAD 7,5,10
35 DISP "IF YOU WISH TO CORRECT ENT 1";
40 INPUT I
45 IF I#1 THEN 155
50 LOAD 6,5,10
55 LOAD 13,5,10

FILE # 9
*********

5 COM N,B,A[150],S1,S5,S6
10 PRINT
15 PRINT "TRANSFORM DATA"
20 PRINT "**************"
25 PRINT
30 DISP "TCODE,C =";
35 INPUT T,C
40 PRINT "TCODE ="T;"C ="C
45 IF T >= 0 AND T <= 14 THEN 75
50 PRINT "TCODE OUT OF BOUNDS: (0,14)"
55 PRINT
60 PRINT
65 DISP "SEE ABOVE:  ";
70 GOTO 30
75 IF T=0 THEN 175
80 PRINT "TRANSFORMING DATA BY ";
85 GOTO T OF 95,105,115,130,140,150
90 LINK 10,10,10
95 PRINT "ADDING"C;"TO";
100 GOTO 155
105 PRINT "MULTIPLYING";
110 GOTO 120
115 PRINT "DIVIDING";
120 PRINT " EACH POINT BY"C
125 GOTO 160
130 PRINT "RAISING"C;"TO THE POWER OF";
135 GOTO 155
140 PRINT "RAISING EACH POINT TO THE"C;"POWER"
145 GOTO 160
150 PRINT "TAKING THE NATURAL LOG OF";
155 PRINT " EACH POINT"
160 PRINT
165 PRINT
170 LINK 12,10,10
175 PRINT "NO TRANSFORMATION"
180 PRINT
185 PRINT
190 DISP "DONE"
195 END
```

```
FILE # 10
*********

10 GOTO T-6 OF 15,25,40,50,65,75,85,115
15 PRINT "ADDING TO";
20 GOTO 30
25 PRINT "SUBTRACTING FROM";
30 PRINT " EACH POINT";
35 GOTO 95
40 PRINT "MULTIPLYING";
45 GOTO 55
50 PRINT "DIVIDING";
55 PRINT " EACH POINT BY";
60 GOTO 95
65 PRINT "RAISING EACH POINT TO THE VARIABLE POWER C"
70 GOTO 100
75 PRINT "TAKING EXPONENTIAL VALUE OF EACH POINT"
80 GOTO 100
85 PRINT "TAKING THE LOG (BASE 10) OF EACH POINT"
90 GOTO 100
95 PRINT " THE VARIABLE C"
100 PRINT
105 PRINT
110 LINK 12,10,10
115 PRINT "USER DEFINED TRANSFORMATION"
120 PRINT
125 PRINT
130 LINK 11,10,10
```

```
FILE # 11
*********

10 FOR I=1 TO N
15 GOSUB 35
20 NEXT I
25 T=1
30 LOAD 5,5,65
35 GOTO T-13 OF 40,70
40 PRINT"ENTER YOUR SUBROUTINE BEGINNING AT LINE 70,THEN PRESS CONT EXECUTE"
45 PRINT "NOTE: THE VARIABLE A(I) REPRESENTS THE DATA."
50 PRINT
55 PRINT
60 T=T+1
65 DISP "ENTER SUBROUTINE; BEGIN AT 70";
70 STOP
9998 RETURN
```

```
ILE # 12
********
0 FOR I=1 TO N
5 GOSUB 35
0 NEXT I
5 T=1
0 LOAD 5,5,65
5 GOTO T OF 40,50,60,115,125,135,145,145,145,145,145,180,190
0 A[I]=A[I]+C
5 RETURN
0 A[I]=A[I]*C
5 RETURN
0 T1=1
5 IF C#0 THEN 105
0 DISP "CANNOT DIVIDE BY 0;";
5 GOTO T1 OF 80,90
0 DISP " C =";
5 GOTO 95
0 DISP " C("I;")=";
5 INPUT C
00 GOTO 65
05 A[I]=A[I]/C
10 RETURN
15 A[I]=C↑A[I]
20 RETURN
25 A[I]=A[I]↑C
30 RETURN
35 A[I]=LOG(A[I])
40 RETURN
45 DISP "C("I;") =";
50 INPUT C
55 GOTO T-6 OF 40,160,50,170,125
60 A[I]=A[I]-C
65 RETURN
70 T1=2
75 GOTO 65
80 A[I]=EXP(A[I])
85 RETURN
90 A[I]=LGT(A[I])
95 RETURN

FILE # 13
*********
 COM N,B,A[150],S1,S5,S6
0 T=S2=0
5 FOR I=1 TO N
0 T=T+A[I]
5 S2=S2+A[I]↑2
0 NEXT I
```

```
45 S5=T/N
50 S6=SQR((S2-S5*S5*N)/(N-1))
55 STORE  DATA 14
60 DISP "DONE"
65 END
70 PRINT
75 PRINT "RELOAD DATA"
80 PRINT "***********"
85 PRINT
90 PRINT
95 LOAD  DATA 14
100 PRINT "DATA RELOADED; PRESS ANY KEY."
105 PRINT
110 PRINT
115 DISP "DONE"
120 END


FILE # 15
*********
5 COM N,B,A[150],S1,S5,S6
10 PRINT
15 PRINT "SERIAL CORRELATION"
20 PRINT "*******************"
25 PRINT
30 C1=0
35 DISP "CORRELATION LAG =";
40 INPUT K
45 FOR I=0 TO INT(N/2)
50 IF K=I THEN 85
55 NEXT I
60 PRINT"LAG ="K;"IS OUTSIDE OF BOUNDS:(0,";INT(N/2);") OR ISN'T AN INTEGER"
65 PRINT
70 PRINT
75 DISP "SEE ABOVE:   ";
80 GOTO 35
85 FOR I=1 TO N-K
90 C1=C1+(A[I]-S5)*(A[I+K]-S5)
95 NEXT I
100 PRINT "SERIAL CORRELATION WITH LAG ="K;"="C1/(N-1)/S6↑2
105 PRINT
110 PRINT
115 DISP " FOR ANOTHER LAG ENT 1";
120 INPUT I
125 IF I=1 THEN 30
130 DISP "DONE"
135 END
```

```
ILE # 16
*********

5 COM N,B,A[150],S1,S5,S6
0 PRINT
5 PRINT "SERIAL PLOT; PRINTER:"
0 P=0
5 GOTO 45
0 PRINT
5 PRINT "SERIAL PLOT; PLOTTER:"
0 P=1
5 PRINT "**********************"
0 PRINT
0 IF S1 THEN 125
5 T1=9E+99
0 T2=-T1
5 FOR J=1 TO N
0 T2=T2*(A[J] <= T2)+A[J]*(A[J]>T2)
5 T1=T1*(T1 <= A[J])+A[J]*(A[J]<T1)
0 NEXT J
5 IF P THEN 115
00 W=(T2-T1)/50
05 WRITE (15,145)T1,T1+10*W,T1+20*W,T1+30*W,T1+40*W,T2
15 LINK 17+P,10,10
25 PRINT "THE DATA HAS BEEN ORDERED; NO SERIAL PLOT IS PERFORMED."
30 PRINT
40 END
45 FORMAT 6X,F9.0,2X,5F10.2


FILE # 17
*********

0 W=(T2-T1)/50
5 GOSUB 145
0 PRINT TAB13;".";
5 PRINT
0 FOR I=1 TO N
5 Y=I
0 FORMAT 2F12.4
5 WRITE (15,40)Y" .";
0 Z=FNP(Y)
5 NEXT I
0 GOSUB 145
5 PRINT
5 PRINT
0 PRINT
5 DISP "DONE"
0 END
5 DEF FNP(Y)
00 R=INT((A[I]-T1)/W)
```

```
105 IF R=0 THEN 125
110 FOR J=1 TO R
115 PRINT " ";
120 NEXT J
125 PRINT "*"
130 RETURN 0
145 PRINT TAB13;" +---------+---------+---------+---------+---------+
150 RETURN


FILE # 18

10 DISP "SET UP THE PLOTTER; ENT 1";
15 INPUT I
20 X0=(N+1)*15/13
25 Y0=4/3*(T2-T1)
30 SCALE -2/15*X0,13/15*X0,-0.15*Y0,Y0
35 FORMAT F12.4,F1.0
40 FORMAT F7.0,F1.0
45 X=-X0/15
50 PLOT -13*X,0
55 PLOT 0,0
60 PLOT 0,0.85*Y0
65 LABEL (*,1.5,2,0,2/3)
70 PLOT X,0.8125*Y0,1
75 LABEL (*)" OBS.";
80 PLOT X,0.7875*Y0,1
85 LABEL (*)"VALUE";
90 FOR J=T1 TO T2 STEP INT((T2-T1)*0.1)+(T2-T1)*(T2-T1<10)*0.1
95 PLOT 13.3*X/8,J-0.99*T1-0.01*T2,1
100 LABEL (35,1.5,2,0,2/3)J;" -";
105 NEXT J
110 PLOT 1.9*X,-0.05*Y0,1
115 LABEL (*)"  OBS. NUMBER:";
120 LABEL (*,1.5,2,PI/2,2/3)
125 FOR J=1 TO N
130 IF J=1 OR J=N THEN 140
135 IF N>30 AND INT(J/10)*10#J THEN 150
140 PLOT J+X0/200,-0.12*Y0,1
145 LABEL (40)J" -"
150 NEXT J
155 LINK 19,10,10

FILE # 19
*********
10 FOR I=1 TO N
15 PLOT I,A[I]-T1
20 NEXT I
25 PEN
30 PLOT 13/15*X0,0.85*Y0,1
```

```
35 DISP "TO LABEL PLOT ENT 1";
40 INPUT I
45 IF I#1 THEN 85
50 DISP "CHARACTER HEIGHT(%)=";
55 INPUT I
60 DISP "REM:  PRESS STOP WHEN FINISHED"
65 WAIT 4000
70 LABEL (*,I,2,0,2/3)
75 LETTER
80 PLOT 13/15*X0,0.85*Y0,1
85 DISP "DONE"
90 END

FILE # 20
*********

5 COM N,B,A[150],S1,S5,S6
10 PRINT
15 PRINT "BASIC STATISTICS:"
20 PRINT "****************"
25 S2=S3=S4=0
30 FOR I=1 TO N
35 S2=S2+A[I]↑2
40 S3=S3+A[I]↑3
45 S4=S4+A[I]↑4
50 NEXT I
52 M2=(N-1)*S6↑2/N
55 M3=S3/N-3*S5*S2/N+2*S5↑3
60 M4=S4/N-4*S5*S3/N+6*(S5↑2)*S2/N
65 M4=M4-3*S5↑4
70 FORMAT /,7X,F12.0,10X,F12.4
75 FORMAT 4X,F12.4,10X,F10.2," %"
80 FORMAT F12.4,9X,F12.4
85 FORMAT F12.4,19X,F12.4,2/
90 WRITE (15,70)"N="N,"STD ERROR OF MEAN="S6/(SQR(N))
95 WRITE (15,75)"MEAN="S5,"COEF OF VARIATION="S6/S5*100
100 WRITE (15,80)"VARIANCE="S6↑2,"STANDARD DEVIATION="S6
105 WRITE (15,85)"SKEWNESS="M3/M2↑(3/2),"KURTOSIS="M4/M2↑2
110 LINK 21,10,10

FILE # 21
*********

10 DISP "CONF. COEFF. FOR C.I. ON MU =";
15 INPUT P
20 IF P >= 0.7 AND P <= 0.995 THEN 50
25 PRINT "CONF. COEFF. ="P;"IS OUT OF BOUNDS: (.7, .995)"
30 PRINT
35 PRINT
40 DISP "SEE ABOVE: CONF COEF. =";
45 GOTO 15
50 P=(1-P)/2
```

```
55 V=SQR(LOG(1/(P*P)))
60 X=2.515517+0.802853*V+0.010328*V*V
65 Y=1+1.432788*V+0.189269*V*V+0.001308*V*V*V
70 LINK 22,10,10

FILE # 22
*********

10 Z=V-X/Y
15 M=N-1
20 T=Z+(Z↑3+Z)/(4*M)+(5*Z↑5+16*Z↑3+3*Z)/(96*M*M)
25 T=T+(3*Z↑7+19*Z↑5+17*Z↑3-15*Z)/(384*M*M*M)
30 T1=S6/SQR(N)*(T+(79*Z↑9+776*Z↑7+148*Z↑5-1920*Z↑3-945*Z)/(92160*M*M*M*M))
35 FORMAT /,F8.2,"% C.I. FOR MEAN:",2X,"(",F12.4," , ",F12.4,")",/
40 WRITE (15,35)100*(-P*2+1),S5-T1,S5+T1
45 PRINT "ONE-TAIL  T("N-1;",";P;")="T
50 PRINT
55 PRINT
60 LINK 23,10,10

FILE # 23
*********

10 DISP "C.I. ON VAR TAKES ABOUT 3.5 MIN."
15 WAIT 6000
20 DISP "CONF. COEFF. FOR C.I. ON VAR=";
25 INPUT P
30 IF P >= 0.7 AND P <= 0.995 THEN 60
35 PRINT "CONF. COEFF.="P;"IS OUT OF BOUNDS: (.7, .995)"
40 PRINT
45 PRINT
50 DISP "SEE ABOVE: CONF. COEFF.=";
55 GOTO 25
60 A=(N-1)/2
65 C=2
70 P2=(1-P)/2
75 I1=1
80 T8=1-(P2>0.5)
85 P1=P2*T8+(1-P2)*(T8=0)
90 T=SQR(LOG(1/(P1*P1)))
95 X=2.515517+T*(0.802853+0.010328*T)
100 B1=1+T*(1.437288+T*(0.189269+0.001308*T))
105 B1=T-X/B1
110 B1=(2*T8-1)*B1
115 B1=A*ABS((1-1/(9*A)+B1*SQR(1/(9*A)))↑3)
120 X1=B1
125 X2=1.01*B1
130 O1=0.5*LOGPI
135 O2=0.5*LOG(PI/4)
140 O3=0.5*LOG2+O1
145 L=1
150 LINK 25,10,10
```

LISTING

```
ILE # 24
********
0 Y1=P2-P9
5 Y2=Y1
0 IF Y1*Y2<0 THEN 110
5 IF Y1<0 THEN 70
0 X1=X2
5 Y1=Y2
0 X2=0.98*X2*10↑(-(X2<1))
5 B1=X2
0 L=2
5 GOTO 215
0 Y2=P2-P9
5 GOTO 20
0 X2=X1
5 Y2=Y1
0 X1=1.01*X1*10↑(X1<1)
5 B1=X1
0 L=3
5 GOTO 215
00 Y1=P2-P9
05 GOTO 20
10 X3=(Y1*X2-X1*Y2)/(Y1-Y2)
15 B1=X3
20 L=4
25 GOTO 215
30 Y5=P9
35 Y=P2-Y5
40 IF ABS(Y)<1E-06 THEN 185
45 IF Y*Y2>0 THEN 165
50 Y1=Y2
55 X1=X2
60 GOTO 170
65 Y1=Y1/2
70 Y2=Y
75 X2=X3
80 GOTO 110
85 IF I1=2 THEN 210
90 D2=2*B1
95 P2=1-P2
00 I1=2
05 LINK 23,10,80
10 LINK 26,10,10
15 LINK 25,10,10
20 GOTO L OF 10,60,100,130
```

```
FILE # 25
*********

10 IF B1<A THEN 90
15 A1=A2=I=1
20 B4=B1
25 B2=B1+1-A
30 A1=B1*A2+I*A1
35 B4=B1*B2+I*B4
40 I=I+1
45 A2=A1+(I-A)*A2
50 B2=B4+(I-A)*B2
55 IF ABS(A1/B4-A2/B2)>10↑(-5) THEN 30
60 C1=0.5*(A1/B4+A2/B2)
65 P1=A*LOGB1-B1
70 Y=FNKA
75 A1=C1*EXP(P1-Y)
80 P9=A1
85 LINK 24,10,220
90 A2=B2=I=1
95 A1=1+A-B1
100 B4=1+A
105 A2=(2*I+A)*A1+I*B1*A2
110 B2=(2*I+A)*B4+I*B1*B2
115 A1=(2*I+1+A)*A2-(A+I)*B1*A1
120 B4=(2*I+1+A)*B2-(A+I)*B1*B4
125 I=I+1
130 IF ABS(A2/B2-A1/B4)>10↑(-5) THEN 105
135 C1=B4/A1
140 C=A*LOGB1-B1-FNK(A+1)
145 C=C1*EXPC
150 P9=1-C
155 GOTO 85
160 DEF FNK(X)
165 IF X>0.5 THEN 180
170 A1=O1
175 RETURN A1
180 IF ABS(X-1.5)#0.5 THEN 190
185 RETURN 0
190 IF X>1.5 THEN 205
195 A1=O2
200 RETURN A1
205 A1=(X-0.5)*LOG(X)-X+O3
210 A1=A1+1/(12*X)-1/(360*X↑3)+1/(1260*X↑5)-1/(1680*X↑7)
215 RETURN A1
```

```
ILE # 26
********

0 FORMAT /,F6.2,"% C.I. FOR VAR:",2X,"(",F12.4," ,",F12.4,")",/
5 T1=(N-1)*S6↑2/D2
0 T2=(N-1)*S6↑2/(2*B1)
5 WRITE (15,10)100*P,T1,T2
0 FORMAT "CHI-SQUARE(",F5.0,",  ",F7.4,")=",F12.4
5 WRITE (15,30)N-1,P2,2*B1
0 WRITE (15,30)N-1,1-P2,D2
5 PRINT
0 PRINT
5 DISP "DONE"
0 END
```

```
ILE # 27
********

 COM N,B,A[150],S1,S5,S6
0 PRINT
5 PRINT "STORE DATA"
0 PRINT "**********"
5 PRINT "(CASSETTE SELECT CODES:  5= 9865A; 10= 9830A)"
0 PRINT
5 PRINT
0 DISP "SEE ABOVE: SELECT CODE=";
5 INPUT F
0 IF F#5 AND F#10 THEN 40
5 PRINT "SELECT CODE="F
0 PRINT
5 DISP "INSERT YOUR TAPE; ENT 1";
0 INPUT I
5 DISP "REM: NEED FILE >"B*4;"WORDS"
0 WAIT 6000
5 DISP "YOUR FILE NUMBER =";
0 INPUT I
5 STORE  DATA #F,I,A
00 PRINT "YOUR DATA IS STORED IN AN ARRAY A("B;") ON YOUR FILE NUMBER"I
05 PRINT
10 PRINT
15 REWIND #F
20 IF F#10 THEN 135
25 DISP "INSERT PGM TAPE; ENT 1";
30 INPUT I
35 DISP "DONE"
40 END
```

LISTING

```
FILE # 28
*********

5 COM N,B,A[150],S1,S5,S6,T
10 FORMAT F12.4,/,F12.4,/,F12.4,/,F12.4
15 PRINT
20 PRINT "ORDER STATISTICS:"
25 PRINT "****************"
30 PRINT
35 IF S1 THEN 55
40 T=28
45 LOAD 30,5,10
50 S1=1
55 DISP "TO PRINT ORDERED DATA ENT 1";
60 INPUT K
65 IF K#1 THEN 75
70 LOAD 29,5,60
75 N1=FNA(N)
90 N2=FNA(N/2)
95 N3=FNA(1.5*N)
100 N4=N3-N2
105 N5=N1/2+(N2+N3)/4
110 PRINT "       N="N
115 WRITE(15,10)" XMIN="A[1]," XMAX="A[N],"RANGE="A[N]-A[1],"MEDIAN="N1
120 PRINT
130 PRINT "TUKEY'S HINGES:"
135 WRITE (15,10)".25 QUANTILE="N2,".75 QUANTILE="N3
140 WRITE (15,10)"MID-RANGE="N4,"  TRIMEAN="N5
145 PRINT
150 DISP "DONE"
155 END
160 DEF FNA(Z1)
165 Z=INT(Z1/2)
170 IF Z1=Z*2 THEN 185
175 M1=A[Z+1]
180 RETURN M1
185 M1=(A[Z+1]+A[Z])/2
190 RETURN M1
```

```
FILE # 29
*********

5 COM N,B,A[150],S1,S5,S6
10 GOTO J OF 45,35,25,15
15 WRITE (15,55)N-3,A[N-3],A[N-2],A[N-1],A[N]
20 RETURN
25 WRITE (15,55)N-2,A[N-2],A[N-1],A[N]
30 RETURN
35 WRITE (15,55)N-1,A[N-1],A[N]
40 RETURN
45 WRITE (15,55)N,A[N]
50 RETURN
```

```
5 FORMAT F4.0,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4,2X,F12.4
0 PRINT "ORDERED DATA:"
5 PRINT
0 WRITE (15,75)
5 FORMAT 3X,"I",10X,"X(I)",8X,"X(I+1)",8X,"X(I+2)",8X,"X(I+3)",8X,"X(I+4)"
0 J=INT(N/5)*5
5 FOR I=5 TO J STEP 5
0 WRITE (15,55)I-4,A[I-4],A[I-3],A[I-2],A[I-1],A[I]
5 NEXT I
00 J=N-J
05 IF J=0 THEN 115
10 GOSUB 10
15 PRINT
20 PRINT
25 LOAD 28,5,75


ILE # 30
*********
 COM N,B,A[150],S1,S5,S6,T,X[8],Y[8]
0 I=I1=M=1
5 J=N
0 IF I >= J THEN 175
5 K=I
0 I2=(J+I)/2
5 T1=A[I2]
0 IF A[I] <= T1 THEN 50
5 Z=FNA(I)
0 L=J
5 IF A[J] >= T1 THEN 90
0 Z=FNA(J)
5 IF A[I] <= T1 THEN 90
0 Z=FNA(I)
5 GOTO 90
0 A[L]=A[K]
5 A[K]=T2
0 L=L-1
5 IF A[L]>T1 THEN 90
00 T2=A[L]
05 K=K+1
10 IF A[K]<T1 THEN 105
15 IF K <= L THEN 80
20 IF (L-I) <= (J-K) THEN 150
25 Y[M]=I
30 X[M]=L
35 I=K
40 M=M+1
45 GOTO 205
50 Y[M]=K
55 X[M]=J
```

```
160 J=L
165 M=M+1
170 GOTO 205
175 M=M-1
180 IF M THEN 195
190 LOAD T,5,50
195 I=Y[M]
200 J=X[M]
205 IF (J-I) >= 11 THEN 25
210 IF I=I1 THEN 20
215 I=I-1
220 I=I+1
225 IF I=J THEN 175
230 T1=A[I+1]
235 IF A[I] <= T1 THEN 220
240 K=I
245 A[K+1]=A[K]
250 K=K-1
255 IF T1<A[K] THEN 245
260 A[K+1]=T1
265 GOTO 220
270 DEF FNA(Z)
275 A[I2]=A[Z]
280 A[Z]=T1
285 T1=A[I2]
290 RETURN Z

FILE # 31
*********

5 COM N,B,A[150],S1,S5,S6,T
10 PRINT
15 PRINT "RANKED DATA:"
20 PRINT "************"
25 PRINT "                  DISTINCT";TAB37;"DISTINCT";TAB62;"DISTINCT"
30 PRINT "(   RANK      DATA POINT)";TAB25;"(   RANK      DATA POINT)";
35 PRINT TAB50,"(   RANK      DATA POINT)"
40 PRINT
45 IF S1 THEN 65
50 T=32
55 S1=1
60 LOAD 30,5,10
65 LOAD 32,5,50

FILE # 32
*********

5 COM N,B,A[150],S1,S5,S6,B[2,2]
50 FORMAT"(",F7.2,1X,F12.4,")",3X,"(",F7.2,1X,F12.4,")",3X,"(",F7.2,1X,F12.4,"
55 J=K=L=0
60 FOR I=1 TO N
```

```
5 K=K+I
0 J=J+1
5 IF I=N THEN 85
0 IF A[I]=A[I+1] THEN 135
5 L=L+1
0 GOTO L OF 95,95,120
5 B[1,L]=K/J
00 B[2,L]=A[I]
05 GOTO 130
10 FORMAT "(",F7.2,1X,F12.4,")"
15 FORMAT "(",F7.2,1X,F12.4,")",3X,"(",F7.2,1X,F12.4,")"
20 WRITE (15,50)B[1,1],B[2,1],B[1,2],B[2,2],K/J,A[I]
25 L=0
30 J=K=0
35 NEXT I
40 GOTO L+1 OF 160,145,155
45 WRITE (15,110)B[1,1],B[2,1]
50 GOTO 160
55 WRITE (15,115)B[1,1],B[2,1],B[1,2],B[2,2]
60 PRINT
65 PRINT
70 DISP "DONE"
75 END

ILE # 33
********

 COM N,B,A[150],S1,S5,S6,FI[50]
0 P1=0
5 PRINT
0 PRINT "HISTOGRAM; PRINTER:"
5 GOTO 45
0 P1=1
5 PRINT
0 PRINT "HISTOGRAM; PLOTTER:"
5 PRINT "*******************"
0 PRINT
5 DISP "FOR NORMAL CURVE OVERLAY ENT 1";
0 INPUT P
5 IF P=1 THEN 80
0 P=0
5 GOTO 95
0 PRINT "WITH NORMAL CURVE OVERLAY"
5 PRINT
0 PRINT
5 T2=-9E+99
00 FOR J=1 TO N
05 IF A[J] <= T2 THEN 115
10 T2=A[J]
15 NEXT J
20 LINK 34,10,10
```

```
FILE # 34
*********

10 DISP "OFFSET =";
15 INPUT O
20 PRINT "OFFSET ="O
25 IF T2>O THEN 55
30 PRINT "OFFSET TOO BIG;  MAX VALUE="T2
35 PRINT
40 PRINT
45 DISP "SEE ABOVE:  ";
50 GOTO 10
55 DISP "# OF CELLS=";
60 INPUT T
65 IF T>0 AND T <= 50 THEN 80
70 PRINT "NO. OF CELLS OUT OF BOUNDS:(1,50)."
75 GOTO 50
80 PRINT "# OF CELLS ="T
82 PRINT "OPTIMUM CELL WIDTH ="(T2-O)/T*1.00001
83 PRINT
85 DISP "CELL WIDTH ="(T2-O)/T*1.00001;"OR=";
90 INPUT C
95 FOR J=1 TO T
100 F[J]=0
105 NEXT J
115 PRINT "YOUR CELL WIDTH ="C
120 PRINT
121 PRINT
125 LINK 35,10,10

FILE # 35
*********

10 T4=T5=0
25 FOR I=1 TO N
30 IF A[I]<O THEN 55
35 Y=INT((A[I]-O)/C+1)
40 IF Y <= T THEN 65
45 T5=T5+1
50 GOTO 70
55 T4=T4+1
60 GOTO 70
65 F[Y]=F[Y]+1
70 NEXT I
75 IF T4=0 AND T5=0 THEN 135
80 IF T4=0 THEN 90
85 PRINT "THERE ARE"T4;"OBS TOO SMALL FOR OFFSET; NEED SMALLER OFFSET"
90 IF T5=0 THEN 105
95 PRINT"THERE ARE"T5;"OBS TOO LARGE FOR"T;"CELLS;NEED LARGER CELL WIDTH"
100 PRINT "OR MORE CELLS."
105 PRINT
```

LISTING

```
10 PRINT
15 DISP "OFFSET AND CELL WIDTH OK; ENT 1";
20 INPUT I
25 IF I=1 THEN 135
30 LINK 34,10,10
35 O=O+C/2
40 IF P1=0 THEN 155
45 DISP "SET UP THE PLOTTER THEN ENT 1";
50 INPUT I
55 LINK 36,10,10

FILE # 36
*********

10 FOR B1=T TO 1 STEP -1
15 IF F[B1] THEN 25
20 NEXT B1
25 N9=0
30 FOR I=1 TO B1
35 IF N9>F[I] THEN 45
40 N9=F[I]
45 NEXT I
50 K=N*C/(S6*SQR(2*PI))
55 IF P1=0 THEN 80
60 X0=C*(T+1)*15/13
65 Y0=4/3*(N9+(K-N9)*(K>N9))
~~70 SCALE  2/15*X0,13/15*X0,-0.15*Y0,0.85*Y0~~
75 LINK 38,10,10
80 W=2.5*N9/N
85 U=K*40/N9
90 FORMAT 2F5.2
95 PRINT
100 WRITE (15,90)"EACH X ="W;" %"
105 PRINT
110 PRINT
115 LINK 37,10,10

FILE # 37
*********

10 FOR I=1 TO B1+1
15 Y=O+(I-1.5)*C
20 FORMAT 2F12.4
25 WRITE (15,20)Y" .";
30 IF P=0 THEN 40
35 GOSUB 215
40 PRINT
45 IF I=B1+1 THEN 70
50 Y=Y+0.5*C
55 PRINT TAB13;".";
60 GOSUB 80
```

PER 6/4/74
MANUAL UPDATE

```
65 NEXT I
70 PRINT
75 LINK 40,10:10
80 T=INT(U*EXP(-((Y-S5)/S6)↑2/2)+0.5)
85 R=INT((100*F[I]/N)/W)
90 IF T <= R THEN 155
95 IF R=0 THEN 115
100 FOR J=1 TO R
105 PRINT "X";
110 NEXT J
115 IF P=0 THEN 145
120 IF T=0 THEN 140
125 FOR J=R TO T-2+(R#0)
130 PRINT " ";
135 NEXT J
140 PRINT "*";
145 PRINT
150 RETURN
155 IF T=0 THEN 175
160 FOR J=1 TO T-(T=R)*P+(P=0)
165 PRINT "X";
170 NEXT J
175 IF P=0 THEN 185
180 PRINT "*";
185 IF T=R THEN 205
190 FOR J=1 TO R-T-1
195 PRINT "X";
200 NEXT J
205 PRINT
210 RETURN
215 T=INT(U*EXP(-((Y-S5)/S6)↑2/2)+0.5)
220 PRINT TABT"*";
225 RETURN


FILE # 38
*********

10 FORMAT F4.0,2F5.1
15 FORMAT 2F7.2
20 FORMAT 2F11.2  ZZ SCALE -2/15*X0, 13/15*X0, -0.15*Y0, 0.85*Y0
25 X=-X0/15
30 PLOT -13*X,0
35 PLOT X,0
40 PLOT X,0.85*Y0
45 LABEL (*,1.5,2,0,2/3)
50 PLOT 1.87*X,0.8125*Y0,1
55 LABEL (*)" CELL   % REL.";
60 PLOT 1.87*X,0.7875*Y0,1
65 LABEL (*)"COUNTS   FREQ.";
70 FOR J=0 TO N9 STEP INT((N9+9)/10)
```

```
75 PLOT 13.3*X/8,J-3*Y0/400,1
80 LABEL (10)J" -"100*J/N;
85 NEXT J
90 PLOT 1.9*X,-0.05*Y0,1
95 LABEL (*)"CELL LIMITS:";
100 LABEL (*,1.5,2,ATN1E+99,2/3)
105 FOR J=0 TO T*C STEP C*INT((T+9)/10)
110 PLOT J+X0/200,-Y0/7,1
115 LABEL (20)J+O-C/2;
120 NEXT J
125 LINK 39,10,10

FILE # 39
*********

10 PLOT 13/15*X0,0
15 PLOT 0,0
20 FOR I=1 TO T
25 PLOT (I-1)*C,F[I]
30 IPLOT C,0
35 PLOT I*C,0
40 NEXT I
45 PEN
50 IF P#1 THEN 80
55 FOR I=0 TO T*C STEP T*C/100
60 N1=-((O-C/2+I-S5)/S6)↑2/2
65 N1=N1*(N1 >= -150)-150*(N1<-150)
70 PLOT I,K*EXP(N1)
75 NEXT I
80 PLOT 13/15*X0,0.85*Y0,1
85 DISP "TO LABEL PLOT ENT 1";
90 INPUT I
95 IF I#1 THEN 135
100 DISP "CHARACTER HEIGHT(%)=";
105 INPUT I
110 DISP "REM:  PRESS STOP WHEN FINISHED"
115 WAIT 4000
120 LABEL (*,I,2,0,2/3)
125 LETTER
130 PLOT 13/15*X0,0.85*Y0,1
135 LINK 40,10,10

FILE # 40
*********

10 DISP "FOR CELL STAT  ENT 1";
15 INPUT I
20 IF I=1 THEN 30
25 GOTO 90
30 PRINT
35 PRINT "CELL STATISTICS:"
```

```
40 PRINT
45 PRINT "  CELL#       LOWER       NUMBER            %RELATIVE"
50 PRINT "              LIMIT       OF OBS.           FREQUENCY"
55 PRINT
60 FOR A=1 TO B1
65 IF F[A] THEN 75
70 NEXT A
75 LINK 41,10,10
80 PRINT
85 PRINT
90 DISP "DONE"
95 END

FILE # 41
*********

10 FOR I=A TO B1
15 WRITE (15,45)I,O+(I-1.5)*C,F[I],100*F[I]/N
20 NEXT I
25 PRINT
30 PRINT
35 DISP "DONE"
40 END
45 FORMAT F5.0,3X,F12.4,F11.0,7X,F12.2


FILE # 42
*********


5 COM N,B,A[150],S1,S5,S6,T1,F9
10 PRINT
20 PRINT "ONE-SAMPLE T-TEST:"
30 PRINT "*******************"
40 PRINT
50 DISP "1 OR 2 TAIL TEST";
60 INPUT T1
70 IF T1#1 AND T1#2 THEN 50
80 PRINT T1;"TAIL TEST"
90 DISP "H0: MU="S5;" OR =";
100 INPUT N1
110 PRINT "           H0: MU=    "N1
120 F9=(S5-N1)/(S6/SQRN)
130 FORMAT 16X,F7.0,/,13X,F12.4,/,F12.4
140 WRITE (15,130)"N="N,"MEAN="S5,"STD ERROR OF MEAN="S6/SQRN
160 LOAD 43,5,10
```

```
FILE # 43
**********

5 COM N,B,A[150],S1,S5,S6,T1,F9
10 FORMAT 16X,F12.4,/,15X,F8.0,2/
15 A9=(N-1)/2
25 WRITE (15,10)"T="F9"DF="A9*2
30 B9=0.5
35 T9=F9
40 F9=F9↑2
55 C9=0
60 X9=A9/(A9+B9*F9)
65 IF X9<0.5 THEN 90
70 C9=A9
75 A9=B9
80 B9=C9
85 X9=1-X9
90 Z9=X9
95 X9=X9/(1-X9)
100 E9=2*((A9>B9)*A9+(B9 >= A9)*B9)
105 E9=20+(E9<50)*E9+(E9 >= 50)*50
110 J9=E9
115 D9=1
120 FOR I9=1 TO J9-1
125 E8=E9/2
130 E7=INT(E8)
135 E6=(A9+E9-2)*(A9+E9-1)
140 IF E8=E7 THEN 155
145 Y9=E7*(A9+B9-1+E7)
150 GOTO 160
155 Y9=(A9+E7-1)*(E7-B9)
160 Y9=(Y9/E6)*X9
165 D9=1+Y9/D9
170 E9=E9-1
175 NEXT I9
180 LINK 44,10,10


FILE # 44
**********

10 D9=1/(D9+1E-90)
15 A4=1
20 A5=(INT(A9)=A9)
25 B5=(INT(B9)=B9)
30 F5=(INT(A9+B9)=A9+B9)
35 IF (A5+B5)>0 THEN 45
40 A4=A4*PI
45 F9=A9+B9
50 A8=(2-SGNA5)*INTA9
55 B8=(2-SGNB5)*INTB9
```

LISTING

```
60 F8=(2-SGNF5)*INTF9
65 A7=2-A5-(A9=0.5)
70 B7=2-B5-(B9=0.5)
75 F7=2-F5
80 A6=B6=F6=1
85 LINK 45,10,10
```

```
FILE # 45
*********
```

```
10 A4=A6*A4/A7
15 A6=A6+A7
20 IF A8>A6 THEN 30
25 A6=A7=A8=1
30 A4=B6*A4/B7
35 B6=B6+B7
40 IF B8>B6 THEN 50
45 B6=B7=B8=1
50 B4=0
55 A4=A4*F7/F6
60 F6=F6+F7
65 B4=B4+1
70 IF F8>F6 THEN 80
75 F6=F7=F8=1
80 IF ((F8=1)+(A8=1)+(B8=1))=3 THEN 100
85 IF ((A8=1)+(B8=1))>0 THEN 10
90 IF B4=2 THEN 10
95 GOTO 55
100 A4=A4*A9
101 C1=A9*LOG(1E-99+Z9)
102 C2=C1*(C1 >= -227 AND C1 <= 230)-227*(C1<-227)+230*(C1>230)
105 A4=EXPC1/(1E-99+A4)
110 A4=A4*EXP((B9-1)*LOG(1-Z9))
115 P=A4*D9
120 P=SGN(C9)*(1-P)+(1-SGNC9)*P
125 IF T1=2 THEN 145
130 WRITE (15,135)"P(T >"ABS(T9),") ="P/2
135 FORMAT F12.4,F11.4
140 GOTO 155
145 WRITE (15,150)"1 - P("-ABS(T9),"  < T <"ABS(T9),") ="P
150 FORMAT F12.4,F12.4,F9.4
155 PRINT
160 PRINT
165 DISP "DONE"
170 END
```

LISTING

```
ILE # 46
********
 COM N,B,A[150],S1,S5,S6
0 PRINT
5 PRINT "CHI-SQUARE GOODNESS-OF-FIT TEST"
0 PRINT "*******************************"
5 PRINT
0 PRINT "GOODNESS-OF-FIT (GOF) CODES:"
5 PRINT "1=NORMAL; 2=EXPONENTIAL; 3=UNIFORM."
0 PRINT
5 PRINT
0 DISP "SEE ABOVE: GOF CODE=";
5 INPUT P
0 IF P#1 AND P#2 AND P#3 THEN 50
5 DIM FI[50]
0 PRINT "GOODNESS-OF-FIT CODE="P
5 PRINT
0 GOTO P OF 120,105,85
5 DISP "LOWER & UPPER LIMIT ON UNIF.=";
0 INPUT L1,L2
5 PRINT "TEST ON UNIFORM ("L1;","L2;")"
00 GOTO 120
05 IF S5>0 THEN 120
10 PRINT " SAMPLE MEAN ="S5;" MUST BE > 0 FOR CODE ="P
15 GOTO 40
20 T2=-9E+99
25 FOR J=1 TO N
30 IF A[J] <= T2 THEN 140
35 T2=A[J]
40 NEXT J
45 LINK 47,10,10

ILE # 47
********
0 DISP "OFFSET=";
5 INPUT O
0 PRINT "OFFSET="O
5 GOTO P OF 75,30,65
0 IF O >= 0 THEN 75
5 L1=0
0 PRINT "OFFSET MUST BE >="L1;"FOR CODE="P
5 PRINT
0 PRINT
5 DISP "SEE ABOVE: ";
0 GOTO 10
5 IF O >= L1 THEN 75
0 GOTO 40
5 IF T2>O THEN 90
0 PRINT "OFFSET TOO BIG; MAX SAMPLE VALUE="T2
5 GOTO 45
```

```
90 DISP "#OF CELLS=";
95 INPUT T
100 IF T>0 AND T <= 50 THEN 130
105 PRINT "# OF CELLS EXCEED BOUNDS: (1,50)"
110 PRINT
115 PRINT
120 DISP "SEE ABOVE: ";
125 GOTO 75
130 PRINT "# OF CELLS="T
132 PRINT "OPTIMUM CELL WIDTH="(T2-O)/T*1.00001
133 PRINT
135 DISP "CELL WIDTH="(T2-O)/T*1.00001;" OR=";
140 INPUT C
145 FOR J=1 TO T
150 F[J]=0
155 NEXT J
165 PRINT "YOUR CELL WIDTH="C
170 PRINT
175 PRINT
180 LINK 48,10,10


FILE # 48
*********
10 T4=T5=0
15 FOR I=1 TO N
20 IF A[I]<O THEN 45
25 Y=INT((A[I]-O)/C+1)
30 IF Y <= T THEN 55
35 T5=T5+1
40 GOTO 60
45 T4=T4+1
50 GOTO 60
55 F[Y]=F[Y]+1
60 NEXT I
65 IF T4=0 AND T5=0 THEN 125
70 IF T4=0 THEN 80
75 PRINT "THERE ARE"T4;"OBS TOO SMALL FOR OFFSET; NEED SMALLER OFFSET"
80 IF T5=0 THEN 95
85 PRINT"THERE ARE"T5;"OBS TOO LARGE FOR"T;"CELLS;NEED LARGER CELL WIDTH"
90 PRINT "OR MORE CELLS."
95 PRINT
100 PRINT
105 DISP "OFFSET AND CELL WIDTH OK; ENT 1";
110 INPUT I
115 IF I=1 THEN 125
120 LINK 47,10,10
125 FOR B1=T TO 1 STEP -1
130 IF F[B1] THEN 140
135 NEXT B1
```

```
40 FOR A=1 TO B1
45 IF F[A] THEN 155
50 NEXT A
55 D=A+2
50 PRINT " CELL #       LOWER      OBSERVED         EXPECTED"
55 PRINT "              LIMIT      # OF OBS.        # OF OBS."
70 X2=O
75 X=0
30 LINK 49,10,10


ILE # 49
********

0 GOTO P OF 15,35,35
5 N1=0
0 N1=N1+2
5 H=C/N1
0 IF C/180*H↑4>1E-08 AND N1 <= 36 THEN 20
5 FOR I=A TO B1
0 X1=X2
5 X2=X2+C
0 GOTO P OF 55,85,115
5 E=FNA(X1)+4*FNA(X1+H)
0 FOR J=1 TO N1/2-1
5 E=2*FNA(X1+H*2*J)+4*FNA(X1+H*(2*J+1))+E
0 NEXT J
5 E=H*(FNA(X2)+E)/3
0 GOTO 120
5 E1=-X1/S5
0 E1=E1*(E1 >= -225)-225*(E1<-225)
5 E2=-X2/S5
00 E2=E2*(E2 >= -225)-225*(E2<-225)
05 E=EXPE1-EXPE2
10 GOTO 120
15 E=C/(L2-L1)
20 IF F[I] THEN 130
25 D=D+1
30 X=(F[I]-E*N)↑2/(N*E)+X
35 WRITE (15,150)I,O+(I-1)*C,F[I],E*N
40 NEXT I
45 LINK 50,10,10
50 FORMAT F5.0,3X,F12.4,F11.0,7X,F12.2
55 DEF FNA(Z)
60 Z1=-0.5*((Z-S5)/S6)↑2-LOG(S6*SQR(2*PI))
65 Z1=Z1*(-227 <= Z1 AND Z1 <= 229)-227*(Z1<-227)+229*(Z1>229)
70 Z1=EXPZ1
75 RETURN Z1
```

```
FILE # 50
*********

10 PRINT
15 PRINT "CHI-SQUARE GOODNESS-OF-FIT FOR ";
20 GOTO P OF 25,35,50
25 PRINT "NORMALITY"
30 GOTO 60
35 PRINT "EXPONENTIAL DISTRIBUTION"
40 D=D-1
45 GOTO 60
50 PRINT "UNIFORM DISTRIBUTION"
55 D=D-2
60 WRITE (15,65)"CHI-SQUARE VALUE ="X;";  DEGREES OF FREEDOM ="B1-D
65 FORMAT /,F10.3,F4.0,2/
70 DISP "FOR ANOTHER GOF CODE ENT 1";
75 INPUT I
80 IF I#1 THEN 90
85 LOAD 46,5,50
90 DISP "DONE"
95 END

FILE # 51
*********

5 COM N,B,A[150],S1,S5,S6,X[8],Y[8]
10 I=I1=M=1
15 J=N
20 IF I >= J THEN 175
25 K=I
30 I2=(J+I)/2
35 T1=A[I2]
40 IF A[I] <= T1 THEN 50
45 Z=FNA(I)
50 L=J
55 IF A[J] >= T1 THEN 90
60 Z=FNA(J)
65 IF A[I] <= T1 THEN 90
70 Z=FNA(I)
75 GOTO 90
80 A[L]=A[K]
85 A[K]=T2
90 L=L-1
95 IF A[L]>T1 THEN 90
100 T2=A[L]
105 K=K+1
110 IF A[K]<T1 THEN 105
115 IF K <= L THEN 80
120 IF (L-I) <= (J-K) THEN 150
125 Y[M]=I
130 X[M]=L
```

```
135 I=K
140 M=M+1
145 GOTO 205
150 Y[M]=K
155 X[M]=J
160 J=L
165 M=M+1
170 GOTO 205
175 M=M-1
180 IF M THEN 195
190 LOAD 52,5,45
195 I=Y[M]
200 J=X[M]
205 IF (J-I) >= 11 THEN 25
210 IF I=I1 THEN 20
215 I=I-1
220 I=I+1
225 IF I=J THEN 175
230 T1=A[I+1]
235 IF A[I] <= T1 THEN 220
240 K=I
245 A[K+1]=A[K]
250 K=K-1
255 IF T1<A[K] THEN 245
260 A[K+1]=T1
265 GOTO 220
270 DEF FNA(Z)
275 A[I2]=A[Z]
280 A[Z]=T1
285 T1=A[I2]
290 RETURN Z
```

```
FILE # 52
*********

 COM N,B,A[150],S1,S5,S6
0 PRINT
5 PRINT "KOLMOGOROV-SMIRNOV GOODNESS-OF-FIT TEST"
0 PRINT "***************************************"
5 PRINT
0 PRINT
5 IF S1 THEN 50
0 LOAD 51,5,10
5 S1=1
0 PRINT "GOODNESS-OF-FIT (GOF) CODES:"
5 PRINT "1=NORMAL; 2=EXPONENTIAL; 3=UNIFORM."
0 PRINT
5 PRINT
0 DISP "SEE ABOVE: GOF CODE=";
5 INPUT P
```

```
80 IF P#1 AND P#2 AND P#3 THEN 70
85 PRINT "GOODNESS-OF-FIT CODE="P
90 PRINT
95 LINK 53,10,10

FILE # 53
*********

10 GOTO P OF 35,35,15
15 DISP "LOWER & UPPER LIMIT ON UNIF.=?,";
20 INPUT L1,L2
25 PRINT "TEST ON UNIFORM ("L1;","L2;")"
30 GOTO 100
35 DISP "MEAN="S5;"OR=";
40 INPUT M
45 IF P=1 THEN 85
50 IF M>0 THEN 75
55 WRITE (15,60)
60 FORMAT /,"MUST HAVE MEAN > 0 FOR CODE =2",2/
65 DISP "SEE ABOVE: ";
70 GOTO 35
75 PRINT "MEAN="M
80 GOTO 100
85 DISP "VARIANCE ="S6↑2;"OR =";
90 INPUT S
95 PRINT "MEAN="M;" VARIANCE="S
100 D=Z=0
105 GOTO P OF 110,120,130
110 M1=S5-4*SQR(S)
111 M1=M1*(M1<A[1]-0.001)+(A[1]-0.001)*(M1 >= A[1]-0.001)
115 LINK 54,10,10
120 M1=0
125 GOTO 135
130 M1=L1
135 LINK 55,10,10

FILE # 54
*********
 10 FOR K=1 TO N
 15 GOSUB 80
 20 D1=ABS((K-1)/N-Z)
 25 D2=ABS(K/N-Z)
 30 D3=D1*(D1 >= D2)+D2*(D2>D1)
 35 D=D*(D >= D3)+D3*(D3>D)
 40 IF Z>0.999 THEN 55
 45 M1=A[K]
 50 NEXT K
 55 LINK 56,10,20
 60 DEF FNC(Y)
 65 Y1=-0.5*((Y-M)↑2/S)-LOG(SQR(2*PI*S))
 70 Y1=EXP(Y1*(Y1 >= -227 AND Y1 <= 230)-227*(Y1<-227)+230*(Y1>230))
 75 RETURN Y1
```

```
80 N1=0
85 N1=N1+2
90 H=(A[K]-M1)/N1
95 IF (A[K]-M1)/180*H↑4>1E-06 THEN 85
100 E=FNC(M1)+4*FNC(M1+H)
105 FOR J=1 TO N1/2-1
110 I=2*J
 15 E=E+2*FNC(M1+H*I)+4*FNC(M1+H*(I+1))
 20 NEXT J
125 E=H*(FNC(A[K])+E)/3
 30 Z=Z+E
135 RETURN


FILE # 55
*********


10 FOR K=1 TO N
15 GOSUB 60
20 D1=ABS((K-1)/N-Z)
25 D2=ABS(K/N-Z)
30 D3=D1*(D1 >= D2)+D2*(D2>D1)
35 D=D*(D >= D3)+D3*(D3>D)
40 IF Z>0.999 THEN 55
45 M1=A[K]
50 NEXT K
55 LINK 56,10,20
60 GOTO P-1 OF 75,65
65 Z=(A[K]-L1)/(L2-L1)*(A[K] >= L1 AND A[K] <= L2)+(A[K]>L2)
70 RETURN
75 Y1=-A[K]/M
80 Y1=Y1*(Y1 >= -227 AND Y1 <= 230)-227*(Y1<-227)+230*(Y1>230)
85 Z=(1-EXPY1)*(A[K]>0)
90 RETURN


FILE # 56
*********

10 FORMAT /,"N=",F4.0,",  KOLMOGOROV-SMIRNOV STATISTICS:  DN =",F9.5
15 FORMAT 29X,"SQR(N)*DN = KN =",F9.5,2/
20 WRITE (15,10)N,D
25 WRITE (15,15)SQR(N)*D
30 DISP "FOR ANOTHER G.O.F. CODE ENT 1";
35 INPUT I
40 IF I#1 THEN 50
45 LOAD 52,5,70
50 DISP "DONE"
55 END
```

```
FILE # 57
*********
5 COM N,B,A[150],S1,S5,S6,X[8],Y[8]
10 I=I1=M=1
15 J=N
20 IF I >= J THEN 175
25 K=I
30 I2=(J+I)/2
35 T1=A[I2]
40 IF A[I] <= T1 THEN 50
45 Z=FNA(I)
50 L=J
55 IF A[J] >= T1 THEN 90
60 Z=FNA(J)
65 IF A[I] <= T1 THEN 90
70 Z=FNA(I)
75 GOTO 90
80 A[L]=A[K]
85 A[K]=T2
90 L=L-1
95 IF A[L]>T1 THEN 90
100 T2=A[L]
105 K=K+1
110 IF A[K]<T1 THEN 105
115 IF K <= L THEN 80
120 IF (L-I) <= (J-K) THEN 150
125 Y[M]=I
130 X[M]=L
135 I=K
140 M=M+1
145 GOTO 205
150 Y[M]=K
155 X[M]=J
160 J=L
165 M=M+1
170 GOTO 205
175 M=M-1
180 IF M THEN 195
190 LOAD 58,5,45
195 I=Y[M]
200 J=X[M]
205 IF (J-I) >= 11 THEN 25
210 IF I=I1 THEN 20
215 I=I-1
220 I=I+1
225 IF I=J THEN 175
230 T1=A[I+1]
235 IF A[I] <= T1 THEN 220
240 K=I
245 A[K+1]=A[K]
```

```
50 K=K-1
55 IF T1<A[K] THEN 245
60 A[K+1]=T1
65 GOTO 220
70 DEF FNA(Z)
75 A[I2]=A[Z]
80 A[Z]=T1
85 T1=A[I2]
90 RETURN Z


ILE # 58
********
 COM N,B,A[150],S1,S5,S6,C$[12],D$[5]
0 PRINT
5 PRINT "SHAPIRO-WILK NORMALITY TEST:"
0 PRINT "***************************"
5 PRINT
0 IF N<3 OR N>50 THEN 115
5 IF S1 THEN 50
0 LOAD 57,5,10
5 S1=1
0 B1=K=0
5 T=INT((N-3)/24)
0 V=(T+1)*(N-2-12*T)+N+56
0 J=0
5 LOAD  DATA V,C
0 V=V+1
5 J=J+1
5 K=K+1
0 B1=B1+C[J]*(A[N-K+1]-A[K])
5 IF J<12 AND K<INT(N/2) THEN 85
00 IF K<INT(N/2) THEN 70
05 LOAD  DATA V,D
10 LINK 182*(N >= 30)+59*(N<30),10,10
15 PRINT"THIS PROGRAM IS FOR SAMPLE SIZES 3-50.TRY G.O.F.TESTS FOR N>50."
20 PRINT
25 PRINT
30 DISP "DONE"
35 END
ILE # 59
********
0 W=B1*B1/((N-1)*S6↑2)
5 FORMAT /,"W STATISTIC FOR NORMALITY (N=",F4.0,") =",5X,F7.3,/
0 WRITE (15,15)N,W
5 PRINT TAB20,"%  POINTS FOR W (SMALL VALUE SIGNIFICANT)"
0 PRINT TAB26,".01      .02      .05      .1       .5"
5 WRITE (15,40)D[1],D[2],D[3],D[4],D[5]
0 FORMAT "CORRESPONDING W VALUES:",5F7.3,2/
5 DISP "DONE"
0 END
```

LISTING

TLIST for ONE SAMPLE ANALYSIS

```
0     4     190   182   0     0     0
1     3     385   333   5     160   622
2     3     385   330   5     165   622
3     3     275   225   5     130   626
4     3     365   315   5     135   626
5     3     410   364   5     160   626
6     3     260   213   5     120   622
7     3     290   244   5     145   622
8     3     340   289   5     155   622
9     3     385   339   5     195   622
10    3     295   244   10    130   0
11    3     185   137   10    9998  0
12    3     330   270   10    195   0
13    3     200   148   5     120   622
14    2     1050  622   3     0     0
15    3     300   249   5     135   622
16    3     295   246   5     145   622
17    3     220   171   10    150   0
18    3     395   344   10    155   0
19    3     190   137   10    90    0
20    3     375   325   5     110   622
21    3     210   159   10    70    0
22    3     280   229   10    60    0
23    3     375   324   10    150   0
24    3     310   256   10    220   0
25    3     420   371   10    215   0
26    3     210   158   10    60    0
27    3     310   259   5     140   622
28    3     410   356   5     190   626
29    3     365   315   5     125   622
30    3     420   375   5     290   694
31    3     200   151   5     65    626
32    3     410   356   5     175   640
33    3     230   179   5     120   674
34    3     275   222   10    125   0
35    3     325   274   10    155   0
36    3     235   184   10    115   0
37    3     370   317   10    225   0
38    3     320   270   10    125   0
39    3     290   236   10    135   0
40    3     200   151   10    95    0
41    3     125   76    10    45    0
42    3     245   193   5     160   630
43    3     325   276   5     180   630
44    3     200   140   10    85    0
45    3     400   346   10    170   0
46    3     340   292   5     145   622
47    3     345   296   10    180   0
```

```
8     3     400   348   10    180   0
9     3     420   371   10    175   0
0     3     240   189   10    95    0
1     3     420   375   5     290   690
2     3     240   190   5     95    622
3     3     320   268   10    135   0
4     3     325   273   10    135   0
5     3     235   185   10    90    0
6     3     180   130   10    55    0
7     3     420   375   5     290   690
8     3     325   278   5     135   660
9     3     225   175   10    50    0
0     2     24    24    1     0     0
1     2     10    10    1     0     0
2     2     24    24    1     0     0

      Files 60,62,..., 180 same size as file 60.

      Files 61,63,...,181  same size as file 61.
180   2     24    24    1     0     0
181   2     10    10    1     0     0
182   3     225   175   10    50    0
183   0     225   0     0     0     0
```

Program Library Entry Forms

PROGRAM LIBRARY ENTRY
Hewlett–Packard Company
Calculator Products Division

A large number of programs in the Hewlett–Packard Program Library have been contributed by our calculator users. Programs that are sent to us are evaluated and the very best ones are featured in KEYBOARD Magazine. If a program is well documented and is considered of general interest in the program's application area we include it in our software library.

If you would like to share a program or group of programs with us, we request that you complete this form and include the following typewritten items:

1. Abstract – a brief description of the program.
2. Program Introduction – a detailed description of the program including general uses, equations solved, limitations or discontinuities, references, memory allocation, and program flow chart.
3. User Instructions – forms may be found in most Program Pacs, or may be obtained from your local HP Sales Office.
4. Numerical Input/Output Examples – describe in detail the input and output of a meaningful example. Include a labeled list of the input data when not normally shown and a sample plot or printer tape if applicable, with labels on all output items.
5. Program Listing – include program steps and step codes (use Printer Alpha Program Listing, if possible).
6. Recorded Magnetic Cards or Cassettes – originals or blank cards or cassettes will be returned upon request.

Program Title____________________

Equipment Required____________________

Program Abstract____________________

____

____

____

General Applications____________________

Program Limitations____________________

Author's Name____________________Title__________

Organization____________________Tele.__________

Address____________________

____

May an HP customer contact you directly? ☐ Yes ☐ No

Shall we return original recorded cards/cassette? ☐ Yes ☐ No

Please send the complete document to: Calculator Users' Group, Hewlett–Packard Company, Calculator Products Division, P. O. Box 301, Loveland, Colorado 80537.

To the best of my knowledge, this contributed program is free of any proprietary information belonging to any person or organization. I am contributing this program on a non–confidential non–obligatory basis to Hewlett–Packard for inclusion in its software library for its use and the use of others. I agree that Hewlett–Packard may use, disseminate, copy, and sell this program thoughout the world and may authorize others to do so, all without obligation or liability of any kind.

Signature____________________Date__________

THIS SIDE FOR HP USE ONLY

CORRESPONDENCE

Source____

Date Received__________Date ack'd.__________by______________Request__________

Date Received__________Date ack'd.__________by______________Request__________

Date Received__________Date ack'd.__________by______________Request__________

Date Received__________Date ack'd.__________by______________Request__________

DOCUMENTATION

☐ Program Introduction

☐ Examples

☐ Recorded Magnetic Cards/Cassette

☐ Released Date______________

☐ User Instructions

☐ Program Listing

☐ ________________________

By________________________

EVALUATION

Copy to________________________Date________________________

Comments____

____

____

____

____

____

____________________________Date________________________

PUBLICATION

☐ UG Library ☐ HP Library ☐ Feature ☐ KEYBOARD Vol.________ No________

☐ CUC ☐ Pgm. Tip ☐________ ☐________

PROGRAM LIBRARY ENTRY
Hewlett–Packard Company
Calculator Products Division

A large number of programs in the Hewlett–Packard Program Library have been contributed by our calculator users. Programs that are sent to us are evaluated and the very best ones are featured in KEYBOARD Magazine. If a program is well documented and is considered of general interest in the program's application area we include it in our software library.

If you would like to share a program or group of programs with us, we request that you complete this form and include the following typewritten items:

1. Abstract – a brief description of the program.
2. Program Introduction – a detailed description of the program including general uses, equations solved, limitations or discontinuities, references, memory allocation, and program flow chart.
3. User Instructions – forms may be found in most Program Pacs, or may be obtained from your local HP Sales Office.
4. Numerical Input/Output Examples – describe in detail the input and output of a meaningful example. Include a labeled list of the input data when not normally shown and a sample plot or printer tape if applicable, with labels on all output items.
5. Program Listing – include program steps and step codes (use Printer Alpha Program Listing, if possible).
6. Recorded Magnetic Cards or Cassettes – originals or blank cards or cassettes will be returned upon request.

Program Title____________________

Equipment Required____________________

Program Abstract____________________

____

____

____

General Applications____________________

Program Limitations____________________

Author's Name____________________Title__________

Organization____________________Tele.__________

Address____________________

____

May an HP customer contact you directly? ☐ Yes ☐ No

Shall we return original recorded cards/cassette? ☐ Yes ☐ No

Please send the complete document to: Calculator Users' Group, Hewlett–Packard Company, Calculator Products Division, P. O. Box 301, Loveland, Colorado 80537.

To the best of my knowledge, this contributed program is free of any proprietary information belonging to any person or organization. I am contributing this program on a non–confidential non–obligatory basis to Hewlett–Packard for inclusion in its software library for its use and the use of others. I agree that Hewlett–Packard may use, disseminate, copy, and sell this program thoughout the world and may authorize others to do so, all without obligation or liability of any kind.

Signature____________________Date__________

THIS SIDE FOR HP USE ONLY

CORRESPONDENCE

Source____

Date Received______________ Date ack'd.______________ by______________ Request______________

Date Received______________ Date ack'd.______________ by______________ Request______________

Date Received______________ Date ack'd.______________ by______________ Request______________

Date Received______________ Date ack'd.______________ by______________ Request______________

DOCUMENTATION

☐ Program Introduction

☐ Examples

☐ Recorded Magnetic Cards/Cassette

☐ Released Date______________

☐ User Instructions

☐ Program Listing

☐ ______________

By______________

EVALUATION

Copy to______________________ Date______________________

Comments____

____

____

____

____

____

______________________ Date______________________

PUBLICATION

☐ UG Library

☐ CUC

☐ HP Library

☐ Pgm. Tip

☐ Feature

☐ __________

☐ KEYBOARD Vol.__________ No__________

☐ __________

PROGRAM LIBRARY ENTRY
Hewlett–Packard Company
Calculator Products Division

A large number of programs in the Hewlett–Packard Program Library have been contributed by our calculator users. Programs that are sent to us are evaluated and the very best ones are featured in KEYBOARD Magazine. If a program is well documented and is considered of general interest in the program's application area we include it in our software library.

If you would like to share a program or group of programs with us, we request that you complete this form and include the following typewritten items:

1. Abstract – a brief description of the program.
2. Program Introduction – a detailed description of the program including general uses, equations solved, limitations or discontinuities, references, memory allocation, and program flow chart.
3. User Instructions – forms may be found in most Program Pacs, or may be obtained from your local HP Sales Office.
4. Numerical Input/Output Examples – describe in detail the input and output of a meaningful example. Include a labeled list of the input data when not normally shown and a sample plot or printer tape if applicable, with labels on all output items.
5. Program Listing – include program steps and step codes (use Printer Alpha Program Listing, if possible).
6. Recorded Magnetic Cards or Cassettes – originals or blank cards or cassettes will be returned upon request.

Program Title________________________________

Equipment Required________________________________

Program Abstract________________________________

____

____

____

General Applications________________________________

Program Limitations________________________________

Author's Name________________________Title____________

Organization________________________Tele.____________

Address______________________________________

____

May an HP customer contact you directly? ☐ Yes ☐ No

Shall we return original recorded cards/cassette? ☐ Yes ☐ No

Please send the complete document to: Calculator Users' Group, Hewlett–Packard Company, Calculator Products Division, P. O. Box 301, Loveland, Colorado 80537.

To the best of my knowledge, this contributed program is free of any proprietary information belonging to any person or organization. I am contributing this program on a non–confidential non–obligatory basis to Hewlett–Packard for inclusion in its software library for its use and the use of others. I agree that Hewlett–Packard may use, disseminate, copy, and sell this program thoughout the world and may authorize others to do so, all without obligation or liability of any kind.

Signature________________________Date____________

THIS SIDE FOR HP USE ONLY

CORRESPONDENCE

Source____________________

Date Received__________Date ack'd.__________by__________Request__________

Date Received__________Date ack'd.__________by__________Request__________

Date Received__________Date ack'd.__________by__________Request__________

Date Received__________Date ack'd.__________by__________Request__________

DOCUMENTATION

☐ Program Introduction

☐ Examples

☐ Recorded Magnetic Cards/Cassette

☐ Released Date__________

☐ User Instructions

☐ Program Listing

☐ __________

By__________

EVALUATION

Copy to__________Date__________

Comments__________

____

____

____

____

____

__________Date__________

PUBLICATION

☐ UG Library

☐ CUC

☐ HP Library

☐ Pgm. Tip

☐ Feature

☐__________

☐ KEYBOARD Vol.__________

☐__________

No__________

PROGRAM LIBRARY ENTRY
Hewlett–Packard Company
Calculator Products Division

A large number of programs in the Hewlett–Packard Program Library have been contributed by our calculator users. Programs that are sent to us are evaluated and the very best ones are featured in KEYBOARD Magazine. If a program is well documented and is considered of general interest in the program's application area we include it in our software library.

If you would like to share a program or group of programs with us, we request that you complete this form and include the following typewritten items:

1. Abstract – a brief description of the program.
2. Program Introduction – a detailed description of the program including general uses, equations solved, limitations or discontinuities, references, memory allocation, and program flow chart.
3. User Instructions – forms may be found in most Program Pacs, or may be obtained from your local HP Sales Office.
4. Numerical Input/Output Examples – describe in detail the input and output of a meaningful example. Include a labeled list of the input data when not normally shown and a sample plot or printer tape if applicable, with labels on all output items.
5. Program Listing – include program steps and step codes (use Printer Alpha Program Listing, if possible).
6. Recorded Magnetic Cards or Cassettes – originals or blank cards or cassettes will be returned upon request.

Program Title____________________

Equipment Required____________________

Program Abstract____________________

____

____

____

General Applications____________________

Program Limitations____________________

Author's Name____________________Title__________

Organization____________________Tele.__________

Address____________________

____

May an HP customer contact you directly? ☐ Yes ☐ No

Shall we return original recorded cards/cassette? ☐ Yes ☐ No

Please send the complete document to: Calculator Users' Group, Hewlett–Packard Company, Calculator Products Division, P. O. Box 301, Loveland, Colorado 80537.

To the best of my knowledge, this contributed program is free of any proprietary information belonging to any person or organization. I am contributing this program on a non–confidential non–obligatory basis to Hewlett–Packard for inclusion in its software library for its use and the use of others. I agree that Hewlett–Packard may use, disseminate, copy, and sell this program thoughout the world and may authorize others to do so, all without obligation or liability of any kind.

Signature____________________Date__________

THIS SIDE FOR HP USE ONLY

CORRESPONDENCE

Source____

Date Received____________ Date ack'd.____________ by_______________ Request____________

Date Received____________ Date ack'd.____________ by_______________ Request____________

Date Received____________ Date ack'd.____________ by_______________ Request____________

Date Received____________ Date ack'd.____________ by_______________ Request____________

DOCUMENTATION

☐ Program Introduction

☐ Examples

☐ Recorded Magnetic Cards/Cassette

☐ Released Date_______________

☐ User Instructions

☐ Program Listing

☐ ______________________________

By______________________________

EVALUATION

Copy to____________________________ Date____________________________

Comments____

____

____

____

____

____

__________________________________ Date____________________________

PUBLICATION

☐ UG Library

☐ CUC

☐ HP Library

☐ Pgm. Tip

☐ Feature

☐ ________

☐ KEYBOARD Vol.________ No________

☐ ________

Part No. 09830-70875

Printed in U.S.A.
4/74 .5M