DEVELOPING STATISTICAL PROGRAMS ON A MICRO COMPUTER FOR SURVEYING DATA ANALYSIS

BY

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A THESIS PRESENTED

IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE

MASTERS OF SCIENCE IN LAND SURVEYING

Department of Surveying
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AUGUST, 1988

DECLARATION

I hereby declare that this Research Project has been conducted by me under the supervision of Prof. N.J. Field of the Department of Surveying, Ahmadu Bello University, Zaria.

(SUNDAY POPOOLA OLALEYE)
Student's Name

....
Sign

CERTIFICATION

This project report/thesis/dissertation entitled Developing statistical programs on a micro computer for surveying data analysis by Sunday Popoola Akhige meets the regulations governing the award of the degree of M.Sc. Land Surveying of Ahmadu Bello Univeesity, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

WITH GRATITUDES TO GOD FOR SPARING OUR LIVES,

THIS PROJECT IS DEDICATED TO OUR LATE MOTHER -

MADAM OYEGBENLE OLALEYE

DIED JULY, 1958

ALSO TO MY BROTHER OLAYODE, AND OUR WIVES

JANET AND REMI.

ACKNOWLEDGEMENTS

I hereby write to express my gratitude to my supervisor, Prof. N.J. Field, Head, Department of Land Surveying, Ahmadu Bello Unversity, Zaria. Apart from introducing the concepts of surveying to me he had also suggested the ideas about this project. His suggestions, regular visits to Kaduna on supervisions had made this project and my course a success.

Special regards go to my worthy mentor - Chief A.B. Ojo (FNIS), Deputy Rector and Director College of Environmental Studies, Kaduna Polytechnic. His fatherly advice originated the desire for the course.

I would want to thank the entire members of staff, Department of Land Surveying, Ahmadu Bello University, Zaria most especially Dr. G.O.A. Egberongbe (Associate Prof. on Sabbatical leave) for valuable suggestions after reading the draft. Thanks also to the entire staff members of the Department of Topographic Science, College of Environmental Studies, Kaduna Polytechnic for their moral assistance.

Thanks to the entire 1986/87 M.Sc. I, Land Surveying students Ahmadu Bello University, Zaria - I am proud of you all.

I wish to acknowledge the contributions of Messrs D. Cooke, A.H. Craven, G.M. Clarke whose production "BASIC STATISTICAL COMPUTING" had supplied adequate algorithms for the project.

My thanks go to my brother David Olayode Olaleye, our wives; Janet Abebi Olaleye and Florence Remi Olaleye and also to our children Bolaji, Yetunde, Kolapo, Bolanle, Tope and Ayo for your endurances while I was always away.

The families of Dr. & Mrs. Ogungbile and Dr. & Mrs. Rag Bello had made my stay in Zaria a successful one. I thank them.

Finally, I thank my God through Christ who strengthens me; .... Phillipians 4:13

ABSTRACT

The project produces a statistical computer package for analysis of survey data. The computer programes are sequentially developed to cover statistical concepts such as, measure of central tendency, measures of dispersion, graphical presentation of data (Histogram, Stemplot, Boxplot, Frequency Table, Scatter Diagram etc.); probability functions and their inverses (Binomial, Normal, Student t, Chisquare and F distribution); significance tests and confidence intervals; analysis of variances. Test data were used to test each of the programs separately and all the programs together as a package. The results are satisfactory.

Einstein a Basic Micro Computer was used.

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/continued.

NOTATIONS AND ABBREVIATIONS

Some Terms that the reader/user may come accross are briefly explained:

TERM	MEANING
MAXMIN	Maximum and Minimum
MVAR	Mean and Variance
QUANTILES	Deciles, Quantiles, Percentiles, etc.
SSP	Sum of Squares and Product
BOXPLOT	Box and Whisker Plot
HISTTOGM	Histogram
STEMPLOT	Stem and Leaf Diagram
FRETAB	Frequency Table
SCATTER	Scatter Diagram
TWO-TAB	Two Way Table
BINOMIAL	Binomial Distribution
NORMAL	Normal Distribution
SIMPSONS	Simpsons Interval
GAMMA	Log Gamma
T	Student-T Distribution
INUT	Inverse T Function
X2	Inverse Chisquare Function
INV X2	Inverse F Function
F	F-Distribution
INVF	Inverse Chi Square Function
T-TEST	T-Test on Mean
T-STAT	T-Statistics (Unpaired)
CONFINT	Confidence Interval
CHIFIT	Chi Square Goodness of Fit

/continued.

CHITAB	Chi Square Contigency Table
WILCONXUN	Wilcoxon Signed Rank Test
ANOVA 1	One Way Analysis of Variance
ANOVA 2	Two Way Analysis of Variances
MULTIFIT	Multiple Regression
LINE SOLU	Linear Solution of Systems of Equations using Cholesky Method
F Ø	Rounding Off Parameter
W Ø	Window Width
H Ø	Window Height
E	Accuracy Parameter LOE-6
P Ø	Probability Value

LIST OF APPENDICES

THE PACKAGE AT A GLANCE

GROUP NAME	OBJECTIVE	PROGRAM LISTS
DATA IN	FILE CREATION	INPUT VAR VAR READ VAR WRITE INPUT MAT MAT READ MAT WRITE
SORT RANK	SORTING AND RANKING	QUICK SORT RANK SORT
DESCRIPT	DESCRIPTIVE STATISTICS	FREQ CONT MAX MIN MEAN VAR QUANTILE SUM SQ PROD CORRELATION
GRAPHICS	GRAPHICAL REPRESENTATION	BOX PLOT HISTOGRAM STEM PLOT FREQ TAB SCATTER TWO TAB
PROBFUNC	PROBABILITY FUNCTIONS, DISTR. & INVERSE FUNCS.	BINOMIAL NORMAL AND INVERSE STUDENT-t & INVERSE CHI SQ & INVERSE F DISTN & INVERSE SIMPSONS INTEGRAL GAMMA FUNCTION
SIGTEST	SIGNIFICANCE TESTS	T TESTS/MEAN T-STATISTICS UNPAIRED CONFINT CHIFIT CHITAB WILCOXON
ANALYSIS	ANALYSIS OF DATA	ANOVA 1 ANOVA 2 LINE FIT MULTIFIT MULTI VAR MULTI SOLVE

LIST OF TABLES

CHAPTER ONE

AIM OF THE PROJECT

In an era of "Utilize Available Resources" as we are in Nigeria, a collection of statistical programs in Basic Language is of utmost importance since MICRO COMPUTERS are readily available and are relatively cheap as compared to computer MAIN FRAMES. This project thus produces a statistical computer package which using file handling techniques evolves a statistical analysis of data. Statistical analysis of data validates reports, claims and conclusions on any project. Sources of data may include various disciplines, but emphasis are laid on survey, land use and photogrammetry data. Since the main theme is STATISTICAL ANALYSIS, the computer package is developed using a sequential procedure to:-

a. Compute the measures of central tendencies and dispersions, arithmetic mean, median, mode, range, standard deviation.

b. Graphically present data using Histograms, Stemplot, Boxplot, Scatter-diagram, frequency table and contigency table.

c. Compute statistical probabilities from Binominal, Normal, Student-t, Chi-square and F-distributions.

d. Use of inverse functions to produce normal, Chi-square and F values if given their corresponding probabilities and degrees of freedom.

e. Analyse data by using significance tests or confidence intervals as criteria to reject and/or accept the data.

f. Perform data analysis using analysis of data (one way and two way classification(s).

g. Carry out multiple regressions given large set of data.

h. Utilise residuals as means of studying the comparative analysis.

The programs are developed on EINSTEIN Micro computer using Basic - a language available in all micro computers. This allows for ease of use and ease of adaptation to other basic versions. All the programs have been separately and collectively tested with already available test data - most results are presented along with the programs. These results are found to be satisfactory.

CHAPTER TWO

THE EINSTEIN COLOUR MICRO COMPUTER

The project was carried out on the Einstein Colour Micro Computer owned by the College of Environmental Studies, of the Kaduna Polytechnic. The computer operates any of the X BASIC and BBC BASIC modes. The X BASIC language was used.

The Tatung/Xtal Basic 4 is based upon Xtal Basic 3.0 which has been extensively enhanced to provide extra facilities for the user. One of the outstanding features of this basic is the ability to create user defined reserved words and user defined error messages with the aid of machine code programming. The interpreter can be expanded by writing appropriate sub-routines and by inserting your own defined words in an auxiliary reserved word table to give the type of BASIC most suited to your own requirements.

The EINSTEIN Computer has 64K RAM (Random Access Memory), 8K ROM (Read Only Memory) with expansive for up to 32K internal and 16K separate video RAM.

The character generator poceses 96 alphanumeric characters and 160 graphic symbols. All characters and symbols are software re-programmable.

The printer output has centronic interface standard. The external disc interface provides signals for up to two self-powered external disc drills. Either 3 high compact floppy, 3½ "micro floppy disc or 5¼ mini floppy.

The key board is the full travel typewriter style Qwerty keyboard. It possesses:-

/continued.

a. 48 alphanumeric/graphics, 8 function keys and 11 control keys.

b. All keys having a lock out with one key roll over

c. An automatic repeat

d. Programmable repeat delay and repeat speed.

The editor provides a wide range of facilities which are not complex to use, and are designed to make the editing process much easier than with most other systems. There are also extensive screen formenting facilities available to the user.

The Tatung/Xtal Basic 4 of the Einstein colour micro computer offers many capabilities which are normally regarded gy other BASICS as enhancement to be purchased separately by the user. For example, the advanced graphics which make use of sprites, the fully programmable sound generator and also the file handling commands.

CHAPTER THREE

STATISTICAL CONCEPTS USED

3.1 Statistics: The programs are developed utilising the following statistical concepts.

3.1.1 Population and Variates: The conceptual knowledge of population, sample and variates, form a general background for the study of statistics. It is very important to understand the statistical use of population, i.e. finite and infinite, the need for samples as representatives of the population. Variates could be single, unpaired, paired, discrete and continuous. It is not enough to be able to define each of these "reserved" words, their meanings and usage should be comprehended in order to be able to frame correctly the analysis required and methods of carrying out such analysis.

3.1.2 Measure of Central Tendencies: It is sometimes referred to as the measure of location. It allows for the measurement of the centre of a set of observations collected, thereby providing means of studying how other data in such a population vary about their 'centre'. The arithmetic mean usually referred to as the most probable value, the mode i.e. observation with highest frequency and also the median i.e. middle observation are studied. Such calculations for measure of central tendencies could be made for grouped and ungrouped data, weighted data etc. Other measures include the geometric mean, weighted averages and index numbers.

3.1.3 Measure of Dispersion: This expresses how data vary about the measure of central tendency used. It is sometimes referred to as measurement of variability. Allied to this measure are range, mean deviation variance and standard deviation, quantiles, deciles, percentiles and the interquentile values.

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3.1.4 Graphical Representation: The description of any population requires a very good graphical representation. Bar charts, pie charts, line graphs, histogram, cummulative frequency diagrams are required in order to present data graphically and also to give aesthetic views of such sets of data. The project also in particular develops other more advanced graphical representation, i.e. the boxplot (which requires quantile information by means of a six-point summary as input, stemplot) which requires sorted data as input) scatter diagram (for paired data) and also the two way table for categorical data.

3.1.5 Probability and Probability Functions: This requires the knowledge of sample space and sample points as means of calculating probability. Interesting topics such as throwing the dice, tossing the coin, playing a game of card are helpful in introducing the ideas about probability. Probability functions may be discrete or continuous. Discrete variables may be summed over specific values while continuous variable are summed up integrally over a given interval range. An example is the sympson intergral for computing the probability. This requires the lower unit, the upper unit and step numbers. For a more advanced knowledge of probability functions, the methods of obtaining statistical probabilities using each of the (a) binomial, (b) normal (c) poisson etc., are required. Inverse functions for computing the normal, T, Chi-square and F values are also used.

3.1.6 Mathematical Expectations: These topics are required for a complete comprehension of probability functions and variates. They include expected values, expectation of a random variables, means of the binomial and geometric distributions, expectation of linear function of a random variable, variances as an expected value, variance of the binomial distribution and also the probability generating functions. These are used for discrete and continuous random variables.

/continued.

3.1.7. Joint Distribution: This refers to bivariate distributions as a means of showing the inter-relationship between two sets of variables. This facts can be obtained about the means of the sum of two variables, means of products oftwo independent random variables, variance of the sum of independent variables, correlation and correlation coefficients, scatter-diagrams, correlation between two random variables, and also rank correlation.

3.1.8. Estimation and Estimation Theory: This is the distribution of estimates of a population, distribution of estimates of a mean, the mean and variance of $\overline{X}$, unbiased estimations of means and variances.

3.1.9. Hypothesis Testing: This includes the tests of hypothesis (null and alternatives), the type I and type II errors, the power of a test. It also includes significance tests and levels, significance tests using normal distribution, single observation, the mean of n observations from a population, one tail or two tail tests. Others are paired comparisons, parametric and non-parametric tests, confidence intervals for a mean of normal distribution, also for a population mean based on a large sample etc.

3.1.10 Analysis: Regression analysis and analysis of variances end up the reliability test of a given data. They include fitting a straight line, regression constants and the computation of residuals as means of comparative analysis for accepting or rejecting any data. Analysis of variance can be of one way classification or two way classifications depending on the number of factors considered for analysis. The least squares approach to regression and analysis are used to minimise errors. Residuals are produced as criteria for acceptance or rejection of any of the data.

3.2 Mathematical Formulae: It is always very difficult to dissociate mathematics from statistics. More so when statistics is an applied discipline of mathematics. Statistics is generally based on mathematical concepts, axioms and formulae. In order to retain the meanings of each statistical term, the mathematical concepts have to be maintained.

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A total of 43 different sub-programs are developed to produce this package. An attempt has been made to link up programs so that available relults from a part of the program are later used as required inputs. As such, sub-routines are available for common program parts. Few of the commonly used formulae are hereby written out. Wherever alternatives are available, the better of the two are considered.

3.2.1 <u>ARITHEMETIC MEAN</u>: $\overline{X} = \frac{\Sigma xi}{N} \qquad i = 1 \text{ ---------- } N$

3.2.2 <u>VARIANCE</u>: $S^2 = \Sigma(x1 - \overline{x})^2 = \left\{ x1^2 - \frac{(\Sigma xi^2)}{N} \right\} N-1$

The mean and variance methods are compared with an updating procedure which is a very accurate method, however, it is a less obvious and straight forward method than those based on direct methods, 3.2.1 and 3.2.2 above and so they are dropped.

3.2.3 <u>MEDIAN</u>: This is the middle observation, ie $\frac{N+1}{2}$th for odd N and $(\frac{N}{2} + 1)$th observation for an even N. In developing the programs, sorting takes place before calculating the median. Same also holds for quantiles in general.

3.2.4 <u>CORRELATION COEFFICIENT</u>: $R = \frac{S(1,2)}{SQR(S(1,2)} XS(2,2))$ programs are developed as matrix elements such that

$$S(1,1) = \Sigma\,(xi - \bar{x})^2 = \sigma^2 XX$$

$$S(1,2) = \sigma^2 xY = S(2,1) = \Sigma(xi - \bar{x})\,(Y_i - \bar{Y})$$

$$S(2,2) = \sigma^2 YY \quad \Sigma(Y_i - \overline{Y})^2$$

The graphical representations are based on the formulae discussed. Although mathematical formulae are not stated to illustrate them, their programs are based on these formulae. The are pictorially presented to represent the given data.

/continued.

3.2.5 BINOMIAL DISTRIBUTION: Parameters are n and p

$$f(x) = \binom{n}{x} p^x (1-p)^{n-x}$$

3.2.6 NORMAL DISTRIBUTION:

$$F(Z) = \int_{-\infty}^{Z} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt$$

3.2.7 INVERSE NORMAL, given probability P

$$q = 1-p = 1-f(Z)$$

$$Z = t - \frac{a_1 + a_2 t}{1 + a_3 t + a_4 t^2} + (q) \quad \text{where } t = \sqrt{(-2\ln q)}$$

The absolute error $|\Sigma(q)| < 3 \times 10^{-3}$

t

3.2.8 Student with K degress of freedom

$$\text{P.D.F.} = \{ (k+1)/2 \}\{\frac{1}{(1+x \quad /K}^{(k+1)/2} \quad -\infty < X < \infty$$

3.2.9 Chi-square with K degrees of freedom

$$X^2 \quad \text{P.D.F.} = \frac{1}{(K/2) \, 2^{K/2}} \; x^{k/2-1} \, e^{-x/2} \quad 0 < X < \infty$$

3.2.10 F with K_1 and K_2 degrees of freedom

$$\{ (K_1+K_2)/2) \, (K_1/k_2)^{k_1/2} \} \{ \frac{X^{(k_1-2)/2}}{1+L_1 x/k_2)}^{(k_1+k_2)/2} \quad 0 < X < \infty$$

3.2.11 X^2 Statistic: $\Sigma \frac{(O_i - E_i)^2}{i}$ For Statistic Test

3.2.12 Test of Means:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} \quad \text{where}$$

$$S^2 = \frac{(n_1-1)\, S_1^2 + (n_2-1)\, S_2^2}{n_1 + n_2 - 2}$$

/continued.

3.2.13 Regression $Y = a + bx$ where

$$a = \bar{y} - b\bar{x}$$

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

and residuals $V_i = y_i - a - bx_i$

3.2.14 Multiple regression

$$Y = a + b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots\ldots + b_cx_c$$

where C are number of independent variables and Y the dependent variables.

For analysis of variance, it should be noted that the actual quantity split into components, i.e. the sum of the squares $\Sigma(x_i-\bar{x})^2$ of the differences between each individual observation x_i and the mean of the whole data set $\bar{x}$. These statements are not wholly exhaustive, readers are advised to refer to book references, e.g Alcock Donald (1977) for more mathematical insight into the developed programs.

CHAPTER FOUR

DEVELOPING THE PACKAGE

D. Cooke, A.H. Craven, G.M. Clarke 1982, produced an extensive work on developing algorithms for statistical programs in basic. Through the listings obtained form their work, the writer has been able to transfer the statistical programms for use in the Einstein Tatung Computer and thorugh their concepts, the writer has been able to test the programs using survey data and also to demonstrate their utility in complete survey context. Their work had made this work practically meaningful.

The programs are all developed in Basic Computer language in form of algorithms for subsequent grouping if necessary. Each of the sub-programs satisfies the basic mathematics underlying its concepts. An attempt therefore is made to develop the package using:-

4.1 Systems of grouping

4.2 Menu approach

4.3 File handling techniques.

4.1 There are 43 sub-programs developed to make up the package. Each of the sub-programs was tested with available data and results were found to be satisfactory. Thus a system of grouping has been developed, which also leads to the production of the whole package. Each group is formed based on similarities in mathematical concepts, similarities in results desired and also sequentially for systematic development. Details of these groupings are:-

a.	SORTRANK	d.	PROBFUNC
b.	DESCRIPTIVE	e.	SIGTEST
c.	GRAPHICS	f.	ANALYSIS

/continued

(a) SORTRANK: There are two sub-programs in this group, i.e sorting and ranking. Usually, not all data require sorting and or ranking for their analysis. Some data specifically require sorting and/or ranking. The two programs are thus grouped for use specifically or for an intermediate result. The sorting method adopted is the quick sort method. The quick sort is a sorting method using menu approach to obtain a very quick result. Other sorting methods compared are the exchange sort, bubble sort and shell-sort. Examples of sorted data are given on Table 1.

Ranking program makes use of exchange sort sub-program. For large set of data of about 500, the difference in time is very remarkable but for few data, the change time-wise is not significant. Example of a sorted and ranked data is on Table II.

(b) DESCRIPTIVE: This is used to group all programs that are for descriptive analysis of data. The programs developed in this group are those to compute, frequency count, maximum and minimum, mean variance, quantiles, ie. percentiles, deciles and quantiles, and also rank correlation (for paired data). Other programs apart from the rank correlation are for unpaired data. The reader must have realised the need for each of these aspects of disciplines in statistics for adequate analysis. They all form the rudimentary basis for statistical analysis. For the paired data, note should be made of the need to compute the sum of squares and products in order to calculate the correlation between the paired values. Parts of the formulae developed into basic programs are written in 3.2. Table III gives an example of the computed minimum value, maximum value, the mean and variance of the given data. Table IV gives the frequency count while Table V gives the six-point summary, ie. sample size and quantiles.

/continued.

TABLE I: ORIGINAL AND SORTED DATA

THE DATA ARE

33	56	50	66
62	63	95	52
28	48	51	63
71	57	59	72
60	83	62	73
34	64	62	98
60	55	50	59
58	55	64	65
59	49	60	62
55	58	72	51
51	55	58	56
52	66	62	55
58	60	55	62
61	53	61	57
54	62	51	60
64	55	52	56
56	63	54	67
54	53	59	62
63	55	61	60
78	50	57	65
69	60	62	67
54	68	60	53
62	72	75	42
33	47	67	52
74	53	63	61

THE SORTED DATA ARE

28	33	33	34
42	47	48	49
50	50	50	51
51	51	51	52
52	52	52	53
53	53	53	54
54	54	54	55
55	55	55	55
55	55	55	56
56	56	56	57
57	57	58	58
58	58	59	59
59	59	60	60
60	60	60	60
60	60	61	61
61	61	62	62
62	62	62	62
62	62	62	62
63	63	63	63
63	64	64	64
65	65	66	66
67	67	67	68
69	71	72	72
72	73	74	75
78	83	95	98

TABLE II: SORTED AND RANKED DATA

THE SORTED AND RANKED VALUES ARE

```
VALUE  28 RANK  1
VALUE  33 RANK  2.5
VALUE  33 RANK  2.5
VALUE  34 RANK  4
VALUE  42 RANK  5
VALUE  47 RANK  6
VALUE  48 RANK  7
VALUE  49 RANK  8
VALUE  50 RANK  10
VALUE  50 RANK  10
VALUE  50 RANK  10
VALUE  51 RANK  13.5
VALUE  51 RANK  13.5
VALUE  51 RANK  13.5
VALUE  51 RANK  13.5
VALUE  52 RANK  17.5
VALUE  52 RANK  17.5
VALUE  52 RANK  17.5
VALUE  52 RANK  17.5
VALUE  53 RANK  21.5
VALUE  53 RANK  21.5
VALUE  53 RANK  21.5
VALUE  53 RANK  21.5
VALUE  54 RANK  25.5
VALUE  54 RANK  25.5
VALUE  54 RANK  25.5
VALUE  54 RANK  25.5
VALUE  55 RANK  31.5
VALUE  55 RANK  31.5
VALUE  55 RANK  31.5
```

TABLE III: MIN, MAX, MEAN AND VARIANCE

```
THE MIN NO IS: 28
THE MAX NO IS: 98
THE MEAN OF THE DATA IS: 59.21
THE VARIANCE IS: 105.006
```

TABLE IV: FREQUENCY COUNT.

THE DATA AND FREQ.ARE

2[illegible]	1
33	2
34	1
42	1
47	1
48	1
49	1
50	3
51	4
52	4
53	4
54	4
55	8
56	4
57	3
58	4
59	4
60	8
61	4
62	10
63	5
64	3
65	2
66	2
67	3
68	1
69	1
71	1
72	3
73	1
74	1
75	1
78	1
83	1
95	1
98	1

THE TOTAL NO CLASSES IS 36

TABLE IV[B]: FREQUENCY TABLE

THE FREQUENCY TABLE:

INTERVAL	FREQUENCY
10 <=X< 20	0
20 <=X< 30	1
30 <=X< 40	3
40 <=X< 50	4
50 <=X< 60	42
60 <=X< 70	39
70 <=X< 80	8
80 <=X< 90	1
90 <=X< 100	2

(c) GRAPHICS: These are programs developed to give the graphical presentation of data being analysed. Their frequencies have earlier been computed and therefore tabulation becomes very easy. Relationship between variables in a set of data are more vividly shown by graphical methods than by numbers alone. The TAB function in basic is essentially useful in graphic programs. It is however important also to note the following constraints viz: window width (wØ), window height (HØ) each describing the dimensions of the screen which is usually of 40 columns and 24 rows. Other data information required for graphs viz, lower limit, upper limit, number of data, etc. are required inputs at the beginning of the programs. The graphical programs developed include boxplot, Table V, histogram Table VI, stemplot, Table VII, scatter diagram, Table VIII and the two way table, Table IX. All based on the given data. Data can be varied if desired. All the necessary inputs for each of the sub-programs are obtained either directly as input or indirectly from output from previous programs. As an example, the boxplot requires the six-point summary which include number of data, the median, the first quantile, the third quantile, the lower end point and the upper end points. The programs are developed so that all these information are available when required. Also, sorting which is required for stemplot is available as a subroutine. The same applies to scatter-diagram which requires information about each set of data. These information are made available in the descriptive statistics section. The two way table - Table IX requires categorical data as input. These are converted to string variables for a two way classification indicating the frequencies for each of the four cells. The total frequencies are thus calculated based on row and column totals.

/continued.

TABLE V: SIX POINT SUMMARY AND BOX PLOT

```
SAMPLE SIZE          100
MEDIAN               59.5
QUARTILES 54                63
EXTREMES  28                98
```

BOXPLOT DIAGRAM

```
N= 100
   28        54  59.5  63   98

              ___
              I  I
   (--------- *------------)
              I  I
              ___
```

TABLE VI: HISTOGRAM

HISTOGRAM

```
10 -I
20 -I*
30 -I***
40 -I****
50 -I*******************************************
60 -I****************************************
70 -I********
80 -I*
90 -I**
100 -I
```

TABLE VII: STEMPLOT

THE STEMPLOT

```
1*
2* 8
3* 334
4* 2789
5* 000111122223333444455555555666677788889999
6* 000000001111222222222233333444556677789
7* 12223458
8* 3
9* 58
```

TABLE VIII: SCATTER DIAGRAM

FOR THE PAIRED DATA:
THE FIRST SUM OF SQUARES =: 7903
THE SECOND SUM OF SQUARE =: 9862.56
THE PRODUCT=: 7034.8
THE CORRELATION COEFFICIENT =: .796821

SCATTER DIAGRAM:

```
96 I                    *
   I                 *
   I
   I                   *
   I
   I                 *
   I                ** 
   I           *  2 2*2*
   I     **   *2 2 5**
   I       *  *  3*2**
   I     ** 2*2 2***
   I       *2**2*2***
   I   * * *  2 2*
   I  * 2 2 2**3***
   I  **3 2 2*
   I      2
   I
   I
   I
33 I*
```

TABLE IX: TWO WAY TABLE

TWO-WAY TABLE:

	M	F	TOTAL
L	47	41	88
G	7	5	12
TOTAL	54	46	100

(d) PROBFUNC: This groups the probability data functions and their inverses. Programs include the Binomial distribution, Normal distribution, simpsons integral, gramma function, student-t distribution, the chi-square distribution and also the F-distribution (for the ratio of two chi-square values). The inverse functions for the normal, student-t, chi-square and F require probability values and respective degrees of freedom (Student-t, Chi-square and F-distributions) as inputs while the individual statistic values are the output. However, the programs are so developed that both the distribution function and the inverse functions cannot be run at a time. The user must decide in advance which aspect of the distribution he requires, so that appropriate inputs are used to obtain correct desired results (output).

It is also pertinent here to mention that one or more programs in the group can be run as desired. The simple yes and no answers given by pressing the Y? N respectively help run the desired programs while skipping the undesired ones. Table XI gives examples of each based on tested data whose results are already known.

(e) SIG-TEST: The programs in this group which are tagged significance testings include the test of mean, T-test of unpaired data, significance confidence interval, chi-square fit, chi-square contigency table and also a non parametric wilcoxon test. Any or all if required of the programs in the group can be run for necessary outputs, Table XI.

(f) ANALYSIS: Programs in this group are tagged analysis as they complete the systems and processes of data descriptions. The programs include the line fit for bivariate regression analysis, multivariate regression analysis is one of the programs that use a combination of subprograms. Table XII gives an example of a multiple regression analysis,

TABLE X: PROBABILITIES AND SIGNIFICANCE TEST

THE BINOMIAL PROBABILITIES ARE:
.216
.432
.288
.064
THE Z-PROBABILITY =: .95019
THE T-PROBABILITY =: .905679
THE SIMPSON-PROBABILITY = .144
THE GAMMA VALUE = .693147
THE CHI-SQ PROBABILITY = .990015
THE F-PROBABILITY IS .999309

THE Z-VALUE FOR PROBABILITY : .95 = 1.64449
THE T-VALUE = 1.81211
THE CHI-SQUARE VALUE IS 18.2594
THE F-VALUE FOR 10 , 15 DEGREES OF FREEDOM = 2.54382

TABLE XI.

T-STATISTIC(MEAN OF POPULATION)

MEAN ON NULL HYPOTHESIS = 518

SAMPLE MEAN = 2.6

STANDARD ERROR OF MEAN = .05

T-STATISTIC =-10308

DEGREE OF FREEDOM = 35

THE T-VALUE FOR 23 DEGREE OF FREEDOM = 2.02963
95 % CONFIDENCE INTERVAL FOR MEAN =
(1.91069 , 3.28931)

TABLE XII MULTIPLE REGRESSION

```
MULTIPLE REGRESSION:-----------
THE SOLUTION MATRIX IS
 1.26667
 .933333
THE  INTERCEPT IS-8.73333
THE REGRESSION COEFFICIENT ARE
 1.26667
 .933333
SUM OF SQUARES RESIDUAL IS 1.73333
SUM OF SQUARES TOTAL IS 30
FITTED VALUES    RESIDUALS
       4.4        -.400002
       6.33333     .666666
       4.8         .2
       8.93333    -.933332
       10.5333     .466668
```

TABLE XIII - ANOVA ONE-WAY

SOURCE SS DF MS

TREATMENTS 99.4286 2

49.7143

RESIDUAL 70 11

6.3636

TOTAL 169.429 13

F(2 ; 11)= 7.81224

TREATMENT MEAN STD ERROR

3	1.4564
7	1.1282
10	1.0299

OVERALL MEANS 7.4286

TREATMENT 1

REPLICATE	OBSERVATION	RESIDUAL
1	1	-2
2	4	1
3	4	1

TREATMENT 2

REPLICATE	OBSERVATION	RESIDUAL
1	3	-4
2	6	-1
3	7	0
4	9	2
5	10	3

TREATMENT 3

REPLICATE	OBSERVATION	RESIDUAL
1	6	-4
2	8	-2
3	10	0
4	11	1
5	12	2
6	13	3

TABLE XIV: ANOVA TWO WAY

TREATMENTS	130.667	2	65.3333
BLOCKS	62	3	20.6667
RESIDUAL	4	6	.6667
TOTAL	196.667	11	

TREATMENTS F(2 , 6)= 98

BLOCKS F(3 , 6)= 31

TREATMENT MEAN

3
6
11
3.6667
6
7
10

OVERALL MEAN 6.6667

S.E OF TREATMENT MEAN .408248

TREATMENT 1

REPLICATE	OBSERVATION	RESIDUAL
1	1	1
2	2	-.333333
3	3	-.333333
4	6	-.333333

TREATMENT 2

REPLICATE	OBSERVATION	RESIDUAL
1	2	-1
2	6	.666667
3	7	.666667
4	9	-.333333

TREATMENT 3

REPLICATE	OBSERVATION	RESIDUAL
1	8	-4.76837E-07
2	10	-.333333
3	11	-.333333

They include all information required to run the package through. A beginner may need to study the instructions thoroughly before running the programs.

1. Sorting and filing of Data: Keyboard I if pressed accesses this part of the programs. Data file creation, input of data, etc., are enumerated. The data filed include those that may not be often required or those that may require little editing in future.

2. Sort-Rank: Keyboard 2 accesses this part of the program. It should be noted that once the data have been filed, any part of the program groups can be 'called' for execution and also any sub-program in the group can also be used at will.

3. Descriptive: Keyboard 3 accesses this part of the program package.

4. Graphics: Keyboard 4 is required to access this program part.

5. Probfunc: Keyboard 5 is used.

6. Sigtest: Keyboard 6 is used.

7. Analysis: Keyboard 7 is used.

8. End: Pressing keyboard 8 terminates the programming.

This device coupled with adequate data filing techniques make execution of programs very logical. It is therefore possible to run the package just for one particular sub program say ranking and terminate the programming immediately after that.

The essence of the menu device therefore is that the program package offers a lot of programs commonly called a menu of which one is chosen at a time, carried out and is followed by a command to return again to the main menu. It is infact interesting in that each time the menu is consulted, any desired sub program may be chosen or program execution terminated.

4.3 FILE HANDLING:

The Einstein Computer operates the commands create, open, close etc., to access discs for data storage etc. Such commands allow for reading and writing from files. This technique has aided the program package very adequately in that different files are created for different 'special' analysis and once such data had been filed they can be called at any time into the memory for usage. In analysis for example, data input for ANOVA 1 are quite different from those for ANOVA 2. Similarly, multiple regression data input and quite different from those for line fit. Also, data originally can be paired and unpaired. Whatever the situation, the file creation techniques are employed to store data separately in different files. Note therefore is made of different file names when required for usage.

Example of these commands in the package are:-

1. 10 creat ₦ FDØ FØ where FØ is the file name

   20 PRINT ₦ FDS: 30 PRINT ₦.......

   40 CLOSE

2. 10 OPEN N FDS: FØ 15 ON EOF GO TO 40

   20 INPUT N FDØ: 30 INPUT ₦.......

   40 CLOSE

The reserved file handling commands generally acceptable to the Einstein Computer include:-

DRIVE OPEN CREATE CLOSE

APPEND PRINT ₦ INPUT ₦ INCH ₦

INCH ₦ (N)

CHAPTER FIVE

CONCLUSION

In the words of Professor N.J. Field, "in the absence of sophisticated equipment for very high accuracy, utilize the existing equipment so far as the accuracy obtained is sufficient for your needs". It is very pertinent to apply always the economy of accuracy as a principle so as to save time, cost and labour.

This statement has reminded one the old teaching method of using "improvised equipment" whenever funds may not be available for expensive ones. Prof. Field suggests that in a developing country like Nigeria where facilities for repairs, rebuilt etc. are not excellent and where communication is not very adequate, it is of utmost importance to make use of available equipment possible the cheap ones which would give desirable results when used.

By this suggestion, the writer has been encouraged to work on a micro computer which not only uses BASIC - a common language but which is also available in his place of work - Kaduna Polytechnic. This readily afords one the opportunity to impart the knowledge to other students and to readily make use of th- skills acquired while executing the project. Such a unique privilege could have been difficult if the projects were carried out on a computer main frame which is not available in Kaduna Polytechnic and which in Ahmadu Bello University uses time sharing system.

Statistics has developed into various fields of studies that its use is of very great importance from day to day. The computer package such as this will surely alleviate some of the problems of statistical analysis. Also, the development of these statistical concepts in

/continued.

computer programs has greatly improved my knowledge of programming particularly the BASIC language. Thenumerous problems encountered in developing the programs have been very great challenges in appreciating the great developments brought about by the computering.

A project of this sort therefore not only helps in developing computer programs but is also a sure way of understanding basic concepts in statistics and mathematics. The three or four in one approach to a project development such as this affords one the opportunity of being versatile. One really appreciates this challenge realising what the role as a lecturer is in Kaduna Polytechnic (an institution which offers courses in multi-dimensional disciplines). And also what effective contributions one can make to uphold its aims of achieving desired goals in future.

APPENDIX I

```
10 DIM X(100),Y(100),A(100),R(20,20),FE(195),H(100),SU(2,2),S(120),RE(120),M(10),Z(10,10),O(10,10)
20 DIMJ(10,10),F(40,30),P(10),Q(10,10),B(20),JE(100),R$(10),C$(10),X$(100),Y$(100),QE(10),G(100),W(100)
30 VO=130:FO=1:WD=30:MD=5:HD=20:PO=.95:E=1.0E-6:N9=0
40 CLS:PRINT:PRINT"MENU!MENU!!MENU!!!
50 PRINT:PRINT"0. USER  INSTRUCTIONS
60 PRINT:PRINT"1. CREATING FILES
70 PRINT:PRINT"2. SORTING AND RANKING
80 PRINT:PRINT"3. DESCRIPTIVE STASTISTICS
90 PRINT:PRINT"4. GRAPHS AND TABLES
100 PRINT:PRINT"5. FUNCTIONS @ INVERSE FUNCTIONS(PROBABILITY)
110 PRINT:PRINT"6.SIGNIFICANCE TESTS
120 PRINT:PRINT"7. ANALYSIS
130 PRINT:PRINT"8.END
140 ON ERR GOTO 8560:REM Err String
150 PRINT:PRINT"PRESS ANY OF 0,1,2,3,4,5,6,7,8 YOU MAY REQUIRE"
160 Z=KBD:IFZ<48 ORZ>56 THEN 160
170 ON Z-47 GOTO 190, 260,930,1650,2170,4030,4710,5580
180 END
190 CLS:PRINT"FOLLOW INSTRUCTIONS CAREFULLY:ENTER YOUR DATA CORRECTLY:USE APPROPRIATE PROGRAMMES!";
200 PRINT"GRAPHIC DATA SUCH AS WINDOW WIDTH,MARGIN,HEIGHT ETC ARE FIXED!ALL DATA ARE STORED ON DISC"
210 PRINT"YOU CANNOT RUN BOTH FNS AND INV.FNS TOGETHER.SO ALSO ANOVA1 AND ANOVA2.KNOW YOUR NEEDS"
220 PRINT"NOTE!1.DESCRIPTIVE COMPUTES FREQUENCY,MAXMIN,QUANTILE, CORRELATION.2.GRAPHICS FOR GRAPHS"
230 PRINT",SCATTER DIAGRAM,TWO-TAB.3.PROBFUNC COMPUTES BINOMIAL,NORMAL,T,GAMMA,CHI,@ FNS ETC"
240 PRINT"4.SIGTEST COMPUTES T-TEST,T-STATS,CON.INTERVAL,CHIFIT,CHITAB AND WILCOXON TESTS"
250 PRINT"5.ANALYSIS PERFORMS ANOVA1,ANOVA2,LINEFIT @ MULTIPLE REGRESSION.YOU CAN ALSO SOLVE EQNS"
260 INPUT"ARE DATA ALREADY FILED Y/N?";F$:IF F$="Y" THEN 610
270 INPUT"WILL YOU NEED TO  COMPUTE PROBABILITY   Y/N?";T$:IF T$="N" GOTO 310
280 INPUT"ENTER NO OF TRIALS @ PROB";NT,P:INPUT"ENTER THE Z VALUE";Z:INPUT"ENTER  T VALUE";TO
290 INPUT"ENTER THE F VALUE AND DEGREES OF FREEDOM";F,K1,K2:INPUT"ENTER SIMPSONS VALUES";UO,NO,LO
300 INPUT"ENTER THE GAMMA ARGUMENT";W
310 INPUT"DO YOU REQUIRE ANY OR ALL OF THE Z-,T-,CHI-,F- STASTISTIC Y/N";T$:IF T$="N" GOTO 330
320 INPUT"PROBABILITY,D/FREEDOM";PO,K1,K2
330 INPUT"DO YOU NEED THE 2-WAY TABLE?";T$:IF T$="N" THEN 390
340 INPUT"INPUT NO OF UNITS,ROW NO,COLUMN NO";N,N1,N2
350 INPUT"INPUT R$(1)";R$(1):INPUT"INPUT R$(2)";R$(2):INPUT"INPUT C$(1)";C$(1):INPUT"INPUTC$(2)";C$(2)
360 PRINT"ENTER PAIR OF DATA X,Y":FOR I=1 TO N:INPUT X$(I),Y$(I):NEXT I:INPUT"INPUT FILE  NAME";F$
370 CREATE F$,FD$:PRINT#FD$:PRINT N:PRINT N1:PRINT N2:PRINT R$(1):PRINT R$(2):PRINT C$(1):PRINT C$(2)
380 FORI=1TO N:PRINT X$(I):PRINT Y$(I):NEXT I:CLOSE
390 INPUT"DO YOU NEED THE CHI-CONTIGENCY  TABLE?";T$:IF T$="N" GOTO 430
400 INPUT"ENTER NO OF ROW,COL.";N1,N2:PRINT "ENTER EACH DATA":FORI=1 TO N1:FOR  J=1 TO N2
410 INPUT"INPUT FILE NAME ";F$
420 CREATE F$,FD$:PRINT#FD$:PRINT  N1:PRINTN2:FOR I=1 TO N1:FOR J=1 TO N2:PRINT O(I,J):CLOSE
430 INPUT"DO YOU REQUIRE ANOVA1 Y/N";T$:IF T$="N" GOTO490
440 INPUT"NO OF TREATMENTS?";N1:FORI=1TON1:PRINT"INPUT REPLICATE";I;"OF TREATMENT N(";I;")"
450 FORI=1TO N1:FORJ=1 TO N(I):PRINT"INPUT DATA Z(";I;",";J;")";:INPUT Z(I,J):NEXT J:PRINT:NEXT I
460 INPUT"NAME OF DATAFILE?";F$
470 CREATE F$,FD$:PRINT#FD$:PRINT N1:FOR I=1 TO N1:PRINT N(I):NEXT I
480 FORI=1 TO N(1):FOR  J=1  TO N(I):PRINT Z(I,J):NEXT J:NEXT I :CLOSE
490 INPUT"WILL YOU REQUIRE ANOVA2 Y/N?";T$:IF T$="N" GOTO550
500 INPUT"ENTER NO OF BLOCKS,NO OF  TREATMENTS";N1,N2
510 PRINT"FOR ANOVA2 ENTER YOUR DATA":FOR I=1 TON1:FOR J=1TO N2:PRINT"INPUT Z(";I;",";J;")"
520 INPUT"NAME OF DATAFILE?";F$
530 CREATE F$,FD$:PRINT#FD$:PRINT N1:PRINT N2:FOR I=1TO N1:FOR J=1  TO N2:PRINT Z(I,J):NEXT J:NEXT I
540 CLOSE
550 INPUT"WILL YOU REQUIRE MULTIFIT Y/N?";T$:IFT$="N"GOTO 610
560 PRINT"MULTIFIT DATA":INPUT"INPUT UNIT NO";N:INPUT"INPUT NO OF EQNS";C:FOR I=1TO N:
570 INPUT"NAME OF DATAFILE?";F$
580 FOR I=1 TO N:FOR J=1TO C:INPUTZ(I,J):NEXT J:NEXT I
590 CREATE F$,FD$:PRINT#FD$:PRINT N:PRINTC:FORI=1TO N:PRINT Y(I):NEXT I
600 CLOSE
```

```
610 INPUT"ARE THE DATA TO BE ANALYSED Y/N?";T$:IF T$="N" GOTO 4020
620 INPUT"ARE YOUR DATA PAIRED OR UNPAIRED P/U?";T$:IF T$="P" GOTO 730
630 INPUT"INPUT NO OF DATA,END PTS,CLASSWIDTH N,L1,U1,D1";N,L1,U1,D1
640 INPUT"ARE YOUR DATA FILED Y/N?";T$:IF  T$="Y" GOTO 840
650 FOR I=1TO N:PRINT"ENTER THE X(";I;")VALUE";:INPUT X(I):NEXT I
660 FOR I=1TO N:PRINT X(I);:NEXT I
670 INPUT"ANY CORRECTION YES OR NO Y/N";F$:IF F$ ="N" GOTO 690
680 INPUT"ENTER THE WRONG ROW NO AND THE CORRECT VALUE ";I,K:X(I)=K:GOTO 660
690 INPUT"INPUT FILE NAME";F$
700 CREATE F$,FD$:PRINT#FD$:PRINT N
710 FOR I=1 TO  N:PRINT X(I):NEXT I:CLOSE
720 GOTO 840
730 INPUT"INPUT NO DATA,NO OF DATA IN EACH SET N,N1,N2";N,N1,N2
740 INPUT"ENTER END PTS FOR EACH SET L1,L2,U1,U2 AND C/WIDTH D1";L1,L2,U1,U2,D1.
750 INPUT"ARE THE DATA ON DISC Y/N?";T$:IF T$="Y" GOTO800
760 PRINT"ENTER YOUR DATA IN THE FORM X,Y":FOR I=1TO N :INPUT X(I),Y(I):NEXT I
770 INPUT"NAME OF DATAFILE?";F$
780 CREATE F$,FD$:PRINT#FD$:PRINT N
790 FOR I=1 TON:PRINT X(I):PRINT Y(I):NEXT I:CLOSE
800 INPUT"INPUT NAME OF DATAFILE?";F$
810 OPEN F$,FD$:ON  EOF GOTO 830
820 INPUT#FD$:INPUT N:FOR I=1TO  N:INPUT X(I):INPUT Y(I):NEXT I
830 CLOSE :GOTO 920
840 INPUT"FILE NAME?";F$
850 OPEN F$,FD$: ON EOF GOTO 870
860 INPUT#FD$:INPUT N:FOR I=1 TO N:INPUT X(I):NEXT I
870 CLOSE
880 PRINT#1;"THE DATA ARE":PRINT MUL$("-",12)
890 FOR I=1TO N:PRINT X(I),:NEXTI:PRINT#0
900 INPUT"ANY CORRECTION YES OR NO";T$:IF T$ ="N" GOTO 930
910 INPUT"ENTER THE WRONG ROW NO AND THE CORRECT VALUE";I,K:X(I)=K :GOTO 890
920 PRINT"THE PAIRED DATA ARE:":PRINT MUL$("-",20):FOR I=1 TO N:PRINIX(I),Y(I):NEXT I
930 INPUT"REQUIRE  SORTRANK? Y/N";T$:IFT$="N" THEN 1650
940 REM*EXCHANGE SORT AND RANK**
950 INPUT"DO YOU NEED RANKING Y/N?";T$:IF T$="N" THEN 1350
960 FORI=1TO N:A(I)=X(I) :NEXT I
970 FOR I=1TO N:W(I)=I
980 NEXT I
990 FOR I=1TO N-1
1000 J1=I
1010 FOR  J=I+1 TO N
1020 IFA(J)>=A(J1)THEN1040
1030 J1=J
1040 NEXT J
1050 IFJ1=I  THEN  1120
1060 W=A(I)
1070 A(I)=A(J1)
1080 A(J1)=W
1090 W1=W(I)
1100 W(I)=W(J1)
1110 W(J1)=W1
1120 NEXT  I
1130 FOR  I=1TO  N
1140 RE(W(I))=I
1150 NEXT I
1160 FOR  I=1 TO  N-1
1170 T1=1
1180 T2=RE(W(I))
1190 IF A(I+1) <> A(I) THEN 1250
1200 T1=T1+1
```

```
1210 T2=T2+RE(W(I+1))
1220 I=I+1
1230 IF  I=N THEN  1250
1240 GOTO 1190
1250 IF  T1=1  THEN 1290
1260 FOR J=(I+1-T1)TO I
1270 RE(W(J))=T2/T1
1280 NEXT J
1290 NEXT I
1300 PRINT#1;"THE SORTED AND RANKED VALUES ARE "
1310 FOR I=1 TON
1320 PRINT"VALUE";TAB(7) ;A(I);"RANK" TAB(17)RE(W(I));
1330 PRINT:NEXT I:PRINT#0
1340 REM**QUICKSORT**
1350 INPUT"DO YOU  REQUIRE QUICKSORT Y/N";T$:IF T$="N" THEN 1650
1360 D=10:K=1:L=1:R=N
1370 IF R-L+1>D THEN 1390
1380 GOSUB1580: GOTO 1550
1390 I=L:J=R:W=RND(1)*(R-L)+0.5:W=INT(W+L):F=X(W)
1400 IFX(I)>=F THEN  1420
1410 I=I+1:GOTO 1400
1420 IFX(J)<=F THEN 1440
1430 J=J-1:GOTO 1420
1440 IFI>J THEN 1460
1450 W=X(I):X(I)=X(J):X(J)=W:I=I+1:J=J-1
1460 IFI<=J THEN 1400
1470 IFJ-L>=R-I THEN 1510
1480 IFI>=R THEN1500
1490 H(K)=I:K=K+1:H(K)=R:K=K+1
1500 R=J:GOTO 1540
1510 IFL>=JTHEN 1530
1520 H(K)=L:K=K+1:H(K)=J:K=K+1
1530 L=I
1540 IFL<R THEN 1390
1550 IFK<=1 THEN 1570
1560 K=K-1:R=H(K):K=K-1:L=H(K):GOTO1370
1570 PRINT#1;"THE  SORTED DATA ARE":FOR I=1 TO N:PRINT X(I),:NEXT I:GOTO  40
1580 PRINT#0:FORI=L TOR-1:K1=I
1590 FORJ=I+1 TO R:IFX(J)>=X(K1)THEN 1610
1600 K1=J
1610 NEXT J
1620 IF K1=I THEN 1640
1630 W=X(I):X(I)=X(K1):X(K1)=W
1640 NEXT  I :RETURN
1650 INPUT  "REQUIRE DESCRIPT Y/N";T$:IF T$="N" THEN  2170
1660 INPUT"DO YOU  WANT TO KNOW THE MAX/MINVALUES Y/N";T$
1670 IFT$="N" THEN 1770
1680 J1=1:L=0
1690 L=0:V0=90 :FORI=1TO V0:FE(I)=0:NEXT I
1700 FOR I=1TO N
1710 L3=X(1):U =X(1):FORI=1 TO  N
1720 IF X(I)<L3 THEN L3=X(I)
1730 IF X(I)>U  THEN U =X(I)
1740 NEXTI
1750 PRINT#1;"THE MIN NO IS:";L3
1760 PRINT"THE MAX NO IS:";U:PRINT#0
1770 INPUT"ARE YOU INTERESTED IN MEAN AND VARIANCE";T$:IF T$="N" THEN 1810
1780 T=0:FOR I=1TO N:T=T+X(I):NEXT I
1790 M=T/N:T=0:FORI=1TO N:W=X(I)-M:T=T+W*W:NEXT I
1800 V=T/N-1:PRINT#1;"THE  MEAN OF  THE DATA IS:";M:PRINT"THE VARIANCE IS:";V:PRINT#0
```

```
1800 V=T/N-1:PRINT#1;"THE  MEAN OF  THE DATA IS:";M:PRINT"THE VARIANCE IS:";V:PRINT#0
1810 INPUT"ARE YOU INTERESTED IN SORTING Y/N";T$:IF T$="N" THEN 1940
1820 FOR I=1TO  N-1
1830 J1=I
1840 FORJ=I+1 TON
1850 IFX(J)>=X(J1)THEN 1870
1860 J1=J
1870 NEXT J
1880 IFJ1=I THEN  1920
1890 W=X(I)
1900 X(I)=X(J1)
1910 X(J1)=W
1920 NEXTI
1930 PRINT#1;"THE SORTED DATA ARE":FOR I=1 TO N:PRINT X(I),:NEXT I:PRINT#0
1940 INPUT"DO YOU NEED THE FREQUENCIES Y/N";T$:IFT$="N" THEN   2030
1950 FORI=1TO N:K=X(I):FE(K)=FE(K)+1
1960 IF FE(K)>=1 THEN Y(L)=K
1970 IF FE(K)>=2 THEN 1980ELSE L=L+1
1980 L=L:NEXT I
1990 C=L:PRINT#1;"THE  DATA AND  FREQ.ARE"
2000 FORL=0TO C-1
2010 W=Y(L):PRINT W,FE(W):NEXT  L
2020 PRINT"THE TOTAL NO CLASSES IS";C
2030 PRINT#0:INPUT"DO YOU NEED THE  QUANTILES Y/N";T$:IF T$="N" GOTO 2070
2040 S=X(1):H=X(N)
2050 Q=4:FORP=1TO 3:J1=INT(P*N/Q)+1:J2=N-INT((Q-P)*N/Q):QE(0)=(X(J1)+X(J2))/2:QE(P)=QE(0):NEXTP
2060 PRINT#1;"SAMPLE SIZE";TAB(22);N:PRINT"MEDIAN";TAB(22);QE(2):PRINT"QUARTILES";QE(1);TAB(29);QE(3)
2070 PRINT#0:INPUT"DO  YOU REQUIRE CORRELATION COEFFICIENT Y/N";T$
2080 IFT$="N" THEN2170
2090 T1=0:T2=0:FOR  I=1 TO N:T1=T1+X(I):T2=T2+Y(I):NEXT I:M1=T1/N:M2=T2/N
2100 T1=0:T2=0:T3=0:FOR I=1 TON:W1=X(I)-M1:W2=Y(I)-M2:T1=T1+W1*W1:T2=T2+W2*W2:T3=T3+W1*W2:NEXT I
2110 SU(1,1)=T1:SU(2,2)=T2:SU(1,2)=T3:SU(2,1)=T3:R=SU(1,2)/SQR(SU(1,1)*SU(2,2))
2120 PRINT#1;"THE FIRST SUM OF SQUARES IS:";T1
2130 PRINT"THE SECOND  SUM  OF SQUARES IS:";T2
2140 PRINT"THE PRODUCT  IS:";T3
2150 PRINT"THE  CORRELATION COEFFICIENT IS:";R:PRINT#0
2160 REM**STEMPLOT**
2170 INPUT"REQUIRE GRAPHICS Y/N";T$:IFT$="N" THEN 4030
2180 REM*INPUT:DATA A(.)IN ASCENDING ORDER**
2190 REM*DATA INTEGERS,NOT MORE THAN 3 DIG   ITS
2200 REM*LOWER ENDPOINT L1,CLASS WIDTH D1*
2210 REM*NO OF DATA N*
2220 INPUT"INPUT DO YOU REQUIRE STEMPLOT Y/N";T$:IF T$="N" THEN 2830
2230 PRINT#1;"THE STEMPLOT":PRINTML1$("-",12)
2240 FORI=1TO N:A(I)=X(I):NEXT I
2250 A$=" "
2260 I1=L1
2270 I2=L1+D1
2280 FOR I=1 TO N
2290 W=A(I)
2300 W1=10*INT(W/10)
2310 L$=STR$ (W-W1)
2320 IF W<I2 THEN 2390
2330 W2=INT(I1/10)
2340 PRINTW2;TAB(3); "*";A$
2350 I1=I2
2360 I2=I1+D1
2370 A$=" "
2380 IF W1>I1 THEN 2330
2390 A$=A$+L$
2400 NEXT I
```

```
2410 I1=INT(I1/10)
2420 PRINT I1;TAB(3); "*";A$:PRINT#0
2430 INPUT "DO YOU REQUIRE BOXPLOT Y/N";T$:IF T$="N" THEN 2830
2440 REM*INPUT:SIX-NUMBER SUMMARY,N,L*
2450 REM*Q(1),Q(2),Q(3),U
2460 REM* WINDOW WIDTH WD;ENDPOINTS L1,I1*
2470 REM*ROUNDING PARAMETER F0
2480 REM*VARIABLES:I,P,S1*
2490 F0=1
2500 DEF FNP(X)=INT(S1*(X-L1))+1
2510 DEF FNR(X)=INT(X*(10↑F0)+0.5)/(10↑F0)
2520 QE(0)=L3
2530 QE(4)=U
2540 S1=WD/(U1-L1)
2550 PRINT#1;"BOXPLOT DIAGRAM":PRINTMUL$("␣",15)
2560 PRINT"N=";N
2570 FOR I=0 TO 4
2580 P(I)=FNP(QE(I))
2590 QE(I)=FNR(QE(I))
2600 PRINT TAB(P(I)-1);QE(I);
2610 NEXT I
2620 PRINT
2630 PRINT
2640 PRINT TAB(P(1));
2650 FOR I=P(1) TO P(3)
2660 PRINT"␣";
2670 NEXT I
2680 PRINT
2690 PRINT TAB(P(1));"T";TAB(P(3));"T"
2700 PRINT TAB(P(0));"(";
2710 FOR I=P(0)+1 TO P(1)
2720 PRINT"␣";
2730 NEXT I
2740 PRINT TAB(P(2));"*";TAB(P(3));
2750 FOR I=P(3) TO P(4)-1
2760 PRINT"␣";
2770 NEXT I
2780 PRINT")"
2790 PRINT TAB(P(1));"T";TAB(P(3));"T"
2800 PRINT TAB(P(1))
2810 FOR I=P(1) TO P(3)
2820 PRINT"␣";:NEXT I:PRINT" ":PRINT#0
2830 PRINT:PRINT: INPUT"DO YOU REQUIRE HISTOGRAM Y/N";T$:IF T$="N" GOTO 2970
2840 DEF FNR(X)=INT(X*(10↑F0)+.5)/(10↑F0)
2850 PRINT#1;"HISTOGRAM":PRINTMUL$("␣",9)
2860 FOR I=1TO N:W=(X(I)-L1+D1)/D1:W=INT(W):FE(W)=FE(W)+1:NEXT I:L=INT((U1-L1)/D1)+1
2870 FOR I=1 TO L
2880 W=L1+(I-1)*D1
2890 W=FNR(W)
2900 PRINTW;"␣";TAB(MD);"T";
2910 IF FE(I) =0 THEN 2950
2920 FORJ=1 TO FE(I)
2930 PRINT "*";
2940 NEXT J
2950 PRINT
2960 NEXT I:PRINT#0
2970 INPUT"DO YOU REQUIRE FREQUENCY TABLE Y/N";T$:IF T$="N" GOTO 3220
2980 REM**FREQUENCY TABLE WITH OUTPUT**
2990 REM*INPUT:TITLE OF DATA T$;NOOF DATA N*
3000 REM*DATA X(.),END POINTS;LOWER L1,UPPER U1*
```

```
3010 REM *CLASS WIDTH  D1*
3020 REM *VARIABLES:C,I,I1,I2,W*
3030 PRINT#1;"THE  FREQUENCY TABLE:":PRINTMLL$("~",20)
3040 C=INT((U1-L1)/D1)+1
3050 FOR I= 1TO C
3060 FE(I)=0
3070 NEXTI
3080 REM CONSTRUCTS  TABLE
3090 FORI=1TO N
3100 W=(X(I)-L1+D1)/D1
3110 W=INT(W)
3120 FE(W)=FE(W)+1
3130 NEXT I
3140 REM PRINTS  TABLE
3150 PRINT"INTERVAL"TAB(18);"FREQUENCY"
3160 PRINT
3170 FOR  I=1TO C-1
3180 I1=L1+D1*(I-1)
3190 I2=I1+D1
3200 PRINT I1;"<=X<";I2,FE(I)
3210 NEXT I:PRINT#0
3220 INPUT"DO YOU REQUIRE  SCATTER DIAGRAM Y/N";T$:IF T$="N" GOTO 3700
3230 REM*INPUT:DATA X(.),Y(.) NO.OF  DATA N*
3240 REM*LOWER ENDPOINTS L1,L2,UPPER  ENDPOINTS U1,U2*
3250 REM*WINDOW WIDTH W0,HEIGHT H0,MARGIN M0*
3260 REM*VARIABLES:HI,I,J,S1,S2,W1,W2,W3*
3270 S1=(W0-1)/(U1-L1)
3280 S2=(H0-1)/(U2-L2)
3290 REM FORMS FREQUENCY TABLE
3300 FOR I=1  TO W0
3310 FOR J=1  TO H0
3320 F(I,J)=0
3330 NEXT J
3340 NEXT I
3350 FOR I=1 TO  N
3360 W1=(X(I)-L1)*S1+1
3370 W2=(Y(I)-L2)*S2+1
3380 W1=INT(W1+0.5)
3390 W2=INT(W2+0.5)
3400 F(W1,W2)=F(W1,W2)+1
3410 NEXT  I
3420 PRINT#1;"SCATTER DIAGRAM:":PRINTMLL$("~",14)
3430 PRINTU2;
3440 H1=H0+1
3450 FOR J=1 TO H0
3460 IF  J<H0  THEN 3480
3470 PRINTL2;
3480 PRINT TAB(M0);"I";
3490 FOR  I=1 TO W0
3500 W3=F(I,H1-J)
3510 IF W3<=0  THEN3560
3520 IF W3>1 THEN 3550
3530 PRINT TAB(M0+I);"*";
3540 GOTO 3560
3550 PRINT TAB(M0+I);W3;
3560 NEXT I
3570 PRINT
3580 NEXT  J
3590 PRINT  TAB(M0);"~";
3600 FOR  I=1 TO  W0
```

```
3610 PRINT"-";
3620 NEXT I
3630 PRINT#0
3640 REM**TWO TAB**
3650 REM**TWO-WAY TABLE WITH OUTPUT**
3660 REM*INPUT:TITLE OF  DATA  T$,NO OF UNITS N*
3670 REM*DATA  X$(.),Y$(.);DESCRIPTORS,ROW R$(.)*
3680 REM*COLUMN C$(.),NO OF  ROWS N1,NOOF COLUMNS  N2*
3690 REM TOTALS,ROW R(.),COLUMN C(.),MARGIN  MO*
3700 INPUT"DO YOU NEED TO MAKE A2-WAY  TABLE  Y/N";T$:IF T$="N" THEN 4030
3710 INPUT"INPUT FILE NAME";F$
3720 OPENF$,FD$:ON EOF GOTO3750
3730 INPUT#FD$:INPUT N:INPUT N1:INPUT N2: INPUT R$(1):INPUTR$(2):INPUTC$(1):INPUTC$(2)
3740 FOR  I=1TO N:INPUT X$(I):INPUT Y$(I):NEXT  I
3750 CLOSE
3760 FOR K=1 TO  N
3770 FOR I=1 TO  N1
3780 IF  X$(K)=R$(I) THEN 3810
3790 NEXT I
3800 GOTO3840
3810 FOR J=1 TO  N2
3820 IF Y$(K)=C$(J)  THEN 3870
3830 NEXT J
3840 PRINT"ERROR  IN DATA  ITEM";K
3850 GOTO 3900
3860 REM ACCUMULATE FREQUENCIES
3870 RE(I)=RE(I)+1
3880 C(J)=C(J)+1
3890 F(I,J)=F(I,J)+1
3900 NEXT K
3910 REM  PRINT  TABLE
3920 PRINT#1;"TWO-WAY TABLE:":PRINTMUL$("-",12)
3930 PRINT
3940 PRINT TAB(MO+1);C$(1);TAB(2*MO+2);C$(2);TAB(3*MO+6);"TOTAL"
3950 PRINT
3960 FOR  I=1 TO  2
3970 PRINT R$(I);TAB(MO+1);F(I,1);TAB(2*MO+1);F(I,2);TAB(3*MO+6);RE(I)
3980 PRINT
3990 NEXT I
4000 PRINT "TOTAL";TAB(MO+1);C(1);TAB(2*MO+1);C(2);TAB(3*MO+6);N
4010 PRINT#0
4020 REM**PROBABILITY FUNCTIONS**
4030 INPUT"REQUIRE PROBFUNC Y/N";T$:IF T$="N"THEN 4710
4040 INPUT"HAVE YOU COMPUTED THE PROBABILITY Y/N";T$:IF T$="Y" GOTO 4090
4050 INPUT"DO YOU  WANT TO USE BINOMIAL  DIST.FOR  YOUR PROBABILITY Y/N";T$:IF T$="N" GOTO 4090
4060 Q=1-P:W=Q^NT:P(0)=W:N1=NT+1
4070 FOR I=1TO NT:W=(N1-I)*P*W/(I*Q):P(I)=W:NEXT   I
4080 PRINT#1;"THE BINOMIAL PROBABILITIES  ARE:":FOR I=0TO NT:PRINT P(I):NEXTI:PRINT#0
4090 INPUT"DO  YOU REQUIRE THE NORMAL DISTRIBUTION Y/N";T$:IF T$="N"GOTO 4180
4100 INPUT "DO YOU WANT THE  PROBABILITY OR Z VALUE P/Z";T$:IFT$="Z"THEN  4140
4110 A1=0.196854:A2=0.115194:A3=0.000344:A4=0.019527:W=ABS(Z):PO=1+W*(A1+W*(A2+W*(A3+W*A4)))
4120 PO=PO^4:PO=1-0.5/PO:PO=0.5+(PO-0.5)*SGN(Z)
4130 PRINT#1;"THE Z-PROBABITY =:";PO:PRINT#0:GOTO 4180
4140 A1=2.30753:A2=0.27061:A3=0.99229:A4=0.04481
4150 QO=0.5-ABS(PO-0.5)
4160 W=SQR(-2*LN(QO)):W1=A1+A2*W:W2=1+W*(A3+W*A4)
4170 Z=W-W1/W2:Z=Z*SGN(PO-0.5):PRINT#1;"THE Z-VALUE FOR PROBABILITY :";PO;"=";Z:PRINT#0
4180 INPUT"DO YOU REQUIRE THE  T-VALUE Y/N";T$:IFT$="N" THEN4300
4190 INPUT"DO YOU WANT THE T-PROBAB.CRITVALUE P/T   ";Y$:IF Y$="T" THEN4260
4200 A1=0.36338023:W=ATN(TO/SQR(K1)):SO=SIN(W):CO=COS(W):W1=K1-2*INT(K1/2):IFW1=0 THEN 4220
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4210 T1=W:IFK1=1 THEN4240:T=S0*C0:T1=T1+T:IF K1=3 THEN4240:J1=0:J2=1:K2=(K1-3)/2:GOTO4230
4220 T1=S0:IF K1=2 THEN 4250:T=S0:J1=-1:J2=0:K2=(K1-2)/2
4230 FOR I=1 TO K2:J1=J1+2:J2=J2+2:T=T*C0*C0*J1/J2:T1=T1+T:NEXT I
4240 T1=T1*(1-A1*W1)
4250 P0=0.5*(1+T1):PRINT#1;"THE T-PROBABILITY =:";P0:PRINT#0:GOTO4300
4260 GOSUB4670
4270 W=Z*(1+2/(1+8*K1))
4280 T0=K1*(EXP(W*W/K1)-1):T0=SQR(T0)
4290 PRINT#1;"THE T-VALLE = ";T0:PRINT#0
4300 PRINT"NOIE:YOU NEED GAMMA FUNCTION FOR CHI SQUARE VALLE"
4310 INPUT"ARE YOU  EVALUATING THE GAMMA FUNTION Y/N?";T$:IF T$="N" GOTO 4400
4320 GOSUB4330:GOTO 4400
4330 G1=0
4340 W=W-1
4350 IFW<=0 GOTO  4370
4360 G1=G1+LN(W):GOTO 4340
4370 IF W=0 THEN 4390
4380 G1=G1+0.57236494
4390 PRINT#1;"THE GAMMA VALLE = ";G1:PRINT#0:RETURN
4400 INPUT"DO YOU WANT PROBABILITY  BY SIMPSON'S RULE Y/N";T$:IF T$="N" THEN 4460
4410 PRINT "YOU NEED TO DEFINE YOUR  FUNCTION.ASK FOR HELP IF NECESSARY"
4420 DEF FNP(X)=0.5*X*X-5*X+14
4430 D1=(U0-L0)/N0:P0=0:W0=FNP(L0)
4440 FOR I=1TO N0:W1=FNP(L0+0.5*D1):L0=L0+D1:W2=FNP(L0):P0=P0+D1*(W0+4*W1+W2)/6:W0=W2:NEXT I
4450 PRINT#1;"THE SIMPSON-PROBABILITY = ";P0/1000 :PRINT#0
4460 INPUT"ARE YOU INIERESTED IN CHI-SQUARE VALLE Y/N";T$:IF T$="N"THEN 4560
4470 INPUT"DO YOU WANT THE PROBABILITY OR THE CHI-SQUARE VALLE P/C?";Y$:IF Y$="C" THEN 4540
4480 W1=0.5*X2:K1=0.5*K1:W=K1+1:GOSUB 4330:G2=0:A2=EXP(K1*LN(W1)-G1-W1):IF A2=0 THEN4520
4490 T=1:G2=1:K=K1
4500 K=K+1:T=T*W1/K:G2=G2+T
4510 IF T/G2>1.0E-6 THEN 4500
4520 P0=G2*A2
4530 PRINT#1; "THE CHI-SQ PROBABILITY =";P0:PRINT#0: GOTO 4560
4540 GOSUB 4670:A1=2/(9*K1):W=1-A1+Z*SQR(A1):X2=K1*(W¼3)
4550 PRINT#1;"THE CHI-SQUARE VALLE IS";X2:PRINT#0
4560 INPUT"DO YOU  ALSO NEED THE F-VALLES Y/N";T$:IF T$="N"THEN 4710
4570 INPUT"INPUT DO YOU REQUIRE THE PROBABILITY OR F-VALLE P/F";Y$:IF Y$="F"THEN  4630
4580 A1=2/(9*K1):A2=2/(9*K2):W=F¼(1/3):W1=W+A1-W*A2-1:W2=A2*W*W+A1:Z=W1/SQR(W2)
4590 IFK2>3 THEN4600:Z=Z*(1+0.08*(Z¼4)/(K2¼3))
4600 A1=0.196854:A2=0.115194:A5=0.000344:A4=0.019527:W=ABS(Z)
4610 P0=1+W*(A1+W*(A2+W*(A3+W*A4))):P0=P0¼4:P0=1-0.5/P0:P0=.5+(P0-0.5)*SGN(Z)
4620 PRINT#1;"THE F-PROBABILITY IS";P0:PRINT#0:GOTO 4710
4630 GOSUB4670:A2=2/(9*K2):A1=2/(9*K1)
4640 W=Z*Z:W1=1+A2*(A2-W-2):W2=A1+A2-A1*A2-1:W3=1+A1*(A1-W-2):W4=SQR(W2*W2-W1*W3)
4650 F=(W4-W2)/W1:F=F¼3
4660 PRINT#1;"THE F-VALLE  FOR ";K1",";K2;"DEGREES OF FREEDOM = ";F:PRINT#0:GOTO  4710
4670 A1=2.30753:A2=0.27061:A3=0.99229:A4=0.04481
4680 Q0=0.5-ABS(P0-0.5)
4690 W=SQR(-2*LN(Q0)):W1=A1+A2*W:W2=1+W*(A3+W*A4)
4700 Z=W-W1/W2:Z=Z*SGN(P0-0.5):RETURN
4710 INPUT"REQUIRE SIGTEST Y/N";T$:IF T$="N" THEN5580
4720 INPUT"DO YOU WANT THE T-TEST Y/N";T$:IFT$="N" THEN  4810
4730 N=36:M=2.6:V=.090:M0=518:M1=5:M2=3:N1=10:N2=15:V1=4:V2=7:P0=.95
4740 S=SQR(V/N):T0=(M-M0)/S:PRINTX$:PRINT
4750 PRINT#1;"T-STATISTIC(MEAN OF POPULATION)":PRINT
4760 PRINT"MEAN ON NULL HYPOTHESIS = ";M0:PRINT
4770 PRINT"SAMPLE MEAN =";M:PRINT
4780 PRINT"STANDARD ERROR OF  MEAN =";S:PRINT
4790 PRINT"T-STATISTIC =";T0:PRINT
4800 PRINT"DEGREE OF FREEDOM =";N-1:PRINT:PRINT#0
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4810 INPUT"ARE YOU INTERESTED IN T-STASTISTIC OFUNPAIRED SAMPLES Y/N";T$
4820 IF T$="N" GOTO 4860
4830 K1=N1+N2-2:W=(N1-1)*V1+(N2-1)*V2
4840 V=W/K1:W=SQR(V/N1+V/N2):T0=(M1-M2)/W
4850 PRINT#1;"THE T-VALUE FOR ";K1;"DEGREE OF FREEDOM = ";T0:PRINT#0
4860 INPUT"DO  YOU NEED THE  CONFIDENCE INTERVAL Y/N";T$:IF T$="N"  THEN 4920
4870 A1=2.30753:A2=0.27061:A3=0.99229:A4=0.04481:Q0=0.5-ABS(P0-0.5):W=SQR(-2*LN(Q0))
4880 Z=Z*SGN(P0-0.5):W=Z*(1+2/(1+8*K1)):T0=K1*(EXP(W*W/K1)-1):T0=SQR(T0)
4890 S=SQR(V/N):I1=M-T0*S:I2=M+T0*S:W=100*P0
4900 PRINT#1;ABS(W);"% CONFIDENCE INTERVAL FOR MEAN = "
4910 PRINT"("I1;",";I2;")":PRINT#0
4920 INPUT"DO YOU NEED THE CHI-SQ-FIT Y/N";T$:IF T$="N" THEN 5090
4930 T1=0:T2=0:C=N
4940 FOR  I=1TO C:T1=T1+X(I):T2=T2+Y(I):NEXTI
4950 IF ABS(T1-T2)>0.5 THEN 5000
4960 PRINT#1;"SUM OF OBSERVED FREQUENCIES = ";T1
4970 PRINT "SUM OF EXPECTED FREQUENCIES = ";T2
4980 GOTO 5000
4990 PRINT"CHI-SQUARE IMPOSSIBLE":GOTO5090
5000 X2=0:FOR I=1TO C:W1=Y(I):W2=X(I)-W1
5010 IFW1>=5 THEN 5030
5020 PRINT"SMALL EXPECTED FREQUENCIES E";I;")=";Y(I)
5030 W=W2*W2/W1:JE(I)=W:X2=X2+W:NEXT  I
5040 K1=C-1-N9:PRINT"DEGREE OF FREEDOM IS";K1
5050 PRINT"OBSERVED ";TAB(11);"EXPECTED";TAB(22);"X2-COMPONENT"
5060 FOR I=1 TO C
5070 PRINT TAB(4);X(I);TAB(14);Y(I);TAB(26);JE(I):NEXTI
5080 PRINT"THE CHI-SQUARE VALUE IS";X2:PRINT#0
5090 INPUT"INPUT DO YOU NEED CHI-SQ-TABLE Y/N";T$:IF T$="N" GOTO 5320
5100 INPUT"INPUT FILE NAME";F$
5110 OPEN F$,FD$:ON EOF GOTO5130
5120 INPUT#FD$:INPUTN1:INPUTN2:FORI=1TO N1:FORJ=1TON2:INPUT O(I,J):NEXT J:NEXTI
5130 CLOSE
5140 FORJ=1 TO  N2:C(J)=0:NEXT J
5150 T=0:FORI=1 TO N1:T1=0
5160 FORJ=1TON2:W=O(I,J):T1=T1+W:T=T+W:C(J)=C(J)+W:NEXT  J
5170 RE(I)=T1:NEXT I
5180 FORI=1TO N1:W=RE(I)/T
5190 FORJ=1TON2:W1=W*C(J):E(I,J)=W1:IF W1>5 THEN 5220
5200 PRINT#1;"THE CHI-SQ-TABLE ":PRINTMUL$("-",16)
5210 PRINT#1;"SMALL EXPECTED  FREQUENCIES E(";I;",";J;")=";E(I,J)
5220 NEXT  J:NEXT I
5230 X2=0:FOR I=1 TON1:FOR  J=1 TON2
5240 W1=E(I,J):W2=O(I,J)-W1:W=W2*W2/W1
5250 J(I,J)=W:X2=X2+W:NEXT J:NEXT  I
5260 K1=(N1-1)*(N2-1)
5270 PRINT"DEGREE  OF FREDOM IS ";K1
5280 PRINT"OBSERVED";TAB(12);"EXPECTED";TAB(26);"X2-COMPONENT"
5290 FOR I=1TO N1:FOR J=1 TO N2
5300 PRINT O(I,J);TAB(15);E(I,J);TAB(28);J(I,J):NEXT  J:NEXT I
5310 PRINT"THE CHI-SQUARE VALUE IS ";X2:PRINT#0
5320 INPUT"DO YOU REQUIRE WILCOXON TEST Y/N";T$:IF T$="N" THEN 5580
5330 FOR I=1TO N:G(I)=X(I):H(I)=Y(I):NEXT I
5340 N0=0:FOR I=1 TO N:W=G(I)-H(I)
5350 IFW<>0 THEN 5390
5360 N0=N0+1
5370 X(I)=1E38
5380 GOTO 5400
5390 X(I)=ABS(W)
5400 W(I)=W
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5410 NEXT I
5420 FORI=1TON:T1=0:T2=0:W=X(I):FOR  J=1 TO N
5430 IFX(J)>WTHEN 5480
5440 IFX(J)<W THEN5470
5450 T2=T2+1
5460 GOTO 5480
5470 T1=T1+1
5480 NEXT J
5490 RE(I)=T1+(T2+1)/2:NEXT  I
5500 T=0:N1=0:FOR I=1TO N:IF  W(I)>=0 THEN 5530
5510 N1=N1+1
5520 T=T+RE(I)
5530 NEXT  I
5540 N2=N-N0:N3=N2*(N2+1)/4:W3=N3*(N2+N2+1)/6:Z=(T-N3)/SQR(W3)
5550 PRINT#1;"LARGE SAMPLE STATISTIC = ";Z
5560 PRINT"THE WILCOXON STATISTIC = ";T:PRINT#0
5570 REM**ANOVA1**
5580 INPUT"REQUIRE ANALYSIS Y OR N?";T$:IF T$="N"  THEN   40
5590 REM*INPUT:DATA Z(.;.),(TREATMENTS*REPLICATES)*
5600 REM*N1 TREATMENTS,N(I)REPLICATES OF  TREATMENTS I*
5610 INPUT"INPUT DO YOU NEED THE ONE WAY ANALYSIS Y/N";T$:IF T$="N" GOTO 6330
5620 REM*VARIABLES:F,I,J,K1,K2,M,N,S1,S2,T,T1,T2,W *
5630 INPUT"NAME OF FILE?";F$
5640 OPENF$,FD$:ON EOF GOTO5660
5650 INPUT#FD$:INPUT N1:FOR I=1TO N1:INPUT N(I):NEXT I:
5660 CLOSE
5670 F0=4
5680 REM CALCULATES MEANS
5690 N=0
5700 T=0
5710 FOR  I=1  TO N1
5720 T1=0
5730 FOR J=1TON(I)
5740 T1=T1+Z(I,J)
5750 NEXT  J
5760 M(I)=T1/N(I)
5770 T=T+T1
5780 N=N+N(I)
5790 NEXT  I
5800 M=T/N
5810 REMCALCULATES SUMS OF SQUARES
5820 S1=0:S2=0
5830 FOR  I=1  TO N1
5840 T2=0
5850 FOR J=1 TO N(I)
5860 W=Z(I,J)-M(I)
5870 T2=T2+W*W
5880 R(I,J)=W
5890 NEXT J
5900 S2=S2+T2
5910 W=M(I)-M
5920 S1=S1+N(I)*W*W
5930 NEXT I
5940 DEF FNR(X)=INT(X*(10^F0)+0.5)/(10^F0)
5950 K1=N1-1
5960 K2=N-N1
5970 PRINT#1;"ANOVA ONE-WAY":PRINTMUL$("-",14)
5980 PRINT
5990 PRINT"SOURCE";TAB(11);"SS";TAB(21);"DF";TAB(27);"MS"
6000 PRINT
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6010 PRINT"TREATMENTS";TAB(11);FNR(S1);TAB(21);K1
6020 PRINT TAB(27);FNR(S1/K1)
6030 PRINT"RESIDUAL";TAB(11);FNR(S2);TAB(21);K2
6040 PRINT TAB(27);FNR(S2/K2)
6050 PRINT"TOTAL";TAB(11);FNR(S1+S2);TAB(21);N-1
6060 PRINT
6070 F=(S1/K1)/(S2/K2)
6080 PRINT"F(";K1;",";K2;")=";F
6090 REM  TABLE OF MEANS
6100 PRINT
6110 PRINT"TREATMENT MEAN STD ERROR"
6120 PRINT
6130 FOR  I=1 TO N1
6140 W=SQR(S2/(N(I)*K2))
6150 PRINTTAB(6);TAB(12);FNR(M(I));TAB(20);FNR(W)
6160 NEXT I
6170 PRINT "OVERALL MEANS";FNR(M)
6180 REM PRINT  TABLES OF RESIDUALS
6190 FORI=1 TO  N1:PRINT#0
6200 PRINT:PRINT:PRINT"PRESS SPACE-BAR TO CONTINUE"
6210 Z=KBD:IF Z<>32  THEN  6210
6220 PRINT:PRINT:PRINT#1;"TREATMENT ";I
6230 PRINT
6240 PRINT"REPLICATE OBSERVATION RESIDUAL"
6250 FOR  J=1 TO N(I)
6260 PRINT TAB(6);J;TAB(12);Z(I,J);TAB(26);R(I,J):NEXT J:NEXT I:PRINT#0
6270 REM**ANOVA2**
6280 REM**ANALYSIS OF VARIANCE(TWO-WAY)**
6290 REM*INPUT:DATAZ(.,.),(TREATMENTS*BLOCKS)*
6300 REM*N1 TREATMENTS,N2BLOCKS*
6310 REM*ROUNDING PARAMETER FO*
6320 REM*VARIABLES:F1,F2,I,J,K1,K2,K3,M,N,S1,S2,S3,T,T1,W*
6330 INPUT"DO YOU REQUIRE THE 2-WAY  ANALYSIS Y/N";T$:IF T$="N" THEN 7220
6340 INPUT"NAME OF  FILE";F$
6350 OPEN F$,FD$:ONEOF GOTO6370
6360 INPUT#FD$:INPUT N1:INPUT N2:FOR  I=1TO N1:FOR J=1 TO N2:INPUTZ(I,J):NEXT J:NEXT I
6370 CLOSE
6380 FO=4
6390 FOR J=1TO  N2
6400 T(J)=0
6410 NEXT J
6420 T=0
6430 FORI=1TON1
6440 T1=0
6450 FORJ=1 TO  N2
6460 W=Z(I,J)
6470 T=T+W
6480 T1=T1+W
6490 T(J)=T(J)+W
6500 NEXT J
6510 M(I)=T1/N2
6520 NEXT  I
6530 FORJ=N1+1TON1+N2
6540 M(J)=T(J-N1)/N1
6550 NEXT J
6560 N=N1*N2
6570 M=T/N
6580 REM CALCULATES SUMS OF SQUARES
6590 T=0
6600 FORI=1  TON1
```

```
6610 W=M(I)-M
6620 T=T+W*W
6630 NEXT I
6640 S1=N2*T
6650 T=0
6660 FOR J=1 TON2
6670 W=M(N1+J)-M
6680 T=T+W*W
6690 NEXT J
6700 S2=N1*T
6710 T=0
6720 FOR  I=1  TO  N1
6730 FOR J=1TO  N2
6740 W=Z(I,J)-M(I)-M(N1+J)+M
6750 R(I,J)=W
6760 T=T+W*W
6770 NEXT J
6780 NEXT  I
6790 S3=T
6800 DEF FNR(X)=INT(X*(10^F0)+0.5)/(10^F0)
6810 K1=N1-1
6820 K2=N2-1
6830 K3=N-N1-N2+1
6840 PRINT#1;"ANOVA TWO-WAY:":PRINT MUL$("-",14)
6850 PRINT
6860 PRINT"SOURCE   SS   DF   MS"
6870 PRINT
6880 PRINT"TREATMENTS";TAB(11);FNR(S1);TAB(21);K1;
6890 PRINT TAB(27);FNR(S1 /K1)
6900 PRINT"BLOCKS";TAB(11);FNR(S2);TAB(21);K2;
6910 PRINT TAB(27);FNR(S2/K2)
6920 PRINT "RESIDUAL";TAB(11);FNR(S3);TAB(21);K3;
6930 PRINT TAB(27);FNR(S3/K3)
6940 PRINT "TOTAL";TAB(11);FNR(S1+S2+S3);TAB(21);N-1
6950 F1=(S1/K1)/(S3/K3)
6960 F2=(S2/K2)/(S3/K3)
6970 PRINT
6980 PRINT"TREATMENTS F(";K1;",";K3;")=";F1
6990 PRINT"BLOCKS F(";K2;",";K3;")=";F2
7000 PRINT
7010 REM TABLE OF MEANS
7020 PRINT
7030 PRINT"TREATMENT MEAN"
7040 PRINT
7050 FOR I=1TO N1+N2
7060 PRINT  TAB(6);TAB(13);FNR(M(I))
7070 NEXT I
7080 PRINT
7090 PRINT"OVERALL  MEAN";FNR(M)
7100 PRINT"S.E OF TREATMENT MEAN";SQR(S3/(K3*N2))
7110 REM PRINTS TABLE  OFRESIDUALS
7120 FORI=1TON1:PRINT#0
7130 PRINT:PRINT:PRINT"PRESS SPACE-BAR TO CONTINUE"
7140 Z=KBD:IF Z<>32 THEN 7140
7150 PRINT#1;"TREATMENT ";I
7160 PRINT
7170 PRINT"REPLICATE OBSERVATION RESIDUAL"
7180 FOR J=1 TON2
7190 PRINT TAB(6);J;TAB(13);Z(I,J);TAB(26);R(I,J)
7200 NEXT J :NEXTI:PRINT#0
```

```
7210 REM**LINEFIT**
7220 INPUT"DO YOU REQUIRE LINEFIT Y/N";T$:IF T$="N" GOTO 7700
7230 REM*INPT VARIABLEX(),DEPT VARIABLEY()*
7240 REM*MEANS  M1,M2,SSCSP MATRIX S(.;.)
7250 REM  ROUNDING PARAMETER F0*
7260 REM *VARIABLES :A,B,I,T,W,W1,W2,W3,W4*
7270 REM CALCULATES SLOPE AND INTERCEPT
7280 B=SU(1,2)/SU(1,1)
7290 A=M2-B*M1:F0=3
7300 REM CALCULATES RESIDUALS AND   RSS
7310 T=0
7320 FOR I=1  TO N
7330 W=A+B*X(I)
7340 FE(I)=W
7350 W=Y(I)-W
7360 RE(I)=W
7370 T=T+W*W
7380 NEXT  I
7390 DEF FNR(X)=INT(X*(10^F0)+0.5)/(10^F0)
7400 PRINT
7410 PRINT#1;"LINE-FIT:":PRINT MUL$("-",8)
7420 PRINT"FITTED LINE IS  Y=A+B*X"
7430 PRINT
7440 W1=T/(N-2)
7450 W2=SQR(W1/SU(1,1))
7460 W3=1/N+M1*M1/SU(1,1)
7470 W4=SQR(W1*W3)
7480 PRINT"COEFFICIENT ESTIMATE ST.ERROR"
7490 PRINT"    A";TAB(15);FNR(A);TAB(26);FNR(W4)
7500 PRINT"    B";TAB(15);FNR(B);TAB(26);FNR(W2)
7510 PRINT
7520 PRINT"SOURCE    SS   DF   MS"
7530 PRINT
7540 W=FNR(SU(2,2)-T)
7550 PRINT"REGRESSION";TAB(13);W;TAB(23);"1"TAB(28);W
7560 PRINT"RESIDUAL",TAB(10);FNR(T);TAB(20);N-2;TAB(25);FNR(W1)
7570 PRINT"TOTAL";TAB(13);FNR(SU(2,2));TAB(23);N-1
7580 PRINT
7590 PRINT"OBSERVED FITTED  RESIDUAL".
7600 FOR I=1 TO N
7610 PRINT FNR(Y(I));TAB(13);FNR(FE(I));TAB(23);FNR(RE(I)):NEXT I:PRINT#0
7620 REM**MULTIFIT**
7630 REM**MULTIPLE REGRESSION**
7640 REM*INPUT:NO OF UNITS N,DEPT VARIABLEY(.)*
7650 REM*N*C INDEPT VARIABLES Z(.;.)*
7660 REM*DIM Z(.;.)>=(N+C+1*
7670 REM*REQIRESLINESOLV AT GOSUB*
7680 REM REQUIRES MULTIVAR AT  GOSUB
7690 REM*VARIABLES:A,C1,I,I1,J,S2,S3,T,W,W1*
7700 INPUT"DO YOU NEED THE  MULTIVARIATE ANALYSIS Y/N";Y$:IF Y$="N" THEN 40
7710 INPUT"NAME OF FILE?";F$
7720 OPEN F$,FD$:ON EOF GOTO7740
7730 INPUT#FD$:INPUTN:INPUTC:FORI=1TON:INPUTY(I):NEXT I:FORI=1TON:FORJ=1TOC:INPUTZ(I,J):NEXTJ:NEXTI
7740 CLOSE
7750 C1=C+1:E=1.0E-6:L=(C*C+C*3)/2
7760 FOR I=1 TO N
7770 Z(I,C1)=Y(I)
7780 NEXT I
7790 FOR  J=1 TO C1:T=0
7800 FORI=1 TO  N:T=T+Z(I,J):NEXT  I
```

```
7810 M(J)=T/N:NEXT J
7820 FORI=1 TO  C1:T1=M(I)
7830 FORJ=1TOI:T=0:T2=M(J)
7840 FORK=1 TON:T=T+(Z(K,I)-T1)*(Z(K,J)-T2):NEXT K
7850 Q(I,J)=T:NEXT J:NEXT  I
7860 S3=Q(C1,C1)
7870 REM SOLVES  NORMAL EQUATIONS
7880 FOR I=  1TO  C1
7890 I1=I*(I-1)/2
7900 FOR  J=1 TO I
7910 S(I1+J)=Q(I,J)
7920 NEXT J :NEXT I
7930 N1=0:J1=1:J2=0
7940 FOR J=1 TO C:I1=0
7950 FOR  I=1TOJ:J2=J2+1:W=S(J2):I2=J1
7960 FOR I3=1TO I:I1=I1+1:IFI3=I THEN7980
7970 W=W-S(I1)*S(I2):I2=I2+1:NEXTI3
7980 IFI=JTHEN8030
7990 IFS(I1)=0THEN2880
8000 S(J2)=W/S(I1):GOTO 8020
8010 S(J2)=0
8020 NEXT  I
8030 IFABS(W)<ABS(E)THEN 8060
8040 IF W<E THEN8340
8050 S(J2)=SQR(W):GOTO8080
8060 S(J2)=0:N1=N1+1
8070 PRINT"ZERO DIAGONAL ELEMENT S(";J2;")"
8080 J1=J1+J:NEXT J
8090 REM  INVERTS S  ONTO ITSELF
8100 N2=C*C1/2:I=C:N3=N2
8110 IFS(N3)=0THEN8240
8120 I1=N3
8130 FOR I3=I TO C:W(I3)=S(I1):I1=I1+I3:NEXT I3
8140 J=C:J3=N2:I2=N2
8150 I1=J3:W=0:IFI<>J THEN 8170
8160 W=1.0/W(I)
8170 J2=C
8180 IF J2=I THEN  8220
8190 W=W-W(J2)*S(I1):J2=J2-1:I1=I1-1
8200 IF  I1<=I2THEN8180
8210 I1=I1-J2+1:GOTO8180
8220 S(I1)=W/W(I):IFI=J  THEN 8260
8230 I2=I2-J:J=J-1:J3=J3-1:GOTO8150
8240 I1=N3
8250 FOR J1=I TOC:S(I1)=0:I1=I1+J1:NEXT J1
8260 N3=N3-I:I=I-1:IF I<>0 THEN8110
8270 REM FORMS INV(S)*B
8280 FOR I=1  TO C:W(I)=S(N2+I):NEXT I
8290 I1=0:FOR I=1 TOC :I1=I1+I-1:S=0
8300 FOR J=1 TOI:I2=I1+J:S=S+S(I2)*W(J):NEXT J
8310 IF I=C THEN8330
8320 FORJ=I+1TOC:I2=I2+J-1:S=S+S(I2)*W(J):NEXT J
8330 B(I)=S:NEXT I
8340 PRINT"THE  NEGATIVE DIAGONAL ELEMENTS,ARE"
8350 FOR I=1 TO C
8360 PRINT J2(I)
8370 NEXT I
8380 PRINT"THE INVERSE MATRIX IS "
8390 FOR I=1  TO  L
8400 PRINT S(I)
```

```
8410 NEXT  I
8420 PRINT#1;"MULTIPLE REGRESSION:":PRINTMUL$("-",20)
8430 PRINT"THE SOLUTION MATRIX IS"
8440 FOR I=1 TO C
8450 PRINT B(I);
8460 PRINT
8470 NEXTI
8480 W=0:FOR I=1 TO C:W=W+B(I)*M(I):NEXT  I:A=M(C1)-W:S2=0
8490 FORI=1TON:T=A:FORJ=1TOC:T=T+B(J)*Z(I,J):NEXTJ:FE(I)=T:W=Y(I)-T:RE(I)=W:S2=S2+W*W:NEXTI:W1=S2
8500 PRINT"THE  INTERCEPT IS";A
8510 PRINT "THE REGRESSION COEFFICIENT ARE"
8520 FOR I=1TO C:PRINT  B(I):NEXT I
8530 PRINT"SUM OF SQUARES RESIDUAL IS";S2:PRINT"SUM OF SQUARES TOTAL IS";S3
8540 PRINT"FITTED VALUES";TAB(18);"RESIDUALS"
8550 FOR I=1TON:PRINT;TAB(8);FE(I);TAB(20);RE(I):NEXT  I :PRINT#0:END
8560 IF ERR$<>"NO FILE"THEN PRINT:PRINT"  ";ERR$;"IN LINE";ERL:END
```

APPENDIX II

USER INSTRUCTIONS

STEP	DISPLAY	INSTRUCTION	PRESS	GOTO STEP
1	READY	TYPE LOAD "DATAFILE"	ENTER	2
2	READY	TYPE RUN	ENTER	3
3	0,1,2,3,4,5,6,7,8	TYPE DESIRED NO SAY Ø	ENTER	
PRESS'GØ 4	LIST OF INSTRUCTIONS	PRESS CONT	ENTER	GO TO 5
" 1:1	DATAFILED	TYPE Y/N	ENTER	2
2	REQUIRE PROBABILITY	Y/N	ENTER	3
3	ENTER DATA INFORMAT'N	INPUT DATA	ENTER	4
4	REQUIRE T, CHI, OR F,	IF STEP 2 IS Y THEN	ENTER	5
5	ENTER DATA INFORM.	TYPE NO INPUT DATA	ENTER	6
6	REQUIRE 2 WAY TABLE	TYPE Y/N	ENTER	7
7	ENTER DATA	INPUT DATA	ENTER	8
8	FILE NAME	INPUT FILE NAME	ENTER	9
9.	REQUIRE CHITAB	TYPE Y/N	ENTER	10
10	ENTER DATA	INPUT DATA		11
11	FILE NAME	INPUT FILE NAME	ENTER	12
12	REQUIRE ANOUA I	TYPE Y/N	ENTER	13
13	EBTER DATA	INPUT DATA	ENTER	14
14	FILE NAME	INPUT FILE NAME	ENTER	15
15	REQUIRE ANOUA 2	TYPE Y/N	NOTE 12	16
16	ENTER DATA	INPUT DATA	ENTER	17
17	FILE NAME	INPUT FILE NAME	ENTER	18
18	REQUIRE MULTIFIT	TYPE Y OR N	ENTER	19
19	ENTER DATA	INPUT DATA	ENTER	20
20	FILE NAME	INPUT FILE NAME	ENTER	21
21	ARE DATA PAIRED	TYPE P/U	ENTER	22
22	ARE DATA FILED	INPE Y/N	ENTER	23
23	FILE NAME	INPUT FILE NAME	ENTER	24
24	DATA PRINTED (Any Correction)	TYPE Y/N	ENTER	24

/continued.

25	ENTER WRONG ROW (correct value)	INPUT R,C	ENTER	26
26	(FOR DATA ON FILE)	INPUT FILE NAME	ENTER	27
G2 1	REQUIRE SORT RAWY	TYPE Y/N	ENTER	2
2	REQUIRE SORTING	TYPE Y/N	ENTER	3
3	REQUIRE RANKING	TYPE Y/N	ENTER	4
3:1	REQUIRE DESCRIPTIVE	TYPE Y/N	ENTER	2
2	REQUIRE MAXMIN	"	ENTER	3
3	" MEAN, VARIANCE	"	ENTER	4
4	" SORTING	"	ENTER	5
5	" QUANTILES	"	ENTER	6
6	" CORRELATION	"	ENTER	-
1	" RAPHICS	"	ENTER	2
2	" BOXPLOT	"	ENTER	3
3	" STEMPLOT	"	ENTER	4
4	" HISTOGRAM	"	ENTER	5
5	" FRETAB	"	ENTER	6
6	" SCATTER	"	ENTER	7
7	" TWOTAB	"	ENTER	-
5: 1	" PROBFUNC	"	ENTER	2
2	" BINOMAL	"	ENTER	3
3	" NORMAL	"	ENTER	4
4	" PROBABILITY or VALUE	"	ENTER	5
5	" T DISTRIBUTION	"	ENTER	6
6	" VALUE OR PROB	"	ENTER	7
7	" SIMPSONS	"	ENTER	8
8	" GAMMA	"	ENTER	9
9	" CHI SOUARE	"	ENTER	10
10	" CHI SOUARE DR PROBABILITY	"	ENTER	11

/continued.

11	REQUIRE	F - DISTRIBUTION	TYPE Y/N	ENTER	12
6.1	REQUIRE	SIGNIFICANCE	"	ENTER	2
2	"	T-Test	"	ENTER	3
3	"	T-STAI	"	"	4
4	"	CONFINI	"	"	5
5	"	CHIFIT	"	"	6
6	"	CHITAB	"	"	7
7	"	WILCOXON	"	"	-
7.1	REQUME	ANALYSIS	"	"	2
2	REQUIRE	AWOUAI	"	"	3
3	"	AWOUAI	"	"	4
4	"	LINEFIT	"	"	5
5	"	MULTIFIT	"	"	6

8. READY IS DISPLAYED TO SHOW END OR TERMINATION OF PROGRAMMING.

1. Alcock Donald (1977), Illustrating Basic. Cambridge University Press, 133pp.

2. Ayeni O.O. (1982), Statistical Analysis and Adjustment.

3. Clarke G.M. (1980), Statistical and Experimental Design 2nd Edition, Edward Arnold Ltd., 188pp.

4. Clarke G.M. and Cooke D. (1983), - A Basic Course in Statistics 2nd Edition, Edward Arnold Ltd., 421pp.

5. Cooke D. Craven A.H. and Clarke G.M. (1982) - Basic Statistical Computing, Edward Arnold Ltd., 155pp.

6. Gibbons J.D. (1971) - Non Parametric Statistical Inference, 306pp.

7. Morrison (1986) - Multivariate Statistical Methods Mc Graw Hill - 415pp.

8. Olayi A. Gabriel (1983) - Introduction to Computer Knowledge and Fortran Programming - 180pp.

9. Walpole R.E. (1974) - Introduction to Statistics Macmillan Publishers 340pp.