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SHARE PROGRAM LIBRARY SUBMITTAL FORM

SHARE PROGRAM LIBRARY AGENCY
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Research Triangle Park, North Carolina USA 27709

SPLA CONTROL NUMBER:

This form should be completed and submitted with the program package to the SHARE Program Library Agency at the address shown above. Standards and instructions for submitting programs are in the SHARE Reference Manual, Section 6.

(1) Program Number (to be filled by SPLA) 360D-13.6.008

(2) Title of Program . . . . . LINEAR LEAST-SQUARES CURVE-FITTING PROGRAM (LINWOOD)

(3) System Type(s) (Machine) S/360

(4) Search Key(s) . . . . . LINEAR LEAST-SQUARES CURVE-FITTING
MULTIPLE-REGRESSION ANALYSIS

(5) Programming Systems/Languages . . . . FORTRAN 66 & FORTRAN 77 (VS Release 3.0, OPT 3)

(6) Primary Subject Code 13.6

(7) Minimum System Requirements OS360

(8) New (N) or Revision (R) (if revision, show prior Program Number in Item 1) R

(9) Date of Submittal 6/1/84

(10) Documentation (number of original pages submitted) 12

(11) Author's Name and Address . . . . . FRED S. WOOD, CONSULTING STATISTICIAN
FRED WOOD & ASSOCIATES
1414 DEL VISTA DRIVE
VALPARAISO, INDIANA 46383
(219) 462-4017

(12) Direct Technical Inquiries to Name & Address (if different than Author)

(13) Submitter's Installation Membership Code . . . . .

(14) Abstract (should contain sufficient information for a reader to determine the value of the program). Listed on the reverse side of this form are subjects which may serve as a guide for a descriptive abstract.

SHARE PROGRAM LIBRARY SUBMITTAL FORM

Subject Guide:

a. Purpose
b. Programming Language used
c. Version and modification level or release number
d. Field of application
e. Type of routine (main program, subroutine, etc.)
f. Specific description of machine requirements

SEE ATTACHED

(Please attach additional pages if necessary) . . . . . Total pages attached 2

An "Acknowledgement of Assistance" statement must be attached to this Submittal Form.

Permission to Publish

"I hereby give the SHARE Program Library Agency permission to reprint, reproduce, and distribute this program"

(15) Signature of Submitter and Date 6/1/84

(15) Signature of Installation Addressee _____

SPLA 1001 (R) Revised 11-76

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(6) Primary Subject Code . . . . . _____

(7) Minimum System Requirements _____

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_____

(13) Submitter's Installation Membership Code . . . . . _____

(14) Abstract (should contain sufficient information for a reader to determine the value of the program). Listed on the reverse side of this form are subjects which may serve as a guide for a descriptive abstract.

1984 Changes in the LINWOOD Program

The 1984 LINWOOD program has been revised to provide computer centers with a choice of versions for their users. Support programs, REPLACE and MODIFY, are included along with the appropriate card images to automatically make versions that are either in FORTRAN IV (66) or in FORTRAN 77. The resulting source code is designed to be compiled either with the FORTRAN H EXTENDED (ENHANCED), Version 1.3.0, opt 3 compiler or with the VS FORTRAN, Version 1.3.0, opt 3 compiler. If desired, versions can be provided which allow users to observe on their terminal-scope (KTTY) file both summary statistics and error messages. Users can then follow the progress of the calculations and decide whether to take action to remedy any difficulty with the data or model, or to wait for the more detailed printout.

Three versions are provided to handle different size problems. They are:

Maximum Variables		
Before Transformations	After Transformations	Maximum Observations
35	10	200
65	40	1000
105	80	1000

In order to allow a larger or smaller number of Cp searches, five alternative choices are made available. They allow searches of 30, 40, 50, 60 or 70 variables to look for candidates of the more influential combinations of variables. As the number of variables searched increases, so do the computer core requirements. The number of possible combinations searched equals two to the power of k variables. However, the search is relatively rapid.

Confidence intervals are now provided as well as lower and upper limits at given levels of probability. This allows the user to observe where the fit of the equation is well known, and where it is not. The wider intervals may be due to a limited amount or lack of data in some areas of factor space. Such information may be crucial and is often useful in designing experiments and collecting future data.

LINWOOD and NONLINWOOD—Linear and Nonlinear Least Squares Curve-Fitting Programs

1. INTRODUCTION

The LINWOOD and NONLINWOOD linear and nonlinear least squares curve-fitting programs are designed for the analysis of both *global* and *interior* characteristics of data—determining the influence of each observation on the fit, assessing the plausibility of assumptions, searching for influential subsets of variables, estimating measurement error to judge the fit of candidate equations, providing statistics on the range and relative influence of variables to recognize the strengths and limitations of the fit, and checking the validity of fitted equations as additional observations become available.

This summary considers the programs dated January 1980. Documentation is found in the second edition of *Fitting Equations to Data* by Daniel and Wood (1980), including the user's manuals and glossary of terms used in the programs. Supplementary information is issued with the programs from the various program libraries as changes occur. For the past six years, the programs have been the most requested programs in both the SHARE Library (double precision for IBM computers) and the VIM Library (single precision for CDC computers). They are also now available from libraries for Burroughs, DECsystem, Honeywell, and UNIVAC computers. The cost for transmitting each program and associated test problems on tape varies from $35 to $64, depending on the library. (A list of program libraries and their addresses can be found in the appendix at the end of this article.)

Because of the many options and voluminous output (to see by means of plots and tables if anything unexpected is going on), the programs are run in the batch mode from cards or selected files. Some users, however, submit jobs and view portions of the output from interactive computer terminals. This summary describes some of the analytical options and features of the programs.

2. FEATURES

In addition to the usual statistics, the linear program lists the minimum and maximum values of each variable as well as its mean, range, and root mean square. The program also calculates the "relative influence" of each variable. If a coefficient has a moderate-size t value and its variable has been varied over a relatively small range, its relative influence may be far less than one with a smaller t value carried over a larger range. Thus, the relative influence of each variable provides useful insight into both the data and the fitted equation.

2.1 Influence of Outlying and Far-Out Observations

The weighted squared standardized distance (WSSD) of each observation from the centroid of all observations is calculated. This helps the user ascertain whether the response to the outlying observations is the same as the response to inner observations. The outer points will be controlling and often are the most closely fitted of all the data. They may represent start-up conditions, unstable process conditions, or unusual sales conditions, which should be fitted separately. The WSSD of each observation is weighted by the sum of the squares of the $b_i(x_{ij} - \bar{x}_i)$ components of the equation (where b_i is the coefficient, x_{ij} the independent variable, $\bar{x}_i$ its mean, i the index of the variable, and j the index of the observation). There is little interest in observations that are far out in dimensions that are not influential. However, there is always the possibility that a defective far-out observation is controlling and making a variable appear to have little influence. To allow the analyst to check this possibility, the ratio of the variance of each fitted observation to the variance of its residual is calculated. These values depend solely on the relative location of the observation. Hence, far-out observations of both influential and noninfluential variables can be easily spotted.

2.2 Estimates of Measurement Error

In order to determine how well an equation fits the data, one must have some knowledge of measurement error. If the data have been obtained from a well-designed experiment, this information is usually available. If the data have been taken by observing "normal" operations, there are seldom exact duplicates. Therefore, the program estimates the standard deviation of the measurement error from near neighbors (points separated by small standardized distances). This criterion provides a basis on which to decide when to stop modeling.

2.3 Information From Residuals

The programs list all residuals—the differences between the observed and fitted values of the dependent variable—both in the sequence in which observations were given to the computer and in the order of the magnitude of the residuals. Plots of the residuals are made to indicate (a) whether they are (roughly) normally distributed, (b) how they are distributed over the fitted values of the dependent variable, and (c) how they are distributed over each of the independent variables. With this information, potential outliers can be spotted. Studentized residuals are

calculated to provide the needed statistics.

The component effect of each variable at each observation can readily be seen when plotted against each variable. Adding the residual of each observation to the component effect at each observation allows the user to obtain some insight into patterns in the residuals and their dependence on each component of the fitted equation. These plots are called *component and component-plus-residual plots*. They are used as an aid (a) to choose an appropriate form of the equation, (b) to observe the distribution of the observations over the range of each independent variable, and (c) to estimate the influence of each observation on each component of the equation.

The program allows the assignment of indicator variables to selected observations. With the help of these indicator variables and the C_p search technique for the selection of influential variables, far-out observations can be tested to see if their responses are compatible with those of the remainder of the data.

2.4 Selection of Subset Equations

The C_p search helps the user judge if there are subsets of variables that fit the data as well as the full equation. This search for candidate equations with influential variables is quite rapid. In an equation with 25 variables, the modified leaps and bounds search of all possible 33 million subset equations has taken as little as three seconds. The 20–40 lower C_p candidate equations are displayed in a single plot and identified on a separate page. In contrast to stepwise regression, which selects one "best" equation, the C_p slate of candidate equations allows the user to choose the appropriate subset equation depending on its expected use.

2.5 Tests of the Candidate Equations

An index of the required precision of each independent variable helps to guard against overoptimism in the fitted equations. Knowing this precision allows the user to determine for a particular equation whether the data have been recorded to a sufficient number of places or to more places than the source of data warrant.

The user can also cross-verify the coefficients of candidate equations with a second sample of data. This provides a relatively rigorous test of both the model and the fitted coefficients. Plots of the components of the equation from the first sample of data and the component-plus-residuals of the second sample reveal which observations fit well and which do not. As a result, new insight may be gained into the strengths and limitations of the fitted equation.

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APPENDIX: PROGRAM LIBRARIES

CUBE Library for Burroughs 4700 and 6700 computers, U.S. Air Force Academy, Dept. of Computer Science, CO 80840; Programs WIS/LINWOOD and WIS/NONLINWOOD.

DECUS Library for DECsystem computers, One Iron Way, Marlboro, MA 01752; DEC 10/20 Programs LINWOOD-10-257 and NONLIN-10-258, DEC PDP-11 Programs LINWOOD-11-419 and NONLIN-11-420.

HLSUA Library for Honeywell 600/6000 computers, Software Library Mail Station K16, Honeywell Information Systems, P.O. Box 6000, Phoenix, AZ 85005; Programs GES-1206 and GES-1207.

SHARE Library for IBM 360–370 computers, Triangle Universities Computation Center, P.O. Box 12076, Research Triangle Park, N.C. 27709; Programs 360D-13.6.008 and 360D-13.6.007.

UNIVAC Source for UNIVAC 1108–1110 computers, Johnson Space Center, Mail Code TN74, Houston, TX 77058; Programs LINWOOD and NONLINWOOD.

VIM Library for CDC 6400–6700 computers, Source Vøgelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, IL 60201; Programs (Single Precision) LINWOOD and NLWOOD.

REFERENCE

Daniel, Cuthbert, and Wood, Fred S., with the assistance of Gorman, John W. (1980), *Fitting Equations to Data, Computer Analysis of Multifactor Data* (2nd ed.), New York: John Wiley & Sons.

Historical Operation of LINWOOD and NONLINWOOD Programs

These programs have operated satisfactorily using the following compilers and IBM computer systems:

Compilers: H with Opt=2, H EXTENDED with Opt=2, and H Extended (ENHANCED) with Opt=3 with and without overlays.
G and G1, with and without overlays.
VS FORTRAN, Version 1.3.0 with Opt=3.

Computer Systems:

360 -	50	PCP
	65	EMFT
	75	EMFT
	85	MVT
370 -	138	DOS-VS
	145	DOS-VS
	155	MVT
	158	VS2
	165	MVT
	168	MVT
	168	MVS
	195	MVT
3033 -		MVS
		CMS

For future reference, please notify the undersigned of your experience in operating with other compiler and/or computer-system configurations.

Fred S. Wood

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(219) 462-4017

Table of Contents

LINWOOD, Computer Linear Least-Squares Curve-Fitting Program

LINWOOD LINEAR LEAST-SQUARES CURVE-FITTING PROGRAM

ABSTRACT

Examples on the use of the LINWOOD and NLWOOD linear and nonlinear least-squares curve-fitting programs are described in detail in the second edition of FITTING EQUATIONS TO DATA, Computer Analysis of Multifactor Data, by Cuthbert Daniel and Fred Wood, Wiley Publisher, 1980. Examples on the use of these programs are provided together with interpretation of results, glossary of terms, and User's Manual. For the past six years, these have been the most requested programs in both the SHARE library for IBM computers and the VIM library for CDC computers.

The LINWOOD program has many options which allow the user to transform data into an appropriate form, fits specified equations to the transformed data by linear least-squares, and provides both statistics and plots to aid in evaluating the fit. A modified leaps-and-bounds Cp search technique determines rapidly if smaller sets of the variables will represent the data equally well.

In addition to the usual statistics, the program calculates the maximum and minimum value of each variable as well as its range, the relative influence of each variable, and the weighted squared standardized distance of each observation from the centroid of all observations. Near neighbors are used to estimate the standard deviation of the dependent variable. Component and component-plus-residual plots are used: (1) to choose the appropriate form of the equation, (2) to determine the distribution of the observations over the range of each independent variable, and (3) to ascertain the influence of each observation on each component of the equation. A table of functions related to the variance of the fitted value provides information on the influence of the location of each observation in x-space. Cross verification of coefficients can be made as additional observations become available.

Acknowledgements

The linear and nonlinear programs have been converted for use on a number of computer systems and are available from the appropriate libraries (not restricted to library membership).

James D. Murat and Thomas R. Zeisler, University of Wisconsin, converted the programs for BURROUGHS 4700 and 6700 computers. The project was initiated by David S. Rumsey of Burroughs. CUBE Library*, WIS/LINWOOD and WIS/NONLINWOOD.

Michael P. Kelly and Eric R. Ziegel, Standard Oil (Indiana), converted the programs for DECsystem-10/20 computers. DECUS Library**, LINWOOD-10-257 and NONLIN-10-258. David F. Zarnow, Naval Avionics, converted the programs for DECsystem PDP-11 computers, DECUS Library**, LINWOOD-11-419 and NONLIN-11-420.

David Zarnow also converted the programs for Honeywell 600/6000 computers. They were updated by James L. Maxwell and John E. Mc Leod, CPC International. HLSUA Library***, GES-1206 and GES-1207.

SHARE Library**** for IMB 360-370 System Computers, 360D-13.6.008 and 360D-13.6.007.

James E. Keith, Johnson Space Center*****, converted the programs for UNIVAC 1108 computer, LINWOOD and NONLINWOOD.

Neil H. Timm, University of California (Berkeley), adapted the programs for the CDC 6400 computer in single precision. They were updated by Eli Cohen and Bruce E. Foster, Northwestern University. VIM Library******, NUCC-LINWOOD and NUCC-NLWOOD.

* CUBE Librarian, Center for Computer and Information Services, Seton Hall University, South Orange, New Jersey 07079.

** Digital Equipment Computer User's Society, One Iron Way, Marlboro, Massachusetts 01752.

*** Software Library, Mail Station K16, Honeywell Information Systems, Post Office Box 6000, Phoenix, Arizona 85005.

**** Triangle Universities Computation Center, Post Office Box 12076, Research Triangle Park, North Carolina 27709.

***** Johnson Space Center, Code SN3, Houston, Texas 77058.

****** Software Distribution Department, ARH230, Control Data Corporation, 4201 North Lexington Avenue, St. Paul, Minnesota 55112. Also Vogelbeck Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Illinois 60201.

FILE 1 DOC DOCUMENTATION OF CONTENTS OF TAPE 1/84 LINWOOD PROGRAM
MAGNETIC TAPE KEY
TAPE IS UNLABLED. TRACK AND DENSITY AS ORDERED.
CARD FILES 1-19, DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000)
PRINT FILES 20-21, DCB=(RECFM=FBA,LRECL=133,BLKSIZE=3059)

CONTENTS OF TAPE

****
*
* NOTE: WHEN COPYING THE FILES OF THIS TAPE, DO NOT RESEQUENCE THE *
* CARD IMAGES. THE SEQUENCE NUMBERS ARE USED IN THE REPLACEMENT *
* PROGRAM TO IDENTIFY AND CHANGE THE DIMENSIONS OF THE PROGRAM. *
*
****

LINWOOD PROGRAM

FILE		CARD IMAGES
1	DOC	129
	CONTENTS OF TAPE AND INSTRUCTIONS ON USE OF FORTRAN REPLACEMENT PROGRAM (1) TO REPLACE CARDS TO MAKE LARGER AND SMALLER VERSIONS OF PROGRAM AND (2) TO MAKE A FORTRAN 77 VERSION OF PROGRAM FROM THE FORTRAN IV SOURCE DECK. INSTRUCTIONS ARE ALSO INCLUDED ON USE OF FORTRAN MODIFICATION PROGRAM TO INSERT CARDS TO PRINT SUMMARY STATISTICS AND ERROR MESSAGES ON USERS TERMINAL SCOPE IF DESIRED.	
2	F4	5651
	FORTRAN IV SOURCE DECK OF LINEAR LEAST-SQUARES CURVE FITTING PROGRAM. AS DIMENSIONED, THE PROGRAM WILL HANDLE 65 VARIABLES BEFORE TRANSFORMATIONS, 40 AFTER, AND 1000 OBSERVATIONS.	
3	TEST	459
	SAMPLE TEST PROBLEMS FROM BOOK FITTING EQUATIONS TO DATA BY DANIEL AND WOOD, SECOND EDITION, WILEY PUBLISHER.	
4	RPL	52
	FORTRAN SOURCE DECK OF REPLACEMENT PROGRAM.	
	REPLACEMENT PROGRAM INSTRUCTIONS	
	AFTER COMPILING THE REPLACEMENT PROGRAM FROM TAPE FILE 4, THE ORIGINAL F4 FORTRAN IV SOURCE OF THE LINWOOD PROGRAM IS READ FROM TAPE FILE 2 ON UNIT 8. THE REPLACEMENT CARDS ARE READ FROM ANY TAPE FILE 5 THROUGH 16 ON UNIT 5. THE CHANGES ARE PRINTED ON UNIT 6 AND THE NEW FORTRAN SOURCE PROGRAM IS PUNCHED OR PUT IN CARD IMAGES ON UNIT 7.	
5	R10IV	204
	FORTRAN IV REPLACEMENT CARDS TO REDUCE PROGRAM TO 35 MAX VARIABLES BEFORE TRANSFORMATIONS, 10 VARIABLES AFTER TRANSFORMATIONS AND 200 OBSERVATIONS MAX.	
6	R40IV	204
	FORTRAN IV REPLACEMENT CARDS TO MAKE PROGRAM WITH 65 MAX VARIABLES BEFORE TRANSFORMATIONS, 40 VARIABLES AFTER TRANSFORMATIONS AND 1000 OBSERVATIONS MAX.	
7	R80IV	91
	FORTRAN IV REPLACEMENT CARDS TO INCREASE PROGRAM TO 105 MAX VARS. BEFORE TRANSFORMATIONS, 80 VARIABLES AFTER TRANSFORMATIONS AND 1000 OBSERVATIONS MAX.	
8	RFT77	115
	REPLACEMENT CARDS TO MAKE A FORTRAN 77 SOURCE DECK FROM THE FILE 2, F4 FORTRAN IV SOURCE DECK.	
9	R1077	204
	FORTRAN 77 REPLACEMENT CARDS TO REDUCE PROGRAM TO 35 MAX VARIABLES BEFORE TRANSFORMATIONS, 10 VARIABLES AFTER TRANSFORMATIONS AND 200 OBSERVATIONS MAX.	

10 R4077 — 204
FORTRAN 77 REPLACEMENT CARDS TO MAKE PROGRAM WITH 65 MAX VARIABLES BEFORE TRANSFORMATIONS, 40 VARIABLES AFTER TRANSFORMATIONS AND 1000 OBSERVATIONS MAX.

11 R8077 — 92
FORTRAN 77 REPLACEMENT CARDS TO INCREASE PROGRAM TO 105 MAX VARS. BEFORE TRANSFORMATIONS, 80 VARIABLES AFTER TRANSFORMATIONS AND 1000 OBSERVATIONS MAX.

12 SR30 — 4
FORTRAN REPLACEMENT CARDS TO REDUCE CORE REQUIREMENTS AND NUMBER OF SEARCHES TO 30 VARIABLES, SAME AS 40 VARIABLE PROGRAM.

13 SR40 — 4
FORTRAN REPLACEMENT CARDS TO INCREASE CORE REQUIREMENTS AND NUMBER OF SEARCHES TO 40 VARIABLES, SAME AS 80 VARIABLE PROGRAM.

14 SR50 — 4
FORTRAN REPLACEMENT CARDS TO INCREASE CORE REQUIREMENTS AND NUMBER OF SEARCHES TO 50 VARIABLES IN THE 80 VARIABLE PROGRAM.

15 SR60 — 4
FORTRAN REPLACEMENT CARDS TO INCREASE CORE REQUIREMENTS AND NUMBER OF SEARCHES TO 60 VARIABLES IN THE 80 VARIABLE PROGRAM.

16 SR70 — 4
FORTRAN REPLACEMENT CARDS TO INCREASE CORE REQUIREMENTS AND NUMBER OF SEARCHES TO 70 VARIABLES IN THE 80 VARIABLE PROGRAM.

17 MOD — 98
FORTRAN SOURCE DECK OF PROGRAM MODIFY.

PROGRAM MODIFY INSTRUCTIONS

AFTER COMPILING THE PROGRAM MODIFY FROM TAPE FILE 17, THE ORIGINAL F4 FORTRAN IV SOURCE OF THE LINWOOD PROGRAM IS READ FROM TAPE FILE 2 ON UNIT 8. THE MODIFY CARDS ARE READ FROM FILE 18. THE CHANGES ARE PRINTED ON UNIT 6 AND THE NEW FORTRAN SOURCE PROGRAM IS PUNCHED OR PUT IN CARD IMAGES ON UNIT 7.

18 MKTTY — 94
MODIFICATION CARDS TO INCLUDE KTTY WRITE STATEMENTS TO A SCOPE TERMINAL (FILE 30) FOR VIEWING THE SUMMARY OF RESULTS AND ALL ERROR MESSAGES BEFORE REQUESTING PRINTING OF OUTPUT. CAN BE USED WITH EITHER THE FORTRAN IV OR 77 VERSIONS OF LINWOOD.

19 JCL — 116
EXAMPLES OF JOB CONTROL LANGUAGE CARDS TO COMPILE, LINK WITH OVERLAY, PLACE IN LIBRARY, RUN FROM LIBRARY, AND COMPILE LINK AND GO WITH THE REPLACEMENT PROGRAM. EXAMPLES OF DOS JCL ARE GIVEN.

20 PRINT
PRINTOUT OF TEST PROBLEMS.

21 PRINT
PRINT OF SUMMARY STATISTICS ON USERS TERMINAL SCOPE.

TOTAL NUMBER OF CARD IMAGES = 7733

LINEAR LEAST-SQUARES CURVE-FITTING PROGRAM

1983 VERSION OF THE LINWOOD 40 VARIABLE, 1000 OBSERVATION PROGRAM

REFER TO FITTING EQUATIONS TO DATA BY DANIEL AND WOOD, SECOND EDITION, WILEY PUBLISHER,
FOR GLOSSARY OF TERMS, USER'S MANUAL, DETAILS OF CALCULATIONS AND INTERPRETATION OF RESULTS.

CONTROL CARD INFORMATION

COL.	INPUT	MAX.	ITEM (NOTE: BLANK OR CARD = 0)
1-18			PROBLEM IDENTIFICATION.
19-20	4		NUMBER OF INDEPENDENT VARIABLES READ IN (ALLOW SPACE FOR TRANSFORMATIONS).
21-22	3		NUMBER OF DEPENDENT VARIABLES READ IN.
	7	65	TOTAL NUMBER OF VARIABLES (BEFORE TRANSFORMATIONS, IF ANY).
24	E		E CAUSES Y, FITTED Y AND RESIDUALS TO BE LISTED WITH AN E RATHER THAN AN F FORMAT.
25	1		1 DO TRANSFORMATIONS.
26	0		1 WEIGHT OBSERVATIONS. WEIGHT ENTERED IN LAST POSITION. 2 WEIGHT BY 1/VAR. OF OBSERVATION. VARIANCE ENTERED.
27	0		1 LET B(0) = ZERO, OTHERWISE B(0) IS CALCULATED VALUE.
28	0		1 CHECK OBSERVATION NUMBER SEQUENCE.
29	0		1 CHECK SEQUENCE WITHIN OBSERVATION NUMBER.
30	0		1 DO BACK TRANSFORMATION OF DEPENDENT VARIABLE.
31	1		1 READ CONFIDENCE INTERVAL CARD(S).
32	0		0 LIST ALL INPUT DATA. 1 LIST ONLY 1ST OBSERVATION. 2 DO NOT LIST ANY INPUT DATA.
33	0		0 LIST TRANSFORMATIONS AND ALL TRANSFORMED DATA. 1 LIST TRANSFORMATIONS AND 1ST TRANSFORMED OBSERVATION. 2 DO NOT LIST TRANSFORMATIONS OR TRANSFORMED DATA.
34	0		1 DO NOT LIST SUMS OF VARIABLES.
35	0		1 DO NOT LIST RAW SUMS AND CROSS PRODUCTS WHEN B(0)=0.
36	0		1 DO NOT LIST RESIDUAL SUMS AND CROSS PRODUCTS.
37	0		1 DO NOT LIST MEANS AND ROOT MEAN SQUARES OF VARIABLES.
38	0		1 DO NOT LIST SIMPLE CORRELATION COEFFICIENTS.
39	0		1 DO NOT LIST INVERSE MATRIX.
40	0		1 DO NOT PRINT PLOTS OF RESIDUALS VS. FITTED Y. 2 PLOT (A) RESIDUALS AND (B) COMPONENT AND COMPONENT-PLUS-RESIDUALS VS. EACH INDEPENDENT VARIABLE. 3 PLOT (A) RESIDUALS ONLY. 4 PLOT (B) COMPONENT AND COMPONENT-PLUS-RESIDUALS ONLY. 5 PLOT (B) BUT EXPAND SCALE TO FILL EACH PLOT. 6 SAME AS 2 WITH STUDENTIZED RESIDUALS. 7 SAME AS 3 WITH STUDENTIZED RESIDUALS. 8 SAME AS 4 WITH STUDENTIZED RESIDUALS. 9 SAME AS 5 WITH STUDENTIZED RESIDUALS. TO OMIT PLOTS OF SPECIFIC INDEPENDENT VARIABLES, ON THE TRANSFORMATION CARDS PUT A 2 IN THE OMIT COLUMNS OF THOSE VARIABLES.
41	1		0 READ DATA WITH STANDARD FORMAT (A6, I4, I2, 10F6.3). 1 READ DATA WITH FORMAT TO BE READ, 1 CARD (72COL) ASSUMED. 2 READ DATA WITH READ DATA (REDATA) SUBROUTINE.
42	0		0 DO NOT SAVE DATA FOR NEXT PROBLEM. 1 SAVE DATA FOR NEXT PROBLEM. 2 REUSE DATA FROM PREVIOUS PROBLEM.
43-44	0	30	MAXIMUM NUMBER OF VARIABLES IN CP SEARCH IF GREATER THAN 24 IN THIS VERSION OF PROGRAM.
45	0	8	NUMBER OF FORMAT CARDS IF GREATER THAN 1.
46-47	12	12	NUMBER OF INFORMATION CARDS TO BE READ FOR DISPLAY ON PRINTOUT IF DESIRED, 72 COL. EACH.
48	1		1 READ NAMES OF VARIABLES FOR DISPLAY ON PRINTOUT. NAMES IN SAME POSITIONS AS VARIABLES ON TRANSFORMATION CARDS - COLS. 1-6, 11-16, - - - , 61-66. NAMES ARE NOT MOVED, ONLY LISTED OR DELETED. 2 REUSE NAMES OF VARIABLES FROM PREVIOUS PROBLEM.
49	3		CP SEARCH FOR CANDIDATE EQUATIONS. USE ESTIMATE OF VARIANCE (RMS) FROM: 1 FULL EQUATION, 2 SUBSET EQUATION WITH MINIMUM RMS VALUE, OR 3 ESTIMATE OF VARIANCE CARD, F16.8 FORMAT.
50	1	3	NUMBER OF CP SELECTED SEARCH CARDS TO BE READ. KEYPUNCH WITH A 18(2X,I2) FORMAT IN ASCENDING ORDER THE IDENTIFICATION NUMBER OF THE VARIABLES (AFTER TRANSFORMATIONS) TO BE USED IN THAT SEARCH. ALL OTHER VARIABLES WILL BE PLACED IN BASIC EQUATION. IF THE TOTAL NUMBER OF VARIABLES TO BE SEARCHED IS LARGE, GIVE TOTAL IN COLUMNS 43-44.
51	0		1 LIST COMPONENT-EFFECT TABLE, REQUIRED X(I) PRECISION, ESTIMATE OF STANDARD DEVIATION FROM NEAR NEIGHBORS, FUNCTIONS OF FITTED Y AND AUTOCORRELATIONS OF RESIDUALS. 2 LIST ONLY ESTIMATE OF STD. DEVIATIONS, FUNCTIONS, AND AUTOCORRELATIONS OF RESIDUALS. 3 LIST ONLY FUNCTIONS OF FITTED Y.
52-53	0		NUMBER OF FILE IF DATA ARE READ FROM SEPARATE FILE, NO END CARD IF ONLY ONE SET OF DATA IS ON EACH FILE.
54-55	0		NUMBER OF INDEPENDENT VARIABLES GREATER THAN THE 99 ALLOWED IN COLS 19-20.
56-58	3		TO REDUCE PRINTOUT WITH MANY OBSERVATIONS, NUMBER OF CENTRAL OBSERVATIONS AND RESIDUALS NOT TO BE PRINTED. THIS REQUIRES AN E IN COL 24.
59	1		CROSS VERIFICATION OF MODEL AND COEFFICIENTS WITH A SECOND SAMPLE OF DATA: 1 WRITE B(0) AND B(I)S ON FILE IN ONE PROBLEM (TRANSFORMATIONS ARE NOT SAVED). 2 READ B(0) AND B(I)S FROM FILE IN NEXT PROBLEM WITH SECOND SET OF OBSERVATIONS.
60	1	5	NUMBER OF DELETE-OBSERVATIONS CARDS. KEYPUNCH OBSERVATION NUMBER OF DATA TO BE DELETED IN ORDER READ BY COMPUTER USING 7(I4,6X) FORMAT.
61	1	5	NUMBER OF INDICATOR-VARIABLE-OBSERVATIONS CARDS. USING A 7(I4,2X,I3,1X) FORMAT, KEYPUNCH OBSERVATION NUMBER (IN ORDER READ) AND VARIABLE NUMBER (BEFORE TRANSFORMATIONS) INTO WHICH A 1 IS TO BE INSERTED.

ORDER OF CARDS

FIRST PROBLEM
1 CONTROL CARD.
2 FORMAT CARD(S), IF ANY.
3 DELETE OBSERVATIONS CARD(S), IF ANY.
4 INDICATOR-VARIABLE-OBSERVATIONS CARD(S), IF ANY.
5 TRANSFORMATION CARD(S), IF ANY.
6 INFORMATION CARD(S) FOR PRINTOUT, IF ANY.
7 NAMES OF VARIABLES CARD(S) FOR PRINTOUT, IF ANY.
8 CP SELECTED SEARCH CARD(S), IF ANY.
9 DATA CARDS (IF NOT READ FROM A FILE).
10 END CARD (END IN COLUMNS 1 - 3 OF IDENTIFICATION FIELD). THE NUMBER OF END CARDS MUST EQUAL THE NUMBER OF CARDS PER OBSERVATION. (END CARDS ARE NOT NEEDED IF DATA ARE READ FROM A FILE).
11 ESTIMATE OF VARIANCE CARD(S), IF ANY, FOR EACH DEPENDENT VARIABLE.
12 CONFIDENCE INTERVAL CARD(S), IF ANY.

SECOND PROBLEM
IF DATA ARE REUSED FROM FIRST PROBLEM, DELETE THE FORMAT, DATA AND END CARDS.
IF NAMES ARE REUSED, DELETE THE NAME CARDS.
IF DIFFERENT INPUT DATA AND NAMES, REPEAT 1 - 12 ABOVE.

LINEAR LEAST-SQUARES CURVE-FITTING PROGRAM

ORDER OF CONFIDENCE INTERVAL CARDS (PLACED AT END OF EACH PROBLEM DECK)

1 CONTROL CARD FOR CONFIDENCE INTERVAL CALCULATIONS.
NOTE - FOR DATA OF FITTED EQUATION, NO ADDITIONAL CARDS ARE NEEDED.
2 CARDS WITH NEW VALUES OF INDEPENDENT VARIABLES, OR CARDS TO GENERATE MATRIX OF INDEPENDENT VARIABLES (READ WITH RETAINED PROBLEM FORMAT).
3 END CARD.
4 ADDITIONAL MATRIX CARDS.
5 END CARD.

CONFIDENCE INTERVAL CONTROL CARD INFORMATION

COL.	MAX.	ITEM
1		0 USE DATA OF FITTED EQUATION.
		1 READ NEW VALUES OF INDEPENDENT VARIABLES WITH SAME FORMAT AS DATA OF FITTED EQUATION.
		2 GENERATE MATRIX OF INDEPENDENT VARIABLES.
3	9	NUMBER OF SETS OF CARDS TO GENERATE DATA.
5	6	NUMBER OF PROBABILITY LEVELS TO BE CALCULATED.
7- 8		NUMBER OF FILE IF DATA ARE READ FROM SEPARATE FILE (NO END CARD NEEDED).
10-14		1ST STANDARD ERROR MULTIPLIER TO GIVE CONFIDENCE INTERVAL (VALUE ASSUMED TO BE 1.0 IF NOT GIVEN).
15-19		1ST PERCENT PROBABILITY LEVEL (DISPLAYED ON PRINTOUT - VALUE ASSUMED TO BE 86 IF NOT GIVEN).
20-24		2ND MULTIPLIER.
25-29		2ND PERCENT PROBABILITY.
30-34		3RD MULTIPLIER.
35-39		3RD PERCENT PROBABILITY.
40-44		4TH MULTIPLIER.
45-49		4TH PERCENT PROBABILITY.
50-54		5TH MULTIPLIER.
55-59		5TH PERCENT PROBABILITY.
60-64		6TH MULTIPLIER.
65-69		6TH PERCENT PROBABILITY.

SETS OF CARDS TO GENERATE ALL COMBINATIONS OF SELECTED LEVELS OF EACH VARIABLE IN SAME ORDER AS IN PROBLEM BEFORE TRANSFORMATIONS.

(A) LOWEST LEVEL OF EACH VARIABLE.
(B) INCREMENT SIZE OF EACH VARIABLE.
(A) AND (B) READ WITH SAME FORMAT AS DATA OF FITTED EQUATION.
(C) NUMBER OF INCREMENTS OF EACH VARIABLE ABOVE, (0 ACCEPTED)

	COL.	VARIABLE
FIRST CARD	1- 2	1
	3- 4	2
	5- 6	3
	. .	. .
	71-72	36
SECOND CARD	1- 2	37
	ETC.	

(D) CARD WITH END IN COLUMNS 1-3 OF IDENTIFICATION FIELD.

Linear Least — Squares Curve Fitting Program
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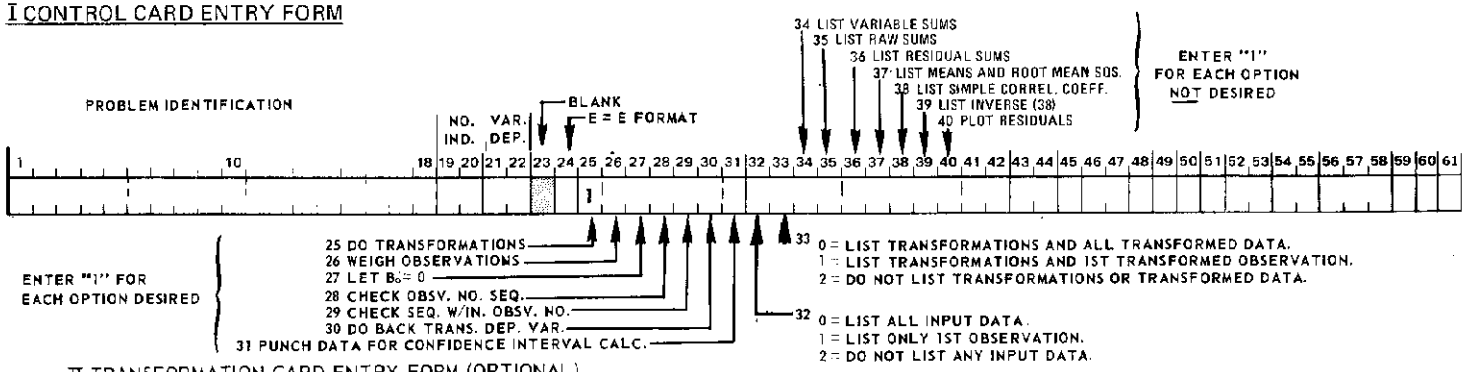
Name	Date

I CONTROL CARD ENTRY FORM



40
2 = PLOT RESIDUALS & COMPONENT-PLUS-RESIDUALS.
3 = PLOT RESIDUALS ONLY.
4 = PLOT COMPONENT-PLUS-RESIDUALS ONLY.
5 = SAME AS 4 BUT EXPANDED TO FILL PLOT.

41
0 = READ DATA WITH STANDARD FORMAT.
1 = READ DATA WITH SPECIAL FORMAT.
2 = READ DATA WITH READ DATA SUBROUTINE.

42
0 = DO NOT SAVE DATA FOR NEXT PROBLEM.
1 = SAVE DATA FOR NEXT PROBLEM.
2 = REUSE DATA FROM PREVIOUS PROBLEM.

43-44 NUMBER OF VARIABLES IN CP SEARCH IF > 12.

45 NUMBER OF FORMAT CARDS IF > 1.

46-47 NUMBER OF INFORMATION CARDS.

48
0 = DO NOT READ NAMES OF VARIABLES FOR DISPLAY.
1 = READ NAMES OF VARIABLES.
2 = REUSE NAMES OF VARIABLES FROM PREVIOUS PROBLEM.

49 CP SEARCH, ESTIMATE OF VARIANCE FROM
1 = FULL EQUATION.
2 = SUBSET EQUATION WITH MINIMUM RMS VALUE.
3 = ESTIMATE OF VARIANCE CARD.

50 NUMBER OF FACTORIAL SEARCH CARDS.

51
1 = LIST COMPONENT EFFECTS, REQ. X PRECISION, EST. STD. DEV. AND FITTED Y FUNCTIONS.
2 = LIST ONLY EST. STD. DEV. AND FUNCTIONS.
3 = LIST ONLY FUNCTIONS.

52-53 NUMBER OF SEPARATE DATA FILE.

54-55 NUMBER OF INDEPENDENT VARIABLES, GREATER THAN 99.

56-58 NUMBER OF OBSERVATIONS DELETED FROM PRINTOUT.

59
1 = SAVE COEFFICIENTS FOR CROSS-VERIFICATION.
2 = REUSE COEFFICIENTS FOR CROSS-VERIFICATION.

60 NUMBER OF DELETE OBSERVATIONS CARDS.

61 NUMBER OF INDICATOR-VARIABLE CARDS.

II TRANSFORMATION CARD ENTRY FORM (OPTIONAL)

C	OPERATION	ARG.
00	NO OPERATION	BLANK
01	NATURAL LOG	
02	COMMON LOG	
03	ANTI-LOG NATURAL LOG	
04	ANTI-LOG COMMON LOG	
05	EXPONENTIATION, X^K	±K*
06	MULTIPLICATION, X • K	±K*
07	DIVISION, X ÷ K	±K*
08	ALGEBRAIC ADDITION, X ± K	±K*
09	X(N) • X(M)	N, M
10	X(N) ÷ X(M)	N, M
11	X(N) + X(M)	N, M
12	X(N) − X(M)	N, M
13	SIN X	BLANK
14	COS X	BLANK

*DECIMAL POINT MUST BE ENTERED

LOC

THE POSITION WITHIN THE USER'S VARIABLE SEQUENCE WHERE THE TRANSFORMED X(N) SHOULD BE LOCATED.

IF LOC IS BLANK, THE TRANSFORMED X(N) WILL REPLACE X(N).

IF (C) IS BLANK OR 00 AND LOC IS NOT BLANK, X(N) WILL BE PLACED AT LOC LEAVING X(N) UNCHANGED.

Ø

A ONE (1) PLACED IN THIS COLUMN PERMITS THE USER TO WITHHOLD X(N) FROM THIS EQUATION WHILE INCLUDING IT IN ANY TRANSFORMATION OPERATION.

VARIABLES

	1–10				11–20				21–30				31–40				41–50				51–60				61–70				71–80
	C	ARG	LOC	Ø	C	ARG	LOC	Ø	C	ARG	LOC	Ø	C	ARG	LOC	Ø	C	ARG	LOC	Ø	C	ARG	LOC	Ø	C	ARG	LOC	Ø	USER'S OPTION
1-7																													
8-14																													
15-21																													
22-28																													
29-35																													
36-42																													
43-49																													
50-56																													
57-60																													

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III STANDARD DATA-CARD ENTRY FORM

ENTER WEIGHTING FACTOR, IF ANY, AS LAST ENTRY.
"END" CARD MUST BE LAST CARD.

IDENT.	OBSV. NO.	SEQ NO.	x1-11-21	x2-12-22	x3-13-23	x4-14-24	x5-15-25	x6-16-26	x7-17-27	x8-18-28	x9-19-29	x10-20-30	USER'S OPTION
1 2 3 4 5 6	7 8 9 0	1 2	3 4 5 6 7 8	9 0 1 2 3 4	5 6 7 8 9 0	1 2 3 4 5 6	7 8 9 0 1 2	3 4 5 6 7 8	9 0 1 2 3 4	5 6 7 8 9 0	1 2 3 4 5 6	7 8 9 0 1 2	3 4 5 6 7 8 9 0

1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0
	1	2	3	4	5	6	7	8

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```
//* EXAMPLE OF JCL TO RUN LINWOOD PROGRAM                                  JCL 0010
//* PROGRAM AT0072AA IN LOAD LIBRARY CAP.LDLIBTW                           JCL 0020
//*  FILE 30 PRINTS OR SHOWS SUMMARY STATISTICS ON USERS TERMINAL-SCOPE     JCL 0021
//RUN EXEC PGM=AT0072AA,REGION=226K                                        JCL 0030
//STEPLIB  DD DSNAME=CAP.LDLIBTW,DISP=SHR                                  JCL 0040
//GO.FT01F001 DD SPACE=(TRK,(65,20)),UNIT=SYSDA,                          *JCL 0050
//    DCB=(RECFM=VBS,LRECL=644,BLKSIZE=1936)                               JCL 0060
//GO.FT02F001 DD SPACE=(TRK,(65,20)),UNIT=(SYSDA,SEP=FT01F001),           *JCL 0070
//    DCB=(RECFM=VBS,LRECL=644,BLKSIZE=1936)                               JCL 0080
//GO.FT03F001 DD SPACE=(TRK,(65,20)),                                     *JCL 0090
//              UNIT=(SYSDA,SEP=(FT01F001,FT02F001)),                     *JCL 0100
//    DCB=(RECFM=VBS,LRECL=644,BLKSIZE=1936)                               JCL 0110
//GO.FT04F001 DD SPACE=(TRK,(65,20)),                                     *JCL 0120
//              UNIT=(SYSDA,SEP=(FT01F001,FT02F001,FT03F001)),            *JCL 0130
//    DCB=(RECFM=VBS,LRECL=644,BLKSIZE=1936)                               JCL 0140
//GO.FT06F001 DD SYSOUT=A,                                                *JCL 0150
//    DCB=(RECFM=FBA,BLKSIZE=1995,LRECL=133),                             *JCL 0160
//              SPACE=(133,(10000,0))                                      JCL 0170
//GO.FT08F001 DD SPACE=(TRK,(65,20)),UNIT=SYSDA,                           JCL 0180
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=19040)                                JCL 0181
//* AT OPTION OF THE USER SOME OF THE DATA ARE READ FROM FILE 9            JCL 0190
//GO.FT09F001 DD DISP=SHR,LABEL=(,,,IN),DSN=CSD.SOR.WOOD.DATA(W3499072)   JCL 0200
//GO.FT30F001 DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=6118)          JCL 0201
//GO.FT05F001  DD  *                                                       JCL 0210
              CONTROL AND DATA CARDS GO BEFORE THIS CARD                   JCL 0220
TO RUN PUT /* IN COLUMNS 1 AND 2 OF THE PREVIOUS CARD.                    JCL 0230
```

```
//*  EXAMPLE OF JCL TO COMPILE, LINK WITH OVERLAY AND PLACE IN LIBRARY.   JCL 2010
// EXEC FRTNHCL,PARM.COMP='MAP,XREF,OPT=3',CREG=350K,LR='XREF,OVLY'        JCL 2020
//COMP.SYSIN  DD *   FORTRAN DECK FOLLOWS THIS CARD                        JCL 2030
//LINK.SYSLMOD  DD DSN=CAP.LDLIBTW,DISP=SHR                                JCL 2040
//LINK.SYSIN  DD *                                                         JCL 2050
      OVERLAY AAA                                                        JCL 2060
       INSERT BASPGM,CCARD,CICARD                                        JCL 2070
      OVERLAY AAA                                                        JCL 2080
       INSERT STAT,REDATA                                                JCL 2090
      OVERLAY AAA                                                        JCL 2100
       INSERT FIT,INV,YBACK,MINMAX,FALPHA,AUTO                           JCL 2110
      OVERLAY AAA                                                        JCL 2120
       INSERT PITCHA                                                     JCL 2130
      OVERLAY AAA                                                        JCL 2140
       INSERT LBMAIN,LANDB,VARSET,SWEEP,STORE,BACK,COEF,PIVOT,CPPLOT     JCL 2150
      OVERLAY AAA                                                        JCL 2151
       INSERT CONFID,CONCRD                                              JCL 2152
      ENTRY MAIN                                                         JCL 2160
      NAME AT0072AA(R)                                                   JCL 2170
                                                                         JCL 2180
NOTE PROGRAM AT0072AA IS PLACED IN LOAD LIBRARY CAP.LDLIBTW.             JCL 2190
TO RUN PUT /* IN COLUMNS 1 AND 2 OF THE PREVIOUS CARD.                  JCL 2200
```

```
      SUBROUTINE REDATA                                                 CF4  0010
C                                                                       CF4  0020
C ---    SUBROUTINE TO READ DATA. CAN BE REVISED TO SUIT SPECIAL NEEDS. CF4  0030
C                                                                       CF4  0040
C ---    CONTROL CARD SHOULD INDICATE THE NUMBER OF INDEPENDENT         CF4  0050
C     VARIABLES BEING RETURNED IN ARRAY LABELLED DATA(106).             CF4  0060
C     IDENTIFICATION CAN BE RETURNED USING A6 FORMAT IN IDENT.          CF4  0070
C ---    NUMBER OF OBSERVATIONS (NOOBSV) ARE COUNTED IN CF2.            CF4  0080
C     THE OBSERVATION NUMBER CAN BE RETURNED USING I4 FORMAT IN IOBSV.  CF4  0090
C     THE SEQUENCE NUMBER CAN BE RETURNED USING I2 FORMAT IN ISEQ IF    CF4  0100
C     DESIRED.                                                          CF4  0110
C ---    DATA CAN BE READ FROM NFILE SPECIFIED IN COLUMNS 52-53 OF      CF4  0120
C --- CONTROL CARD.                                                     CF4  0130
C ---    ARRAYS THAT CAN BE USED IN REDATA TO SAVE COMPUTER CORE SPACE  CF4  0140
C     ARE COM4, LSORT AND IDZB, E.G.                                    CF4  0150
C     EQUIVALENCE (COM4,NEWARY)  WHERE NEWARY IS USED IN REDATA.        CF4  0160
C ---    KSL2 CAN BE USED AS A SWITCH.  KSL2 IS SET = 1 IN MAIN AFTER   CF4  0170
C     CONTROL CARD IS READ.  IF KSL2 IS SET = 2 IN REDATA AFTER READING CF4  0180
C     FIRST OBSERVATION, SUBSEQUENT OBSERVATIONS CAN BE READ IN         CF4  0190
C     DIFFERENT MANNER USING KSL2 AS A SWITCH.                          CF4  0200
C                                                                       CF4  0210
      IMPLICIT REAL*8(A-H,O-Z)                                          CF4  0220
      DOUBLE PRECISION IDENT, IEND                                      CF4  0230
      DIMENSION AVATR( 65), DATA( 66), FMT(144), IOMIT( 65), ITLOC( 65) CF4  0240
      COMMON /AAAAAA/ COM1(1000)                                        CF4  0250
      COMMON /BBBBBB/ COM2(186)                                         CF4  0260
      COMMON /CCCCCC/ COM3(240)                                         CF4  0270
      COMMON /DDDDDD/ COM4(3500)                                        CF4  0280
      COMMON /EEEEEE/ LSORT(1000)                                       CF4  0290
      COMMON /FFFFFF/ VARTR( 65), ITRFM( 65)                            CF4  0300
      COMMON /GGGGGG/ BI(65), EQU(144)                                  CF4  0310
      COMMON /HHHHHH/ BETA(41), C(40,40), Z(41,41), NNNN, MXSIZE        CF4  0320
      COMMON /JJJJJJ/ IDZB(1000)                                        CF4  0330
      COMMON /KKKKKK/ IQ(40), PR1, PR2, PR3, K, KFM, NODEP, NOIND,      CF4  0340
     1                NOOBSV, ICURY                                    CF4  0350
C                                                                       CF4  0360
      COMMON /MMMMMM/ IDENT, IEND, BZRO, IOBSV, ISEQ, JOBSV, KSL2,      CF4  0370
     1                NOERR, NVP1, NOEQ                                CF4  0380
      COMMON /OOOOOO/ KNODEP, KNOIND, KNOVAR, KNVP1, L, NOVAR           CF4  0390
      COMMON /QQQQQQ/ KTIN, KTOU, KTPCH, KKK, KONE, KTWO, MNO, NFILE    CF4  0400
      COMMON /RRRRRR/KTBIN1, KTBIN2, KTBIN3, KTBIN4, KTBIN5             CF4  0410
C ---          EQUIVALENCE STATEMENTS IN CF 4 ARE THE SAME AS IN CF 1   CF4  0420
      EQUIVALENCE (COM1(1),AVATR(1)), (COM1(106),ITLOC(1)),             CF4  0430
     1            (COM1(321),IOMIT(1))                                 CF4  0440
      EQUIVALENCE (COM2(1),DATA(1))                                     CF4  0450
      EQUIVALENCE (COM3(1),FMT(1))                                      CF4  0460
C     READ(NFILE,FMT,END=99) IDENT,IOBSV,ISEQ,(DATA(JZ), JZ=1,40)       CF4  0470
      IF(IDENT - IEND ) 4,99,4                                          CF4  0480
    4 IA = IA                                                           CF4  0490
      RETURN                                                            CF4  0500
   99 IDENT = IEND                                                      CF4  0501
      RETURN                                                            CF4  0502
      END                                                               CF4  0510
```

```
//* THE FOLLOWING JCL ASSUMES THAT SOME OF THE FILES ON THE SHARE TAPE  JCL 3010
//* HAVE BEEN STORED AS FOLLOWS: FILE 2 = LINFTN, 4 = LINRPL,           JCL 3020
//*                                    5 = LINR10 AND 7 = LINR80.       JCL 3030
//*                                                                     JCL 3040
//*  JCL TO COMPILE REPLACEMENT PROGRAM, LINK AND GO REPLACEMENT CARDS  JCL 3050
//* TO INCREASE DIMENSIONS OF PROGRAM.                                  JCL 3060
//*  (TO REDUCE DEMINSIONS, CHANGE LINR80 TO LINR10 AND LINWOOD8 TO     JCL 3070
//* LINWOOD1).                                                         JCL 3080
//*  SUBSTITUTE YOUR COMPUTER CENTER'S COMPILER NAME FOR FTNG1CLG.      JCL 3090
//*  FILE 30 PRINTS OR SHOWS SUMMARY STATISTICS ON USERS TERMINAL-SCOPE JCL 3091
//COPY EXEC PGM=IEBGENER,REGION=64K                                     JCL 3100
//SYSIN DD DUMMY                                                       JCL 3110
//SYSPRINT DD SYSOUT=A                                                 JCL 3120
//SYSUT1 DD DISP=(OLD,KEEP),DSN=CSP.SORCELIB.YURFILE(LINR80)           JCL 3130
//SYSUT2 DD DISP=(NEW,PASS),DSN=&&TEMP,UNIT=SYSDA,SPACE=(80,300,RLSE), JCL 3140
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000)                                JCL 3150
// EXEC FTNG1CLG                                                       JCL 3160
//COMP.SYSIN DD DISP=SHR,DSN=CSP.SORCELIB.YURFILE(LINRPL),DCB=OPTCD=W  JCL 3170
//GO.FT06F001 DD SYSOUT=A                                             JCL 3180
//GO.FT07F001 DD DISP=(NEW,PASS),DSN=&&TEMP2,UNIT=SYSDA,              JCL 3190
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000),SPACE=(80,5000,RLSE)           JCL 3200
//GO.FT08F001 DD DISP=SHR,DSN=CSP.SORCELIB.YURFILE(LINFTN),           JCL 3210
// DCB=OPTCD=W,LABEL=(,,,IN)                                          JCL 3220
//GO.FT30F001 DD SYSOUT=A,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=6118)      JCL 3221
//GO.FT05F001 DD DISP=(OLD,DELETE),DSN=&&TEMP                         JCL 3230
//COPZ EXEC PGM=IEBGENER,REGION=64K                                   JCL 3240
//SYSIN DD DUMMY                                                      JCL 3250
//SYSPRINT DD SYSOUT=A                                                JCL 3260
//SYSUT1      DD DISP=(OLD,DELETE),DSN=&&TEMP2                        JCL 3270
//SYSUT2 DD DISP=(OLD,KEEP),DSN=CSP.SORCELIB.YURFILE(LINWOOD8)        JCL 3280
TO RUN PUT /* IN COLUMNS 1 AND 2 ON JCL                               JCL 3290
```

```
//* EXAMPLE OF DOS JCL TO COMPILE LINWOOD, LINK AND PLACE IN LIBRARY.  JCL 4010
// JOBNAME LINWOOD CATAL TO C/I/L                                      JCL 4020
// OPTION CATAL                                                        JCL 4030
 PHASE JOBNAME,*                                                      JCL 4040
// EXEC FFORTRAN                                                       JCL 4050
      FORTRAN DECK GOES BEFORE THIS CARD                             JCL 4060
TO RUN PUT /* IN COLUMNS 1 AND 2 OF THE PREVIOUS CARD.               JCL 4070
 INCLUDE ILFGHTAB                                                     JCL 4080
// EXEC LNKEDT                                                         JCL 4090
                                                                      JCL 4100
TO RUN PUT /* IN COLUMNS 1 AND 2 OF THE PREVIOUS CARD.               JCL 4110
```

```
//* EXAMPLE OF DOS JCL TO RUN LINWOOD PROGRAM.                        JCL 5010
// JOB JOBNAME  LINWOOD                                               JCL 5020
// PAUSE  MOUNT 4 SCRATCH TAPES ON 280,281,282, & 283                 JCL 5030
// ASSGN SYS001,X'280'                                                JCL 5040
// ASSGN SYS002,X'281'                                                JCL 5050
// ASSGN SYS003,X'282'                                                JCL 5060
// ASSGN SYS004,X'283'                                                JCL 5070
// EXEC JOBNAME                                                       JCL 5080
            CONTROL AND DATA CARDS GO BEFORE THIS CARD                JCL 5090
TO RUN PUT /* IN COLUMNS 1 AND 2 OF THE PREVIOUS CARD.                JCL 5100
```

```
//* JCL TO LIST FILES FROM NONLABLED SHARE TAPE CALLED "SHARE1", LINWOOD PGM.
//* JCL TO LIST FILE 1, DOCUMENTATION OF TAPE FILES.
//COPY EXEC PGM=IEBGENER,REGION=64K
//SYSUDUMP DD SYSOUT=A
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(1,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 2, FORTRAN SOURCE DECK OF LINWOOD.
//COP2 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(2,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 3, CARDS OF SAMPLE TEST PROBLEMS.
//COP3 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(3,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 4, FORTRAN SOURCE DECK OF REPLACEMENT PROGRAM.
//COP4 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(4,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 5, FORTRAN REPLACEMENT CARDS TO REDUCE SIZE OF LINWOOD.
//COP5 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(5,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 6, FORTRAN REPLACEMENT CARDS TO INCREASE SIZE OF LINWOOD.
//COP6 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(6,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 7, EXAMPLES OF JOB CONTROL LANGUAGE CARDS.
//COP7 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(7,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 8, FORTRAN REPLACEMENT CARDS FOR 30 VARIABLE SEARCH PROGRAM
//COP8 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(8,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 9, FORTRAN REPLACEMENT CARDS FOR 40 VARIABLE SEARCH PROGRAM
//COP9 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(9,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 10, FORTRAN REPLACEMENT CARDS FOR 50 VARIABLE SEARCH PGM.
//COP10 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(10,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 11, FORTRAN REPLACEMENT CARDS FOR 60 VARIABLE SEARCH PGM.
//COP11 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(11,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 12, FORTRAN REPLACEMENT CARDS FOR 70 VARIABLE SEARCH PGM.
//COP12 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(12,NL,,IN),
//   VOL=SER=SHARE1,
//   DCB=(RECFM=FB,LRECL=80,BLKSIZE=4000,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 13, PRINTOUT OF TEST PROBLEMS.
//COP13 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(13,NL,,IN),
//   VOL=SER=SHARE1,
//      DCB=(RECFM=FBA,LRECL=133,BLKSIZE=3059,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
//* JCL TO LIST FILE 14, PRINTOUT OF TERMINAL-SCOPE FILE.
//COP14 EXEC PGM=IEBGENER,REGION=64K
//SYSIN DD DUMMY
//SYSPRINT DD SYSOUT=A
//SYSUT1 DD DSN=CSD.SHARE,UNIT=T9,LABEL=(14,NL,,IN),
//   VOL=SER=SHARE1,
//      DCB=(RECFM=FBA,LRECL=133,BLKSIZE=3059,DEN=4),DISP=(OLD,KEEP)
//SYSUT2 DD SYSOUT=A
```

Machine Requirements

FORTRAN Compiler

Card Reader (file 5, set in Subroutine BASPGM, card CF1 0900)

5 Scratch Files (files 1, 2, 3, 4 and 8 set in BASPGM, cards CF1 0820, 0840, 0860, 0880, and 0940)

Printer (file 6, set in BASPGM, card CF1 0920)

Scope-Terminal (optional, file 30, set in BASPGM, card CF1 0942)

Dimensions for Loading Various Versions of Program

		FORTRAN IV H Compiler
10 Variables, 200 Observations		164K
40 Variables, 1000 Observations		270K
80 Variables, 1000 Observations, with 40 Variable Cp Search		414K
Effect of Various Options:		
With Overlay	Subtract	73K
With Scope-Terminal File	Add	3K
With VS FORTRAN Compiler	Add	167K
With Vs FORTRAN Compiler and Scope-Terminal File	Add	172K
With 50 Variable Cp Search	Add	100K
With 60 Variable Cp Search	Add	240K

Time Required for Cp Searches, 3033 IBM Computers

Variables Searched	Number of Searches	CPU Run Time
18	262,144	0.3 Seconds
25	34 Million	3.1 Seconds
46	70 Trillion	25 Seconds
55	36 Thousand Trillion	8 Minutes