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UCRL-51742

REDUCED, A DATA REDUCTION CODE

Neil Maron

MASTER

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LAWRENCE LIVERMORE LABORATORY
University of California, Livermore, California, 94550

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MS. date: January 22, 1975

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REDUCED, A DATA REDUCTION CODE

Abstract

REDUCED, a Fortran program currently running on a Lawrence Livermore Laboratory (LLL) CDC 6600, provides a simple means of accumulating a large base of experimental data (up to 21 parameters for up to 500 experiments) and interactively making two-dimensional plots of any pair of functions of the parameters. For each experiment, each pair of function values is displayed as a discrete point. Linear or quadratic least-squares fits to the array of these points can be drawn. Results can be displayed on a variety of output media including printer/plotters, COM and CRT devices. User inputs required include a data base of parameter values; specification of functions to be performed; specification of symbols to appear on the actual plots; and necessary control cards. This report includes a description of REDUCED, instructions on how to use it, and a source listing of the complete code.

Introduction

A typical experiment in, for example, plasma physics would produce values of many raw parameters such as density, temperature, magnetic field, etc. for many runs. Physical effects would be identified by correlating dimensionless functions of these raw parameters, such as the ratio of plasma pressure to magnetic pressure, ion-to-electron temperature ratios, etc. The REDUCED program provides a simple means of accumulating a large base of experimental data (≤ 21 parameters for ≤ 500 experiments) and then interactively making two-dimensional plots of any pair of functions of the parameters. For each experiment, each pair of function values can be displayed as a discrete point. The user can then request REDUCED to draw linear or quadratic least-squares fits to the array of these points.¹

In addition to providing a quick and effective way of examining experimental results, REDUCED also can interact with the LLL SKOPE program, thus permitting observation of results on a CRT. The connection routine to SKOPE is via the LLL Fortran subroutine TVOUT.

The user must supply four types of input in order to use REDUCED. These are:

1. A card-format data base of the parameter values to be used,
2. A simple Fortran program (prepared by the user) defining all his desired functions. This allows the user to group data as required for his needs.

1. T. C. Varljen, General Linear Least Squares, Lawrence Livermore Laboratory, LLL Report E2,2-005 (1967).

3. A simple Fortran program defining the symbols to be used on the plots of the parameters. This program allows the selection of several different types of plot symbols in order to identify such things as various groupings of runs, etc.
4. A file of control cards for running the program. This report describes the use of control cards for the LLL ORDER system.

This report provides a description of the Lawrence Livermore Laboratory's implementation of REDUCED, gives an explanation of its use that includes step-by-step examples, and supplies as an appendix the program's complete source listing.

Features of REDUCED

REDUCED provides the user with the ability to employ arbitrary functional forms of the raw parameters $\{p_i\}$ for both the abscissa variable $X = X(\{p_i\})$, and the ordinate variable $Y = Y(\{p_i\})$. Four types of fits are available: log-linear, linear-log, log-log and linear-linear. The user may then plot the results on any one or more of 12 grid types. The user also has the ability to specify a plotting symbol as a function of one or more of the parameters. Linear and quadratic fits of the X-Y pairs are provided automatically. Up to four constants in functions (e.g., $X = (\log(P(2)))^{C(1)}$ where C(1) is the first constant) are available to be varied at run time. Finally, the resulting graphs which appear in dd80 files may be viewed on the LLL CDC 6600 "G"-machine CRT scopes during the run.

Run Requirements

The following are required in order to perform a complete run using REDUCED:

1. The REDUCED program file itself. In the LLL system described in this report the binary disk file is called REDUB.
2. The data base file of input parameter values (called BASE2) in the present system). See below under the heading Data Base Structure.
3. A Fortran program defining the function to be used (designated as subroutine F of the disk file FNCS in the present system). See below under the heading Fortran Routines.
4. A Fortran program defining the plotting symbols to be used (designated as subroutine S of the disk file FNCS in the present system). See below under the heading Fortran Routines.
5. A disk file (designated RDC in the present system) containing control cards for the LLL ORDER system. See below under the heading ORDER Control Deck.

Thus, to actually run the code the following files must be on disk: (1) REDUB, (2) RDC, (3) BASE2, (4) FNCS. The user then types the following on line on the LLL system: ORDER RDC / t v. The following is a sample of what will result:

```
#ID      452MMH      9.34 //001      07/09 14,398G REDUCED      BOX U05
COMPILE
LOADING
CODE BLOC      REDUCED WRITTEN
CODE BLOC      REDUCED WRITTEN
FILE SIZE=      0106521
FLD LGTH=      0106121      0106121
EXECUTION
```

For an example of how the user interacts with code see the heading Sample Run.

Data Base Structure

The core storage, as programmed in REDUCED, allows for 500 sets of 21 parameters. The data base disk file, BASE2, must have the following card format:

Columns 1-5: the experimental run number, right justified, value: 1-500
 Columns 6-10: the card number of the run, right justified, value 1-3
 Columns 11-80: 7 F10,0 floating point entries of parameter values.

The cards need not be in order of run because the program sorts on the information in columns 1 to 5 and 6 to 10 to determine this order. Card 1 of each run contains parameters 1 to 7, card 2 of each run contains parameters 8 to 14, etc. All parameters need not be given at once or even on a single set of three cards per run. The last card of the data file must always have a -1 in columns 4 and 5 (using an 11 punch in column 4 for the minus). If it is desired to correlate the run number with the parameter of a run one of the parameters must be the floating point run number. The subroutines F and S can then sort on the run number and group the output accordingly.

Certain parameters will be measured in some runs but not in others. For the runs in which a parameter is not measured enter a 0, but do NOT leave the entry blank. Only leave blanks for entries that are never used. Thus, if only ten parameters are measured, columns 11 through 14 of the second card can be left blank and the third card can be omitted. Table 1 is a sample listing of a data base file made up of 2 cards per run, 5 runs, and 8 parameters per run.

Table 1. Sample data base.

Run No.	Card No.	Entries 1 through 7						
1	1	1.	2.7	3.	0.02	1.	0.	4.
1	2	101.1						
2	1	2.	2.4	0.	0.11	2.	56.	5.
2	2	102.4						
3	1	3.	2.6	2.8	0.15	1.	54.	4.
3	2	102.0						
4	1	4.	2.6	2.7	0.17	2.	50.	4.
4	2	101.7						
5	1	5.	2.5	2.5	0.19	1.	55.	4.
5	2	101.1						
-1								

Fortran Subroutines

SUBROUTINE F

Subroutine F contains all the parameter functions for X and Y. The user can specify a maximum of 99 functions. Note the following example of how F is structured:

```

SUBROUTINE F(I, P, IER, VAL, C)
  DIMENSION P(21), C(4)
  C THIS ROUTINE DEFINES THE FUNCTIONS TO BE PLOTTED
  C I IS THE FUNCTION NUMBER TO BE REFERENCED
  C P IS THE PARAMETER LIST FROM ONE EXPERIMENT
  C IER IS A FLAG TO INDICATE TO THE CALLING PROGRAM WHETHER OR NOT
  C   TO USE THE VALUE RETURN
  C   =0 MEANS USE VAL ON GRAPH
  C   =1 MEANS DONT USE VAL(FOR REASONS SPECIFIED BY THE USER)
  C VAL IS THE VALUE RETURNED
  C C IS THE ARRAY OF FOUR CONSTANTS
  IER=0
  J=1
  IF(J, GT, 10) GO TO FIX1
  GO TO (1, 2, 3, 4, 5, 6, 7, 8, 9, 10), J
FIX1 J=J-10
  IF(J, GT, 10) GO TO FIX2
  GO TO (11, 12, 13, 14, 15, 16, 17, 18, 19, 20), J
FIX2 J=J-10
  etc,

```


If the value of a parameter is 0, it is assumed to be a blank entry and is not used, so this condition must be checked for. Note the following:

```

1 IF(P(2) EQ, 0.) GO TO ERR
  VAL=P(2)
  RETURN
2 IF(P(3), EQ, 0., OR, P(4), EQ, 0.) GO TO ERR
  VAL=P(3)/P(4)
  RETURN
etc.
```

C THIS SHOWS THE USE OF THE C ARRAY, CHECKING FOR C BEING SOME VALUE
C IS OPTIONAL

```

10 IF(P(2), EQ, 0., OR, P(5), EQ, 0., OR, C(1), GT, 10.) GO TO ERR
  VAL = (P(2)/C(1))*4. P(5)
  RETURN
etc.
ERR IER=1
  RETURN
END
```

Intermediate values can be checked to give a 'don't use' return also. Note the following:

```

15 IF(P(2), EQ, 0., OR, P(3), EQ, 0.) GO TO ERR
  TEMP=P(2)/P(3)
  IF(TEMP, GE, 1.) GO TO ERR
  VAL=(-LOG(TEMP))*2
  RETURN
```

At run time the user will be asked for the function numbers corresponding to X and Y. These numbers are the values of "I" and "J" when interacting with the program.

SUBROUTINE S

Subroutine S contains the parameter functions for determining the symbols used in the actual plots. The structure of S is shown in the following example:

```

SUBROUTINE S(I, P, IER, SYM)
  DIMENSION P(1)
```

```

C THIS ROUTINE DEFINES SYMBOLS THAT WILL APPEAR ON THE PLOT
C I IS THE FUNCTION NUMBER
C P IS THE PARAMETER LIST FROM ONE EXPERIMENT
C IER IS A FLAG TO INDICATE TO THE CALLING PROGRAM WHETHER OR NOT TO
C   USE THIS RUN FOR FITTING AND PLOTTING
C   =0 MEANS USE RUN AND PLOT SYMBOL RETURNED
C   =1 DONT USE RUN
C SYM IS SYMBOL RETURNED
```

```

IER=0
J=I
IF(J.GT.10) GO TO FIX1
GO TO (1,2,3,...etc.)

```

From this point, follows the same pattern as subroutine F.

```

1 IF(P(2).EQ.0.) GO TO ERR
SYM=1H-
IF(P(2).LT.10.) SYM=1H*
IF(P(2).GE.10..AND.P(2).LT.20.) SYM=1H+
C WHEN THE PLOT IS MADE, THE ABOVE YIELDS THE SYMBOL * FOR P2 LESS
C THAN 10, THE SYMBOL + FOR P2 BETWEEN 10 AND 20
C AND THE SYMBOL - FOR P2 GREATER THAN 20
RETURN
etc.

ERR IER=1
RETURN
END

```

When it is desired to use only a single plot symbol (e.g. a *) a simplified program can be used, as in the following example:

```

SUBROUTINE S(I, P, IER, SYM)
DIMENSION P(1)
IER=0
SYM=1H*
RETURN
END

```

ORDER Control Deck

To increase ease of running, the following control deck for ORDER, the LLL special batch processor,² must be supplied in the order given. This is the disk file RDC (five cards).

Col. 1	Col. 7	Col. 25	Col. 49	Col. 66
*ID	ACCOUNT	REDUCED	YOURNAME	BOX NUM
*LOD	REDUB\$			
*CONTROLLEE	0 REDUCED			
*FORTRAN	FNCS+, , M, M			
*XEQ				

2. R. Potter, The ORDER System, Lawrence Livermore Laboratory, Rept. LTSS-202 (1972).

ACCOUNT is the LLL user's account number, NUM is the user's LLL box number.

Example of a Program Run

The following is an actual example of a run using REDUCED. Included here is the entire teletype output and two typical pages of the resultant 21 frames of dd80 output. See Figs. 1 and 2. In the example, the user's response is underlined. The comments on the right have been added to aid in reading the example.

The machine response HOW MANY BRACKETS? is asking for how many subsets of the data are to be used. If all the data are to be used for fitting, then 01 is the response. If runs 1 to 13 and run 17 are to be used, then the response is 02, etc. A single run isolated from others constitutes 1 subset or bracket.

BOX AND ID

Box and id for use in labeling plots

BOX U12 J, FOOTE REDUCE

INPUT I, J WHERE X=F(I, P), Y=F(J, P) (212)

Fortran formats for input values are in parentheses at or near end of lines. These are input values of P in subroutine F.

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18=I, 16=J

INPUT K WHERE PLOTSYM=S(K, P), (12)

These are the values of P in subroutine S.

01

INPUT CONSTANTS (UP TO 4) COMMA DELIMITED

These are values of C in subroutine F.

,

Must end with a comma. In this case, none are specified.

HOW MANY BRACKETS? (12)

This feature allows one to fit sections of data and exclude others.

02

INPUT BRACKET LIMITS, 3 PAIRS/LINE (613), FOLLOWING OK

OK FOR 1 TO 2

001162200233

196 VALID POINTS, PLOT? Y OR N

Program now processes data sets 1-162 and 200-233. This response tells how many valid data points were found to be fit.

Y

INPUT TITLE, 72 CHARS MAX

K-PERPENDICULAR VS GYRORADIUS (ALL BBI AND BBI DATA)

Title for plot (see Fig. 1).

INPUT X-LABEL, 40 CHARS MAX

GYRORADIUS (CM)

INPUT Y-LABEL, 40 CHARS MAX

Fig. 1. Typical plotted output of data processed by REDUCED.

IK-PERPENDICULAR VS GYRORADIUS (ALL BB1 AND BB11 DATA)

15:56: G 04/

XLOG YLOG FIT 1

COEFFICIENTS

ESTIMATED STD DEV

C1 11 1.2802591280E-01
C1 21 -6.9187811486E-013.3570331242E-02
4.0419927006E-02

EST STD DEV IN FIT = 4.0897325220E-01

RAW RMS ERROR = 4.0688130369E-01

DETERMINANT = -1.4135353465E+02

INDEPENDENT VARIABLE GYRORADIUS (CM)	DEPENDENT VARIABLE K-PERPENDICULAR (CM)	WEIGHTS	CALCULATED Y
5.1180933259E-01	2.6012722964E+00	1.0000000000E+00	1.8066025426E+00
4.0280498913E-01	2.9010025898E+00	1.0000000000E+00	2.1321962723E+00
2.8998791321E-01	2.9424859436E+00	1.0000000000E+00	2.6768911278E+00
2.4885479200E-01	3.4223196773E+00	1.0000000000E+00	2.9753131705E+00
4.3930301046E-01	2.8372959429E+00	1.0000000000E+00	2.0080040324E+00
3.4574095433E-01	3.0552617601E+00	1.0000000000E+00	2.3689952804E+00
6.1180933259E-01	2.2498051650E+00	1.0000000000E+00	1.5946366230E+00
3.4723244465E-01	2.4466153393E+00	1.0000000000E+00	2.3628155775E+00
4.8242923660E-01	2.1526631217E+00	1.0000000000E+00	1.8820289380E+00
5.1180933259E-01	2.6364761354E+00	1.0000000000E+00	1.8066025426E+00
5.1180933259E-01	2.4079818163E+00	1.0000000000E+00	1.8066025426E+00
6.0136987084E-01	1.8318848705E+00	1.0000000000E+00	1.6159758691E+00
6.0136987084E-01	1.6759793381E+00	1.0000000000E+00	1.6159758691E+00
5.1180933259E-01	2.5876875812E+00	1.0000000000E+00	1.8066025426E+00
4.0280498913E-01	2.3024219241E+00	1.0000000000E+00	2.1321962723E+00
3.1263730889E-01	2.3942325511E+00	1.0000000000E+00	2.5408039886E+00
5.1180933259E-01	2.2505868867E+00	1.0000000000E+00	1.8066025426E+00
5.1180933259E-01	2.7553248021E+00	1.0000000000E+00	1.8066025426E+00
4.0280498913E-01	2.6855213989E+00	1.0000000000E+00	2.1321962723E+00
4.0280498913E-01	2.0182044329E+00	1.0000000000E+00	2.1321962723E+00
4.0280498913E-01	2.4163015745E+00	1.0000000000E+00	2.1321962723E+00
3.1263730889E-01	2.2360587235E+00	1.0000000000E+00	2.5408039886E+00
5.1180933259E-01	3.0716628888E+00	1.0000000000E+00	1.8066025426E+00
4.0280498913E-01	3.1314683571E+00	1.0000000000E+00	2.1321962723E+00
3.1263730889E-01	2.9738454717E+00	1.0000000000E+00	2.5408039886E+00
4.0280498913E-01	3.2915580771E+00	1.0000000000E+00	2.1321962723E+00
5.1180933259E-01	2.1158820400E+00	1.0000000000E+00	1.8066025426E+00
6.0136987084E-01	1.5815385732E+00	1.0000000000E+00	1.6159758691E+00
5.1180933259E-01	2.5119730013E+00	1.0000000000E+00	1.8066025426E+00
5.1180933259E-01	2.8738595444E+00	1.0000000000E+00	1.8066025426E+00
6.7344137326E-01	1.9148437218E+00	1.0000000000E+00	1.4941581302E+00
1.4662607792E-01	1.0282385738E+00	1.0000000000E+00	8.9436655445E-01
1.0555650467E+00	9.8069647880E-01	1.0000000000E+00	1.0948295134E+00
5.1180933259E-01	2.6867207912E+00	1.0000000000E+00	1.8066025426E+00
7.4641134462E-01	1.2266912697E+00	1.0000000000E+00	1.3915042445E+00
6.0461178043E-01	2.0443702624E+00	1.0000000000E+00	1.6096768242E+00
5.2716056987E-01	1.1466061627E+00	1.0000000000E+00	1.2950410128E+00
7.6580188133E-01	1.2775223091E+00	1.0000000000E+00	1.3670306570E+00
7.2380769948E-01	7.6382520114E-01	1.0000000000E+00	1.4214270772E+00
7.2380769948E-01	7.6248867308E-01	1.0000000000E+00	1.4214270772E+00
6.0461178043E-01	1.6326504977E+00	1.0000000000E+00	1.6098162624E+00
6.0461178043E-01	1.1155652979E+00	1.0000000000E+00	1.6098162624E+00
4.0280498913E-01	1.9473120195E+00	1.0000000000E+00	2.1321962723E+00
4.0280498913E-01	2.3494968260E+00	1.0000000000E+00	2.1321962723E+00
3.4531919441E-01	2.2619069375E+00	1.0000000000E+00	2.3718975464E+00
5.1180933259E-01	1.6273898688E+00	1.0000000000E+00	1.8066025426E+00
5.1180933259E-01	1.7821865099E+00	1.0000000000E+00	1.8066025426E+00

Fig. 2. Example of tabulated output data processed by REDUCED.

K-PERPENDICULAR (/CM)

DO YOU WANT HELP FOR FIT TYPES? Y OR N

Y

1 XLIN YLIN FIT

2 XLIN YLOG FIT

3XLOG YLIN FIT

4 XLOG YLOG FIT

INPUT FIT TYPE (I1)

4

HOW MANY DIFFERENT PLOT GRIDS? (1 TO 12) (I2)

01

DO YOU WANT HELP FOR GRID TYPES? Y OR N

Y

NO GRID FULL GRID PARTIAL GRID

X Y X Y X Y

1 LIN LIN 5 LIN LIN 9 LIN LIN

2 LOG LOG 6 LOG LOG 10 LOG LOG

3 LIN LOG 7 LIN LOG 11 LIN LOG

4 LOG LIN 8 LOG LIN 12 LOG LIN

INPUT GRID TYPE (1) (I2)

06

DO YOU WANT TO VIEW ON SKOPE? Y OR N

Y

MONITOR NO. ?

.100

TYPE DD80 FILENAME

.BBIIX

CAN'T OPEN FILE

TYPE DD80 FILENAME

.BBIY

.S4

.S2

.

.END

SKOPE DONE

INPUT

1 NEW F(X), F(Y)

2 NEW FIT TYPE

3 NEW CONSTANTS ONLY

4 NEW CONSTANTS, BRACKETS ETC

5 MORE PLOT GRIDS

6 END

This allows user to view results at run time.

Error because this is not the filename while REDUCED is running.

This is the correct response.

REDUCED now asks if user wants to continue or end.

1

User specifies option 1
(i.e., use different functions
for X and Y axes).

INPUT I, J WHERE $X=F(I, P)$, $Y=F(J, P)$ (212)

1617

INPUT K WHERE PLOTSYM=S(K, P), (I2)

01

INPUT CONSTANTS (UP TO 4) COMMA DELIMITED

1.7, 3E7,

HOW MANY BRACKETS? (I2)

02

INPUT BRACKET LIMITS, 3 PAIRS/LINE (613), FOLLOWING OK

OK FOR 1 to 2

00.162200233

196 VALID POINTS, PLOT? Y OR N

Y

INPUT TITLE, 72 CHARS MAX

K-PARALLEL VS K-PERPENDICULAR (ALL BBI AND BBII DATA)

INPUT X-LABEL, 40 CHARS MAX

K-PERPENDICULAR (/CM)

INPUT Y-LABEL, 40 CHARS MAX

K-PARALLEL (/CM)

DO YOU WANT HELP FOR FIT TYPES? Y OR N

N

INPUT FIT TYPE (I1)

4

HOW MANY DIFFERENT PLOT GRIDS (1 TO 12) (I2)

01

DO YOU WANT HELP FOR GRID TYPES? Y OR N

N

INPUT GRID TYPE (1) (I2)

06

DO YOU WANT TO VIEW ON SKOPE? Y OR N

N

INPUT

1 NEW F(X), F(Y)

2 NEW FIT TYPE

3 NEW CONSTANTS ONLY

4 NEW CONSTANTS, BRACKETS ETC

5 MORE PLOT GRIDS

6 END

6

ALL DONE

When finished running, two files resulting from this run will be present in the user's private files. These are: BBIIX (the dd80 plot file) and TAPE3 (the HSP file containing the same numbers as those on the dd80 file). To get microfiche and hard-copy of the BBIIX file on the LLL system, execute:

FROG BBIIX DD80. / 2 .2

After this, BBIIX will be gone from the disk. To get hardcopy of TAPE3 execute:

ALLOUT HSP TAPE3 BOX LNN YOURID / 1 .1

LNN is the user's LLL box number and YOURID is 20 characters of user identification information that will appear on the file.

Viewing Results With SKOPE

To view the resulting files on a CRT scope, REDUCED uses the utility routine SKOPE.³ If the user replies YES to the program query: DO YOU WANT TO VIEW ON SKOPE?, then connection is made to the SKOPE routine. To get back to running REDUCED, type CONT (linefeed) on the teletype. The next time that SKOPE is running, the word CONT is types back to the user as a prompt. The only two features of SKOPE that can't be used are its GO and GIVE options. Be sure to be familiar with the SKOPE routine before attempting to use this feature of REDUCED.

Additional Information

For those interested in using REDUCED for their applications, a source version of REDUCED or the corresponding binary version (i.e. REDUB) may be obtained from the author. Those interested in applications or simply in obtaining additional information on this program, can contact the author at the following address:

Neil Maron
M-Division
Lawrence Livermore Laboratory
Mail Stop L-382
P. O. Box 808
Livermore, California 94550

³. B. Thornquist, D. Fuss, B. Howard, N. Maron, SKOPE, Lawrence Livermore Laboratory, Rept. UR-422, Revision 1 (1974).

Acknowledgments

The author would like to thank B. McNamera for suggesting the preparation of this report which will hopefully be a useful aid to the experimentalists of the LLL M-Division and to others. Also, many thanks to J. Foote for his use of this package in its developmental stages as well as his suggestions for specific features.

Appendix

COMPLETE SOURCE LISTING OF REDUCED

```

PROGRAM REDUCED(TAPE59,TAPE100,TAPE3,TAPE5,BASE2=TAPE5)

C
C      PROGRAM:          REDUCED
C      PROGRAMMER:       NEIL MARON (FOR DRIVER OF GLS)
C      DATE THIS VERSION: 03DEC1974
C
C NVAR MUST BE A MULTIPLE OF 7
C NRUN SHOULD BE EQUAL TO THE PARAMETER NF
C
C NRUN  =TOTAL POSSIBLE RUNS ALLOWED IN DATA BASE
C NVAR  =MAXIMUM NUMBER OF VARIABLES PER RUN ALLOWED
      PARAMETER (NRUN=500,NVAR=21)
      DIMENSION CORE(NRUN,NVAR),BUF(7),KON(30),FC(2),MNBR(99),MXBR(99)
      DIMENSION X(NRUN),Y(NRUN),PRM(NVAR),XLAB(7),YLAB(7),CALCON(4)
      DIMENSION MS(14),MT(8),MU(23)
      COMMON/GOB/OM/ IB(4)
      COMMON/LABELS/TITLE(10),XT(15),YT(15)
      COMMON/ISYM/SYM(NRUN)
      COMMON/SKOPEON/ISONQ
C HELP MESSAGES TO BE ISSUED WITH SYSTEM CALLS
      DATA(MS(01))=50HINPUT--- 1 NEW F(X),F(Y)--- 2 NEW FIT TYPE--- 3 NE)
      DATA(MS(06))=50HWH CONSTANTS ONLY--- 4 NEW CONSTANTS,BRACKETS ETC---
      DATA(MS(11))=40H 5 MORE PLOT GRIDS--- 6 END---
      DATA(MT(01))=50H1 XLIN YLIN FIT---2 XLIN YLOG FIT---3 XLOG YLIN F)
      DATA(MT(06))=30HT---4 XLOG YLOG FIT---
      DATA(MU(01))=50H NO GRID FULL GRID PARTIAL GRID--- X Y )
      DATA(MU(06))=50H X Y X Y---1 LIN LIN 5 LIN LIN 9)
      DATA(MU(11))=50H LIN LIN---2 LOG LOG 6 LOG LOG 10 LOG LOG---
      DATA(MU(16))=50H---3 LIN LOG 7 LIN LOG 11 LIN LOG---4 LOG LIN )
      DATA(MU(21))=30H 8 LOG LIN 12 LOG LIN---
C OPEN DATA BASE
      CALL DEVICE(4HOPEN,5HBASE2,LEN,IER,IOC,LEV)
      IF(IER.EQ.0) GO TO 1
C INFORM THAT DATA BASE CANT BE OPENED
      WRITE(59,2)
      2 FORMAT(20H CANT OPEN DATA BASE)
      CALL EXIT
C READ IN DATA AND SORT INTO CORE
      1 DO 3 J1=1,NRUN
        DO 3 J2=1,NVAR
      3 CORE(J1,J2)=0.
      4 READ(5,6) NF,NC,(BUF(I),I=1,7)
      6 FORMAT(15,15,7F10.0)
      IF(NR.LT.1) GO TO 10
      I=NR
      IF(I.GT.NRUN) GO TO 8
      IF(NVAR/7 .LT. NC) GO TO B
      DO 7 IVAR=1,7
        J=7*(NC-I)+IVAR
        CORE(I,J)=BUF(IVAR)
      7 CONTINUE
      GO TO 4
C INFORM THAT EITHER THE RUN NUMBER OR THE NUMBER
C OF PARAMETERIS IS TOO LARGE
      8 WRITE(59,9)
      9 FORMAT(30H DATA BASE ENTRIES EXCEED CORE)
      CALL EXIT
      10 CALL DEVICE(5HCLOSE,5HBASE2,IER,IOC)
C ASK FOR BOX AND ID INFORMATION FOR PLOTS
      WRITE(59,5)

```

```

5 FORMAT(10HBOX AND ID)
  READ(59,120) (IB(J),J=36,38)
120 FORMAT(3A10)
  CALL CRTID(2HNM,1)
  CALL KEEP80(5RBB110)
  ICON=0
C
C **READ IN TELETYPE INPUT WITH PROMPT LINES**
C
35 WRITE(59,11)
11 FORMAT(40H INPUT I,J WHERE X=F(I,P),Y=F(J,P) (212))
  READ(59,12) IFX,IFY
12 FORMAT(212)
C// LOOP FOR SETTING UP X-S AND Y-S
  WRITE(59,13)
13 FORMAT(35H INPUT K WHERE PLOTSYM=S(K,P), (12))
  READ(59,12) ISYM
38 WRITE(59,36)
36 FORMAT(41HINPUT CONSTANTS (UP TO 4) COMMA DELIMITED)
  READ(59,37) (CALCON(J),J=1,4)
37 FORMAT(4F15.0)
  IVALID=0
  IF(ICON=1) ,44
  WRITE(59,40)
40 FORMAT(23HHOW MANY BRACKETS? (12))
  READ(59,76) NBRK
  NI=NBRK/3
  IF((NI*3).NE.NBRK) NI=NI+1
  WRITE(59,41)
41 FORMAT(53HINPUT BRACKET LIMITS, 3 PAIRS/LINE (613),FOLLOWING OK)
C
C SEARCH DATA AND SET UP X AND Y FOR FITTING
C
  DO 45 J1=1,NI
    J2=(J1-1)*3+1
    J3=J1*3
    IF(J3.GT.NBRK) J3=NBRK
    WRITE(59,42) J2,J3
42 FORMAT(7HOK FOR ,13,4H TO ,13)
    READ(59,43) (MNR(I),MXBR(I),I=J2,J3)
43 FORMAT(613)
45 CONTINUE
44 DO 13 J3=1,NBRK
  DO 20 J1=MNR(J3),MXBR(J3)
  DO 21 J2=1,NVAR
    PRM(J2)=CORE(J1,J2)
21 CONTINUE
  CALL F(IFX,PRM,IER,VAL,CALCON)
  IF(IER.EQ.1) GO TO 20
  X(IVALID)=VAL
  CALL F(IFY,PRM,IER,VAL,CALCON)
  IF(IER.EQ.1) GO TO 20
  Y(IVALID)=VAL
  CALL S(ISYM,PRM,IER,PSYM)
  IF(IER.EQ.1) GO TO 20
  SYM(IVALID)=PSYM
  IVALID=IVALID+1
20 CONTINUE
19 CONTINUE
C NOTIFY OF HOW MANY VALID POINTS FOR FITTING WERE FOUND

```

```

        WRITE(59,25) IVALID
25  FORMAT(16,27H VALID POINTS, PLOT? Y OR N)
    READ(59,26) IPL
26  FORMAT(A1)
    IF(IPL.NE.1HN) GO TO 50
30  WRITE(59,31)
31  FORMAT(35HTYPE END TO END, TYPE LF TO RESTART)
    READ(59,32) GO
32  FORMAT(A3)
C CHECK TO SEE IF SKOPE IS ON IF END IS DESIRED
    IF(GO.EQ.3HEND) GO TO 111
    GO TO 35
50  WRITE(59,69)
69  FORMAT(25H INPUT TITLE,72 CHARS MAX)
    READ(59,72) (TITLE(I),I=1,9)
    WRITE(59,70)
70  FORMAT(27H INPUT X-LABEL,40 CHARS MAX)
    READ(59,72) (XTI(I),I=1,5)
    WRITE(59,71)
71  FORMAT(27H INPUT Y-LABEL,40 CHARS MAX)
    READ(59,72) (YTI(I),I=1,5)
72  FORMAT(9AB)
C// SET UP KON ARRAY
    KON(1)=IVALID
    KON(5)=0
    KON(8)=0
C** TO ALLOW MORE COEFS MAKE CHANGES HERE. C1C E2.2-005 P7
    KON(2)=2
    KON(3)=3
    IF(IVALID.LT.3) KON(3)=2
C*** TO ALLOW MORE FUNCTIONS FOR FIT MAKE CHANGES HERE. C1C E2.2-005 P7
    KON(4)=1
    IF(1CON-1) ,105
103 WRITE(59,73)
73  FORMAT(39HDO YOU WANT HELP FOR FIT TYPES? Y OR N)
    READ(59,26) IPL
    IF(IPL.EQ.1HN) GO TO 65
    GOB(14008,1ER,10B,MT)
65  WRITE(59,68)
68  FORMAT(19HINPUT FIT TYPE (1))
    READ(59,74) KON(6)
74  FORMAT(11)
104 WRITE(59,75)
75  FORMAT(45HHOW MANY DIFFERENT PLOT GRIDS? (1 TO 12) (12))
    READ(59,76) KON(7)
76  FORMAT(12)
C** TO ALLOW MORE THAN ONE FIT FUNCTION THIS MUST BE CHANGED
    DO 78 J=9,18
    KON(J)=1
78  CONTINUE
    WRITE(59,79)
79  FORMAT(39HDO YOU WANT HELP FOR GRID TYPES? Y OR N)
    READ(59,26) IPL
    IF(IPL.EQ.1HN) GO TO 100
C THESE 2 SYSTEM CALLS SEND OUT PLOT GRID HELP PACKAGE.
C THIS IS FASTER THAN USING WRITE STATEMENTS.
    GOB(14008,1ER,17B,MU)
    GOB(14008,1ER,10B,MU(16))
100 DO 101 J=1,KON(7)
    WRITE(59,102) J

```

```

102 FORMAT(16HINPUT GRID TYPE(,12,6H) (12))
   READ(59,76) KON(J+18)
101 CONTINUE
C// SET UP FC ARRAY
105 FC(1)=0.
   FC(2)=0.
C DO ACTUAL FITTING, THIS IS WHERE THE GLS PACKAGE TAKES OVER.
   CALL MAFIT(KON,FC,X,Y)
   CALL PLOTEA
   ICON=0
   CALL TVOUT
C SEND OUT TERMINATION PACKAGE OF QUESTIONS.
   GOB(14008,IER,168,MS)
   READ(59,74) IPL
   GO TO (35,103,112,38,104,111) ,IPL
C IF SKOPE ROUTINE IS ON SHUT OFF.
111 IF(150NQ.NE.0) CALL TVOFF
   CALL EXIT
112 ICON=1
   GO TO 38
END

```



```

JRET IFL=-1
GO TO RET
C INFORM THAT SKOPE IS DONE AND RESET FLAG
FIN IB(1)=10H$KOPE DONE
  IB(2)=10H$--$
  GOB(1400B,1ER,2,IB)
  IFL=1
  GO TO RET
  ENTRY TVOFF
  IB(1)=6HEND$
  GOB(1500B,1ER,101B,IB)
  GOB(1700B,1ER,1700B,IB)
  ISONQ=0
  RETURN TVOFF
END

```



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C      FORTRAN          MAFIT      LEAST SQUARES INITIALIZATION AND CONTROL
C      SUBROUTINE MAFIT(KON,FC,X,Y)
C
C      MULTIPLEARGS YOFX, EDEV
C
C      7/14/71
C
C      MAFIT      SUBROUTINE TO INITIALIZE FITS AND PROVIDE OUTPUT
C                  T.C.VARLJEN 12/20/66
C                  MODIFIED 4/23/69 -- F.N.FRITSCH
C
C*****  INPUT SENTINEL ARRAYS KON AND FC
C
C  KON 1 = LX      NUMBER OF INPUT X-Y PAIRS
C      2 = MINCO   MINIMUM NUMBER OF COEFFICIENTS TO BE FOUND
C      3 = MAXCO   MAXIMUM NUMBER OF COEFFICIENTS TO BE FOUND
C      4 = NFIT = 0,1 FIT FUNCTION WILL BE STANDARD POLYNOMIAL
C                  OTHERWISE NFIT IS THE NUMBER OF DIFFERENT FORMS
C                  TO BE TRIED
C      5 = IWT = 0  RESIDUALS WEIGHTED BY UNITY
C                  = 1 RESIDUALS WEIGHTED BY INVERSE OF INPUT
C                  = -1 RESIDUALS WEIGHTED DIRECTLY BY INPUT
C      6   ILG = 1  XLIN YLIN FIT
C          = 2  XLIN YLOG FIT
C          = 3  XLOG YLIN FIT
C          = 4  XLOG YLOG FIT
C      7   NCRT = 0  STANDARD CRT GRID WILL BE USED TO PLOT RESULTS
C                  OTHERWISE NCRT IS NUMBER OF GRID TYPES TO BE USED
C      8   IBAND = 0 STD DEV OF FITTED CURVE WILL NOT BE PLOTTED
C                  = 1 STD DEVIATION BAND WILL BE PLOTTED ON FITTED CURVE
C      9 ...
C      18 ...      STARTING IN KON(9) UP TO TEN FIT TYPES MAY BE
C                  CALLED FOR
C      19 ...
C      30 ...      STARTING IN KON(19) UP TO 2 GRID TYPES MAY BE
C                  CALLED FOR
C
C      FC(1)      MINIMUM VALUE OF X ON GENERATED FIT CURVE
C      FC(2)      MAXIMUM VALUE OF X ON GENERATED FIT CURVE
C*****
C                  IF FC(2) LESS THAN OR EQUAL TO FC(1) THEN XMIN
C                  IS MIN(X) AND XMAX IS MAX(X)
C
C*****  PARAMETER NF SETS MAXIMUM DIMENSION FOR INPUT POINTS
C
C      PARAMETER (NF=500,NO=3)
C
C      DIMENSION KON(30),FC(2),X(NF),Y(NF),XP(200),YP(200),C(NO),EC(NO) 4/23/69
C      1,COV(NO,NO)
C      DIMENSION IFITLAB(4)          $$$ NM
C      COMMON/ISYM/SYM(NF)
C      COMMON/LABELS/TITLE(10),XTI(5),YTI(5)/YYY/YC(NF)/WWW/WT(NF)
C      COMMON/STATS/IWT,ICALC,ILG1,ICOV,DET,SIGMA,ERMS
C      COMMON/MATDAT/A(NF,NO),BQ(NF,NO),YB(NF),RQ(NF),WQ(NO),VQ(NO)
C      EQUIVALENCE (A,COV), (BQ,YP), (YB,EC)
C      EXTERNAL FIT1,FIT2,FIT3,FIT4,FIT5,FIT6,FIT7,FIT8,FIT9,FIT10
C      DATA (LA=8), (LB=10), (LC=5), (TITLE=20(0H)), (LU=13), (BLANK=0H) 4/23/69
C      DATA (IFITLAB(J),J=1,4)/10HXLIN YLIN ,10HXLIN YLOG ,10HXLOG YLIN ,
C      10HXLOG YLOG /
C
C
C      ICALC = 1      $ CALL CLOCK(T1,T2)      $ ICOV = -1

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LXY = KON(1) $ MINCO = KON(2) $ MAXCO = KON(3)
IWT = KON(5) $ ILG = KON(6) $ IBAND = KON(8)
ILG1=0 $ $C NM
IF (ILG.EQ.2.OR.ILG.EQ.4) ILG1=1 $ $C NM
IF ITY=ILG $ $C NM
IF (IFITY.LT.1) IFITY=1 $ $C NM
IF (KON(4)) , 48
KON(4) = 1 $ KON(9) = 1
48 NFIT = KON(4)
C
C***** INITIALIZE WEIGHTS
C
IF (IWT) 62, .55
DO 50 J=1,LXY
50 WT(J) = 1. $ GO TO 65
55 DD = -1.E50 $ CC = -DD
DO 60 J=1,LXY
CC = MINIF(Y(J)+WT(J),Y(J)-WT(J),CC)
DD = MAXIF(Y(J)+WT(J),Y(J)-WT(J),DD)
60 WT(J) = 1./WT(J)
GO TO 68
62 DO 64 J=1,LXY
64 WT(J) = SQRTF(WT(J))
65 CALL AMINMX(Y,1,LXY,1,CC,DD)
68 IF (KON(7)) , 70
KON(7) = 1 $ KON(19) = 5
70 NCRT = KON(7)
IF (KON(8)) 75,75,
ICOV = 1
75 IF (FC(2)-FC(1)-1.E-50) 80,80,
XMAX = FC(2) $ XMIN = FC(1) $ GO TO 85
80 CALL AMINMX(X,1,LXY,1,XMIN,XMAX)
85 DP = (XMAX-XMIN)/200.
XP(1) = XMIN
DO 100 I=2,199
100 XP(I) = XP(I-1)+DP
XP(200) = XMAX
XMAX = MAXIF(XMAX*1.01,XMAX/1.01)
XMIN = MINIF(XMIN*1.01,XMIN/1.01)
C
C***** MAIN LOOP - NUMBER OF COEFFICIENTS VARIED FROM MINCO TO MAXCO
C
DO 300 LS=1,NFIT
IFIT = KON(LS+8)
IF (IFIT.LT.1.OR. IFIT.GT.10) 330,
DO 300 L=MINCO,MAXCO
IF (SENSE SWITCH 1) 777,
IF (ILG.EQ.1) GO TO 95
IF (ILG.EQ.2) GO TO SKX1
DO X90 J=1,LXY
IF (X(J)) 320,320,
X90 X(J)=LOGF(X(J))
SKX1 IF (ILG.EQ.3) GO TO 95
DO Y90 J=1,LXY
IF (Y(J)) 320,320,
Y90 Y(J)=LOGF(Y(J))
C
C***** SELECTION OF THE FORM OF THE FIT FUNCTION
C
95 GO TO (FF1,FF2,FF3,FF4,FF5,FF6,FF7,FF8,FF9,FF10), IFIT

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FF1 CALL COLIN(X,Y,LXY,C,L,FIT1) $ GO TO 115
FF2 CALL COLIN(X,Y,LXY,C,L,FIT2) $ GO TO 115
FF3 CALL COLIN(X,Y,LXY,C,L,FIT3) $ GO TO 115
FF4 CALL COLIN(X,Y,LXY,C,L,FIT4) $ GO TO 115
FF5 CALL COLIN(X,Y,LXY,C,L,FIT5) $ GO TO 115
FF6 CALL COLIN(X,Y,LXY,C,L,FIT6) $ GO TO 115
FF7 CALL COLIN(X,Y,LXY,C,L,FIT7) $ GO TO 115
FF8 CALL COLIN(X,Y,LXY,C,L,FIT8) $ GO TO 115
FF9 CALL COLIN(X,Y,LXY,C,L,FIT9) $ GO TO 115
FF10 CALL COLIN(X,Y,LXY,C,L,FIT10)
115 IF(ILG.EQ.1) GO TO 118
    IF(ILG.EQ.2) GO TO SKX2
    DO X116 J=1,LXY
X116 X(J)=EXP(X(J))
SKX2 IF(ILG.EQ.3) GO TO 118
    DO Y116 J=1,LXY
Y116 Y(J)=EXP(Y(J))
118 IF(ILG.EQ.1.OR.ILG.EQ.2) GO TO A118
    DO B118 J=1,200
B118 XP(J)=LOGF(XP(J))
A118 CALL YGFX(XP,YP,200)
    IF(ILG.EQ.1.OR.ILG.EQ.2) GO TO A119
    DO B119 J=1,200
B119 XP(J)=EXP(XP(J))
A119 CONTINUE
    DO I19 J=1,L
I19 EC(J) = SIGMA*SQRTE(ABSF(COV(J,J)))
C
C***** LIST RESULTS
C
    KT = 100
    CALL SETCH(1.,.64.,0,0,0,0)
    DO LIST, MP=1,2
    WRITE OUTPUT TAPE KT,20,LU,LA,(TITLE(J),J=1,LB),BLANK,T1,T2
    WRITE OUTPUT TAPE KT,24,IFITLAB(IFITY),IFIT
125 WRITE OUTPUT TAPE KT,32
    WRITE OUTPUT TAPE KT,34,((J,C(J),EC(J)),J=1,L)
    WRITE OUTPUT TAPE KT,40,SIGMA,ERMS,DET
    WRITE OUTPUT TAPE KT,36,LB,LA,(XTI(J),J=1,LC),(YTI(J),J=1,LC)
    WRITE OUTPUT TAPE KT,38,(X(J),Y(J),WT(J),YC(J),J=1,LXY)
    KT = 3
LIST CONTINUE
    CALL AMINMX(YP,1,200,1,AA,BB)
    YMAX = MAXIF(BB,DD) $ YMAX = MAXIF(YMAX*1.01,YMAX/1.01)
    YMIN = MINIF(AA,CC) $ YMIN = MINIF(YMIN*1.01,YMIN/1.01)
C
C***** PLOT RESULTS
C
    DO 300 MP=1,NCRT
    CALL FRAME
    KPL = KON(MP+18)
    CALL MAPX(KPL,XMIN,XMAX,YMIN,YMAX)
    CALL SETPCH(1,0,1,0,2)
    DO 121 J=1,LXY
    CALL POINTC(SYM(J),X(J),Y(J),1)
121 CONTINUE
    CALL TRACE(XP,YP,200)
    CALL SETCH(15.,.2,1,1,0,1,0)
    WRITE OUTPUT TAPE 100,10,LC,LA,(XTI(J),J=1,LC)
    CALL SETCH(1.,.20.,1,0,1,1)

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WRITE OUTPUT TAPE 100,10,LC,LA,(YTI(J),J=1,LC)
XLB = 50.
YLB = 63.5
DO 120 K=1,L
CALL SETCH(XLB,YLB,1,0,0,0)
WRITE OUTPUT TAPE 100,45,K,C(K)
120 YLB = YLB-1.
    YLB = YLB-.5
    CALL SETCH(XLB,YLB,1,0,0,0)
    WRITE OUTPUT TAPE 100,46,SIGMA
    CALL SETCH(110.,4.,0,0,0,0)      $SC NM
    WRITE OUTPUT TAPE 100,24,IFITLAB(IFITY),IFIT
140 CALL SETCH(24.,1.,0,0,0,0)
    WRITE OUTPUT TAPE 100,10,LU,LA,(TITLE(J),J=1,LB),BLANK,T1,T2
    IF (IBAND) 280,280,
    DO 250 J=1,200,2
    CALL EDEV(XP(J),SY,1)
    AA = YP(J)+SY
    CALL POINT(XP(J),AA,0)
    AA = YP(J)-SY
    CALL POINT(XP(J),AA,0)
250 CONTINUE
280 IF (IWT) 300,300,
    IF (IWT) 300,300,
    DO 290 J=1,LXY
    YLB = 1./WT(J)      $ AA = Y(J)+YLB $ BB = Y(J)-YLB
    CALL SETLCH(X(J),AA,1,0,2,0)
    CALL CRTBCD(1H-)
    CALL SETLCH(X(J),BB,1,0,2,0)
    CALL CRTBCD(1H-)
290 CALL LINE(X(J),AA,X(J),BB)
300 CONTINUE
C
C***** END OF MAIN LOOP - RETURN
C
1 RETURN
888 CALL EXIT
C
320 WRITE OUTPUT TAPE 3,47
GO TO 1
330 WRITE OUTPUT TAPE 3,49,IFIT
PRINT 49,IFIT
CALL DUMP
777 WRITE OUTPUT TAPE 3,707
PRINT 707
GO TO 888
C
10 FORMAT(*A*)
20 FORMAT(1H1,*A*,///)
24 FORMAT(A10,4H FIT,13)
32 FORMAT(28X,12HCOEFFICIENTS,18X,17HESTIMATED STD DEV //)
34 FORMAT(10X,2HC(.12,1H),10X,E18.10,14X,E18.10)
36 FORMAT(//10X,20HINDEPENDENT VARIABLE,21X,18HDEPENDENT VARIABLE,19X
1 7HWIGHTS,10X,12HCALCULATED Y,/,*A*,//)
38 FORMAT(11X,E18.10,22X,E18.10,11X,2E20.10)
40 FORMAT(//21H EST STD DEV IN FIT = E18.10, 8X,15HRAW RMS ERROR = ,
1 E18.10, 8X,13HDETERMINANT = E18.10 //)
45 FORMAT(2HC(.12,4H) = ,E17.10)
46 FORMAT(8HSIGMA = ,E17.10)
47 FORMAT(// 77H LINEARIZED EXPONENTIAL FIT ATTEMPTED WITH NEGATIVE 0

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      !R ZERO VALUES IN ARRAY      )
49  FORMAT(// 2BH -MAFIT- INPUT ERROR  IFIT = I3,40H MUST BE GREATER T
      IHAN 0 AND LESS THAN 11 )
707 FORMAT(//3BH PROBLEM TERMINATED BY SENSE SWITCH 1 )
      END

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C      FORTRAN          COLIN      LINEAR LEAST SQUARES ROUTINE
SUBROUTINE COLINX,Y,LL,CO,NN,FUNFORM)
C
C      MULTIPLEARGS YOFX, EDEV
C
C      SOLUTION OF THE LEAST SQUARES PROBLEM FOR FUNCTIONS WITH
C      LINEAR COEFFICIENTS
C      T.C.VARLUEN 12/1/66
C      MODIFIED BY F.N.FRITSCH: 11/4/69
C
C      X,Y      = SET OF INPUT DATA PAIRS (POINTS TO BE FITTED)
C      LL      = NUMBER OF INPUT X-Y PAIRS
C      CO      = OUTPUT VALUES OF THE COEFFICIENTS
C      NN      = NUMBER OF COEFFICIENTS IN THIS FIT
C      IWT     = 0 OR UNDEFINED, RESIDUALS WILL BE WEIGHTED BY UNITY
C      = 1 RESIDUALS WILL BE WEIGHTED BY INPUT ARRAY WT
C      ICALC   = 0 OR UNDEFINED, YC ARRAY WILL NOT BE CALCULATED
C      = 1 YC = F(X) WILL BE CALCULATED
C      ILG     = 0 STANDARD LINEAR FIT
C      = -1 MAIN DIAGONAL COVARIANCES ONLY WILL BE FOUND
C      = 1 LINEARIZED EXPONENTIAL FIT
C      ICOV    = 0 COVARIANCES WILL NOT BE COMPUTED
C      = 1 ENTIRE N X N COVARIANCE MATRIX WILL BE FOUND
C      DET     = OUTPUT DETERMINANT OF LEAST SQUARES MATRIX
C      SIGMA   = OUTPUT EST STD DEV IN THE FIT
C      ERMS    = OUTPUT RAW RMS ERROR IN THE FIT
C
C      C****    PARAMETER NO SETS MAXIMUM DIMENSION FOR COEFFICIENTS
C      C****    PARAMETER NF SETS MAXIMUM DIMENSION FOR INPUT POINTS
C      PARAMETER (NF=500,NO=3)
C
C      COMMON/STATS/IWT,ICALC,ILG,ICOV,DET,SIGMA,ERMS
C      COMMON/YYY/YC(2)/WWW/WT(2)
C      COMMON/MATDAT/A(NF,NO),BQ(NF,NO),YB(NF),RQ(NF),WQ(NO),VQ(NO)
C      DIMENSION X(2),Y(2),CO(2),FN(NO),COV(NO,NO)
C      EQUIVALENCE (A,COV), (VQ,FN)
C      DATA(IWT=0),(ICALC=0),(ILG=0),(ICOV = 0)
C      LXY = LL $ NCO = NN
C      IF (LXY-2) 200, .
C      IF (LXY-NCO) 220, .
C      IF (NCO.GE.2.AND.NCO.LE.NO) . 230
C
C      C***    SET UP THE LEAST SQUARES MATRIX
C
C      DO 50 J=1,LXY
C      CALL FUNFORM(NCO,X(J),FN)
C      WW = 1.
C      IF (IWT) .30,
C      WW = WT(J)
C      30 YB(J) = Y(J)*WW
C      DO 50 K=1,NCO
C      50 A(J,K) = FN(K)*WW
C
C      C***    FIND SOLUTION VECTOR
C
C      CALL MLR(NF,LXY,NCO,A,YB,C),BQ,RQ,WQ,VQ)
C
C      C***    CALCULATE DETERMINANT OF NORMAL MATRIX

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```

C      DET = 1.
      DO 62 J=1,NCO
62      DET = -DET*WQ(J)
C
C
C***  CALCULATE FIT STATISTICS
C
      IF (ICOV) .70,60
      CALL MLRE(FN)
      DO 55 I=1,NCO
55      COV(I,I) = FN(I)
      GO TO 70
C
C      FORM T-INVERSE
C
60      DO 620 I=1,NCO-1
          COV(I,I) = -1.0/WQ(I)
          DO 620 J=I+1,NCO
              S = 0.
              DO 610 K=I,J-1
610          S = S+COV(I,K)*BQ(K,J)
620          COV(I,J) = S/WQ(J)
          COV(NCO,NCO) = -1.0/WQ(NCO)
C
C      TAKE PRODUCT OF T-INVERSE BY T-INVERSE-TRANPOSE
C
      DO 640 I=1,NCO
          DO 640 J=1,NCO
              S = 0.
              DO 630 K=J,NCO
                  S = S+COV(I,K)*COV(J,K)
630          COV(J,I) = COV(I,J) = S
640          SIGMA = ERMS = 0.
          DO 80 J=1,LXY
              WW = 1.
              IF (IWT) .75,
              WW = WT(J)
75          CALL FUNFORM(NCO,X(J),FN)
              RES = 0.
              DO 76 I=1,NCO
                  RES = RES+CO(I)*FN(I)
              IF (ILG) . , 78
              RES = Y(J)-RES $ GO TO 79
78          RES = EXPF(Y(J))-EXPF(RES)
79          ERMS = ERMS+RES*RES
80          SIGMA = SIGMA+WW*RES*RES
          SIGMA = SQRTF(SIGMA/(MAXOF(.,Y-NCO,1))) $ ERMS = SQRTF(ERMS/LXY)
C
C***  FIND YC = F(X)
C
      IF (ICALC) ,100,
      DO 90 J=1,LXY
          CALL FUNFORM(NCO,X(J),FN)
          YC(J) = 0.
          DO 90 I=1,NCO
90          YC(J) = YC(J)+CO(I)*FN(I)
          IF (ILG) 100,100,
          DO 95 J=1,LXY
95          YC(J) = EXPF(YC(J))

```

```

100 RETURN COLIN
C
C*** THIS ENTRY POINT PERMITS EVALUATION OF Y=F(X) FOR ANY INPUT X
C
ENTRY YOFX(X,Y,LL,CO,NN,FUNFORM)
C
LXY = LL $ NCO = NN
DO 400 I=1,LXY
CALL FUNFORM(NCO,X(I),FN)
Y(I) = 0.
DO 400 J=1,NCO
400 Y(I) = Y(I)+CO(J)*FN(J)
IF (ILG) 430,430,
DO 420 I=1,LXY
420 Y(I) = EXPF(Y(I))
430 RETURN YOFX
C
C*** THIS ENTRY POINT PERMITS ESTIMATION OF THE STANDARD
C*** DEVIATION OF POINTS ON THE FITTED CURVE
C
ENTRY EDEV(X,Y,LL,CO,NN,FUNFORM)
C
LXY = LL $ NCO = NN
DO 360 I=1,LXY
AR = 0.
CALL FUNFORM(NCO,X(I),FN)
DO 350 J=1,NCO
DO 350 K=1,NCO
350 AR = AR+FN(J)*FN(K)*COV(J,K)
Y(I) = AR
360 Y(I) = SIGMA*SQRTF(ABS(Y(I)))
RETURN EDEV
C
C*** INPLT ERROR DIAGNOSTICS SECTION
C
200 WRITE OUTPUT TAPE 3,205,LXY
PRINT 205,LXY
CALL DUMP
220 WRITE OUTPUT TAPE 3,225,NCO,LXY
PRINT 225,NCO,LXY
CALL DUMP
230 WRITE OUTPUT TAPE 3,235,NCO,N0
PRINT 235,NCO,N0
CALL DUMP
205 FORMAT(// 18H ERROR IN -COLIN- // 6H LXY =,16,23H MUST BE GREATER
1 THAN 1 )
225 FORMAT(// 18H ERROR IN -COLIN- //6H LXY = 16,14H EXCEEDS NCO = 14)
235 FORMAT(// 18H ERROR IN -COLIN- //6H NCO =,14,31H IS LESS THAN 2 OR
1 GREATER THAN , 14)
END

```



```

C      FORTRAN          FIT(1)      SUM C(N)*X**(N-1)
      SUBROUTINE FIT1(NC,X,FNC)
C
      DIMENSION FNC(2)
      FNC(1) = 1.
      DO 20 J=2,NC
20    FNC(J) = X**(J-1)
      RETURN
      END

*      FORTRAN          FIT(2)      SUM C(N)/X**(N-1)
      SUBROUTINE FIT2(NC,X,FNC)
C
      DIMENSION FNC(2)
      FNC(1) = 1.
      DO 20 J=2,NC
20    FNC(J) = X**(1-J)
      RETURN
      END

*      FORTRAN          FIT(3)      POLYNOMIAL (+/- INTEGRAL POWERS)
      SUBROUTINE FIT3(NC,X,FNC)
C
      DIMENSION FNC(2)
      FNC(1) = 1.0 $ ISIGN = 1 $ K = 0
      DO 20 J=2,NC
      IF (ISIGN) 10,10.
      K = K+1
10    FNC(J) = X**(ISIGN*K)
20    ISIGN = -ISIGN
      RETURN
      END

*      FORTRAN          FIT4
      SUBROUTINE FIT4(NC,X,FNC)
C
      DIMENSION FNC(2)
      DO 20 J=1,NC
20    FNC(J) = EXPF(X*J)
      RETURN
      END

*      FORTRAN          FIT5      SUM C(N)*EXPF(-N*X)
      SUBROUTINE FIT5(NC,X,FNC)
C
      DIMENSION FNC(2)
      DO 20 J=1,NC
20    FNC(J) = EXPF(-X*J)
      RETURN
      END

```

* FORTRAN FIT(6) FOURIER SINE SERIES
 SUBROUTINE FIT6(NC,X,FNC)

C
 DIMENSION FNC(2)
 DO 20 J=1,NC
 20 FNC(J)=SINF(X*J)
 RETURN
 END

* FORTRAN FIT(7) FOURIER COSINE SERIES
 SUBROUTINE FIT7(NC,X,FNC)

C
 DIMENSION FNC(2)
 DO 20 J=1,NC
 20 FNC(J)=COSF(X*(J-1))
 RETURN
 END

* FORTRAN FIT(8) FOURIER SERIES
 SUBROUTINE FIT8(NC,X,FNC)

C
 DIMENSION FNC(2)
 FNC(1)=1.
 IF(NC.EQ.2) GO TO 12
 L=(NC-1)/2
 DO 10 I=1,L
 J=2*I \$ Y=I*X
 FNC(J)=SINF(Y)
 10 FNC(J+1)=COSF(Y)
 IF(NC.REM.2) . . 11
 I=NC/2
 FNC(NC)=SINF(I*X)
 GO TO 11
 12 FNC(2)=SINF(X)
 11 RETURN
 END

* FORTRAN FIT(9) SUM C(N)*SINH((N-1)*X)
 SUBROUTINE FIT9(NC,X,FNC)

C
 DIMENSION FNC(2)
 DO 20 J=1,NC
 20 FNC(J)=SINH(X*J)
 RETURN
 END

* FORTRAN FIT(10) SUM C(N)*COSH(N*X)
 SUBROUTINE FIT10(NC,X,FNC)

C
 DIMENSION FNC(2)
 DO 20 J=1,NC
 20 FNC(J)=COSH(X*(J-1))
 RETURN
 END